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# Cognitive Characteristics of Students in Middle Schools in State of Kuwait, with Emphasis on High Achievement

By

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A thesis submitted for the degree of Doctor of Philosophy (Ph.D.)
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بسم الله الرحمن الرحيم

﴿قالوا سُبْحَانَكَ لاَعِلْمَ لَنَا إِلاَّ مَا عَلَّمْتَنَا إِنَّكَ أَنتَ الْعَلِيمُ الْحَكِيمُ﴾ البقرة 32

*They said: Glory be to Thee! We have no knowledge but that which thou has taught us; surely thou art the knowing, the wise.*

﴿إِنَّ الَّذِينَ آمَنُوا وَالَّذِينَ هَادُوا وَالنَّصَارَى وَالصَّابِئِينَ مَنْ آمَنَ بِاللَّهِ وَالْيَوْمِ الآخِرِ وَعَمِلَ صَالِحاً فَلَهُمْ أَجْرُهُمْ عِندَ رَبِّهِمْ
وَلاَ خَوْفٌ عَلَيْهِمْ وَلاَ هُمْ يَحْزَنُونَ﴾ البقرة 63

*Surely those who believe, and those who are Jews, and the Christians , and the Sabians, whoever believes in Allah and the last day and does good, they shall have their reward from their lord , and there is no fear for them , nor shall they grieve.*

In memory of the Late his Highness Emir State of Kuwait

Sheikh Jaber Al-Ahmad Al-Jaber Al-Sabah

To my mother

For her suffering for all her children after my father died, and who has always been behind every success of my life.

To my father

Who left life too early, before I could learn the meaning of learning from him.

## Abstract

Kuwait has a history over a number of decades of identifying the most academically able school students and, in recent years, this has to the establishment of an enrichment programme for those students described as 'gifted'. The process of selection is basically according to academic achievement and the enrichment provision aims to give them special activities for high thinking skills through a specially designed syllabus.

This study seeks to explore the cognitive characteristics of such high achievement students in middle school (ages 13-15) as well as a wider range of students, the work being carried out in the State of Kuwait. This study aims to establish a new understanding of some of characteristics of those seen as gifted students as well as to consider some aspects of the ways selection is conducted and needs are met.

The study discusses the nature of giftedness and how it might be defined, moving on to look at ways by which selection can be considered. Various cognitive characteristics are considered and what is known from previous research is discussed. Much of this is set in terms of an established model of information processing.

In Kuwait, gifted students are selected for enrichment according to total marks in six compulsory subjects and various IQ tests are then used but, in general, schools use the total marks in the six compulsory subjects as the basis for deciding those who are 'gifted'. There are questions about the adequacy of such procedures and this study seeks to offer some insights on giftedness, perhaps this being able to lead to finding new ways to understand the gifted student.

The current study was conducted on a total sample of 2169 students, from middle schools in State of Kuwait. Several cognitive characteristics and school performance variables are interrelated, the aim being to see how these characteristics relate to very high performance.

The research study for this thesis was carried out in three experiments. In the first experiment, the relationship between cognitive characteristics (working memory capacity, field dependency, divergency, and visual-spatial characteristics) and performance in six subjects are explored with a large sample containing a high proportion of very able students aged about 13.

It was found that those who were very able (in terms of examination performance) tended to be divergent, strongly visual-spatial, field independent and of high working memory. It was also found that assessment in the six school subjects measured the same ability, and this is likely to be recall.

The second experiment investigated the relationship between cognitive characteristics and self awareness, along with school performance with two samples: the first one selected students from the first experiment who scored highly in most of the cognitive characteristics (124 from grade 8); the second group was 299 students in grade 7 from the same 15 Kuwaiti middle schools who participated in experiment one.

The aim of this experiment was to see whether the students were self aware on these cognitive characteristics and to see how their responses related to the test on these cognitive characteristics, particularly with the gifted students. The results indicated that students of this age are either unable or unwilling to report clearly on these cognitive characteristics and it was possible that this simply reflects that they see themselves as they would like to be seen rather than as they actually are. It was also suggested that it is not possible to measure visual-spatial abilities using a self-report approach.

In the third experiment, samples in this experiment were drawn from grade 7, grade 8 and grade 9, the aim of this experiment being to examine the relationship between cognitive characteristics (divergency, convergency; and visual-spatial abilities), using freshly designed tests for visual-spatial abilities and convergency.

The most important result in this experiment was that the highest marks in school examinations in Kuwait at this age are related to visual-spatial thinking, extent of divergency *and* extent of convergency. This casts serious doubt on the idea that convergency and divergency are opposites. Self-reports tried to allow the students to describe how they preferred to work but, again, these did not give clear results.

Although gender was not a major issue in this study, it was found that girls outperformed boys in almost every measurement made (except working memory capacity which is gender-neutral). This places boys at a disadvantage at this age. Of greater importance was the observation that the relationship of certain cognitive characteristics with examination performance was more marked for boys and it is suggested that this reflects the relative unwillingness of boys in Kuwait at this age to rely so heavily on recall skills.

The overall findings are interpreted in terms of the way learners process information. It should be pointed out that all these conclusions derived from this study must be treated tentatively due to the limitations of this research as it is set in one culture in one education system. Nonetheless, the study has highlighted many key issues relating to the way educational provision can be made to meet the needs of the most able and a few suggestions for further work have been made.

# Acknowledgements

*In the Name of Allah, the Beneficent, the Merciful*

Praise to Allah whose Hand was always over mine in the achievement of this humble study. Praise to Allah for His countless blessings ever since I started my long journey to continue my learning and for all the support I managed to get from my beloved Kuwait.

First of all, I would like to express my sincere appreciation to my supervisor, Professor Norman Reid, for being the main inspiration behind the structure and the intellectual content of this thesis. Without his advice, guidance, suggestions, encouragement and "*anti-panic injection*" throughout my entire doctoral years, this study could not have been completed.

I would like to express my gratitude to Professor Rex Whitehead: "*the human encyclopaedia*". It was extremely interesting to learn with him the Java. Sharing his deep thoughts in various topics was much fun and joy. I appreciate his encouragements and volunteering to read my thesis at the final stage with his useful advice always coloured by his sense of humour.

I wish to express my thanks to my colleagues in the centre for sciences education, since I joined the centre, especially my dear friends Mona El-Sawaf and Dalal Alenezi .

I wish to express my thanks to all the schools I worked with and to all the staff and students who willingly participated in this study.

I appreciate the assistance from the engineers in the information centre in the Ministry of Education as they cooperated with me in the provision of the required data and preparation of the computer laboratories.

I will never forget to express my deep thanks to all my family members and all my friends in Kuwait for their support, encouragement and their prayers for me during these years abroad.

Of all, the one that deserves all the gratitude and honour is my beloved mother. I am so indebted to her support, care and constant worry about me. This whole effort is nothing compared to a precious tear drop from your blessed eyes when you faced a difficulty to register me in a school after my father's recent passing away.

Finally, it is my pleasure to feel that this is the last (but not the least) stop for my dedicated journey of learning in Scotland where my first little brown school bag.

*Huda Al-Hindal*

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# High Achievement in Kuwait

## 1.1 Introduction

Humans have an enormous capacity for learning but the whole process of learning is highly complex and may involve spoken or written language, the use of symbols and other mental representations along with the uses of imagination, images and creativity. In addition, learning involves attitudes, emotions and feelings as well as the use of movement and practical skills (Johnson, 1996).

The aim of education must be to enable *all* learners to develop their full capacities in as many areas of life as possible. In the past, this involved the transfer of knowledge and its translation into use for action in society. This is still a dominant emphasis today. There is a much larger range of thinking skills which need to be developed along with opportunities to encourage greater creativity, insight and critical thought.

School students spend five to six hours at school each day for nearly three-quarters of each year, often over a period of ten years or more. This is an enormous investment of time and energy into formal education and there is a great need to ensure the time is spent to the greatest advantage for all students.

In the formal school situation, students all perform in widely varying ways. Some students learn faster than others, some students develop academic skills at a younger age, some students have enhanced skills of memory, creativity, analytical thought as well as performing exceptionally well in all kinds of practical skills including the creative arts and sport. There is a real problem in meeting the needs of such diverse ranges of abilities. In many countries, steps have been taken to identify those seen as having exceptional abilities and then providing them with extra learning opportunities. Such students have some times been described as gifted. Freeman (1997) has reported that labelled children can be pressurised by parents and teachers to be successful in examinations and this illustrates one problem of labelling.

This study focuses on the State of Kuwait where the identification of those seen as gifted takes place and there is provision for enrichment. It seeks to explore some of the learner characteristics and to see how these relate to the concept of giftedness as used in Kuwait. It seeks to offer insights into high achievement and how this might relate to learner characteristics.

## 1.2 Giftedness

There are many students who need, and perhaps deserve, special help: for example, slower learners, students with physical or psychological disabilities, and students with language and cultural differences. In the light of this, it might be argued that those who are gifted (in some way) students deserve some kind of special education and that this is a matter of 'equity and excellence' (Davis and Rimm, 1998).

If this argument has validity, then it will be important to identify the gifted students and give them some kind of special education to develop them emotionally, socially and academically. Much of the school curriculum is designed for the average student and the highly gifted students may not find in the school things that are challenging them to reach their potential. In Kuwait, this has been found to be one factor behind a lot of behaviour problems (Hindal, 1997).

In some societies, those with exceptional ability and who demonstrate high achievement are labelled as gifted and given extra learning experiences because it is thought that such students bring to society great benefits which can help others. Such a view often underpins the desire to identify and support those seen as capable of high achievement.

However, there are many problems in considering just high achievement at school level. There is a real danger in making assessments of student performance and then labelling certain students as gifted. Students considered gifted as a result of high achievement at one point in time may not perform as well at other times and another circumstances.

Indeed, higher performance may be limited to certain curriculum areas, to certain skills or to certain circumstances. Nonetheless, there may well be students who demonstrate high achievement in a wide range of skills and tasks under very diverse circumstances. The fundamental problem is how to define giftedness and how to relate this to high achievement.

This study offers an overview of the concept of giftedness. It seeks to describe ways to define giftedness. Because this study is mainly conducted in Kuwait, it might be useful for the reader, in order to understand better the design of the study and students' responses, to have some information about how the Kuwait education system functions and this is offered.

## 1.3 Kuwaiti Education

In the Kuwait education system, there are 8 years of compulsory education since 2004: four years elementary education (age 6-10), and four years middle education (11-14). After that, there are four years of secondary education (age 15-18). In 2005, the education system was changed to be five years elementary education (age 6-11), and four years middle education (age 11-15) to raise the compulsory years to nine years of education. After that, there are three years of secondary education (16-18). The level grades run from 1 to 12. This study investigated a sample of students in grade 7 and followed them until grade 9.

Dixon (1983) argues that the adolescent years are the most important time for developing self-concepts and identity. For this reason, this study has focused on students in the middle school years rather than later stages.

## 1.4 The Aims of the Research

In Kuwait, the trend of selecting those seen as gifted has developed over several decades. Today, the main emphasis is on those students who have demonstrated high achievement in school examinations, followed by testing using various measures of IQ. This study starts by looking at these formal examinations and relating performance in them to working memory capacity. In the next stage, there is a consideration of a number of learning characteristics to see how these relate to examination performance.

The overall aim is to explore how these various characteristics relate to high achievement and thus to being labelled as gifted in Kuwait. It is possible that those who achieve very highly do so because of some combination of learner characteristics. This will be explored. While the study focuses on the situation which occurs in Kuwait, the aim is to look for broader underlying principles which can be related to high achievement in academic studies in general. The hope is that the study will throw some light on learning in general and what makes it particularly successful.

While the emphasis is on high achievement and those described as 'gifted' in Kuwait, the aim of all education is to enable all students to reach their full potential. Are there specific learner characteristics which are of advantage and is it possible for a school system to enhance such characteristics in students?

In the light of this, the main lines of enquiry in this study can be summarised as:

(1) What are some of the key cognitive characteristics which relate to high achievement?
(2) Are students (especially those with high achievement) aware of these cognitive characteristics?
(3) Is their any relationship between some preferred cognitive characteristics and high achievement?
(4) Is it possible to interpret characteristics related to high achievement to a model describing the way humans process information?

## 1.5 The Structure of the Thesis

After a review of the literature related to giftedness, this study looks at some cognitive characteristics which were thought to be of particular importance in relation to high achievement. Information processing offers helpful insights into the processes of learning and these models are summarised critically.

In the first part of the experimental work, school achievement is related to working memory capacity. This is then followed by attempts to measure various cognitive characteristics and to relate these to academic achievement. There has been much emphasis in recent years on the differences in learner characteristics (e.g. Riding, 2002; Douglas and Riding, 1995, Riding *et al*, 2003). Some of these characteristics will be summarized and the evidence from the literature considered critically. It is possible that some of these characteristics will be important in relation to those who demonstrate high achievement in schools subjects and have thus been labelled as 'gifted'. This will be explored in this study. Various alternative approaches in considering such cognitive characteristics are explored and the need for new test material is demonstrated. Several new tests are developed and described, and then applied to large numbers of school students to see what insights they offer.

Working memory capacity and extent of field dependency have both been shown to relate to performance in many subject areas taught at school and university levels (see, for example, Al-Naeme and Johnstone, 1991; Danili and Reid, 2004). In every case, having a higher working memory capacity and being field independent are advantages in terms of high achievement, this being particularly important in the mathematics-science areas of study. In recent work, being divergent has been shown to be advantageous (see Al-Qasmi, 2006) while there are arguments that to possess visual-spatial abilities characteristic is of great value in school learning (Golon, 2004). These characteristics will all be discussed in this study and measurements will be made to explore the extent to which these relate to performance. The question is whether such characteristics are important among students who are considered to be gifted in the Kuwaiti education system.

The study concludes by drawing together the evidence obtained and seeking to point to a better way forward in meeting the needs of those who are capable of high academic achievement. Such students, in Kuwait, under present arrangements, would be offered enrichment experiences and would be described as 'gifted'.

Broader questions relating to the way individual needs can be met are addressed and it is hoped that the study will offer many countries an agenda for action and for further research. One of the major issues facing all countries is how to meet the needs of all students at school level. It is possible to argue for a system of inclusion where all learners are kept together at all times. It is also possible to consider experiences within the classroom which provide for accelerated learning for those considered most able. A third possibility is to consider various forms of special provision where those with particular needs are treated separately.

Another issue of major importance is the extent to which various cognitive characteristics are genetically fixed and the extent to which such characteristics can be enhanced by means of formal learning or more general life experiences. Of course, it is possible that different students might choose various approaches to learning which they find attractive or more successful. Thus, insights on these questions will offer educational planners a more sound basis by which learning experiences can be structured.

The needs of those who are capable of exceptional achievement and thus can be considered as gifted are as important as the needs of the rest of the school population. This study will focus particularly on such gifted students and their characteristics.

# Chapter Two

# Giftedness

*When our students are given the opportunity to let their light shine, they reveal a full prism of colours or abilities that may never be discovered if they are not allowed to use their full spectrum of intelligences* (Teele, 2000).

## 2.1 Introduction

In this world, people vary enormously. When faced with learning experiences, the variations in approaches, preferences, and success are enormous as well. Students, at all levels, face a fast-changing world. It is the mission of education to prepare individuals for that world. In such a process, the individual learners may well adapt their styles of learning in order to make the most satisfactory sense of what is offered to them. Of course, some are more successful, other less so. Those who are most successful (by some measure) are sometimes described as 'gifted'.

Concepts of giftedness abound in the literature and methods of identification have been in a continuous state of development for over a hundred years. These developments will be explored in the seven sections this chapter. First the background to the history of giftedness will be discussed, followed by the introduction of two important ideas: intelligence, and giftedness. There are both traditional and 'recent' definitions of giftedness, and the identification of the gifted depends on which definition is adopted.

## 2.2 Background to the History of Giftedness

It was assumed that gifted students were born with high intelligence, and were identifiable by their high grades and test scores, often at a very early age. For example, when Francis Galton (1822-1911) stated his views on 'the classification of man' (1869), he was arguing for evidence that men are not born equal in ability:

> *"There can hardly be surer evidence of the enormous difference between the intellectual capacity of man, than the prodigious differences in the numbers of marks obtained by those who gain mathematical honours at Cambridge" (Freeman, 1979:4).*

Galton defined superior intellectual ability by describing characteristics such as tremendous energy, good health, independence, vivid imagination, fluent mental association, and a strong purposeful drive. His efforts to measure intelligence, therefore, involved tests such as those of visual and auditory acuity, tactile sensitivity, and reaction time (Davis and Rimm, 1989). Later, in the 1920s, the father of gifted education, Lewis Terman, defined gifted people as:

> *"The top one percent level in general intelligence ability as measured by the Stanford-Binet intelligence scale or a comparable instrument" (Terman, 1919: 95).*

Having described giftedness in terms of the attributes measured by an intelligence test, Terman felt justified in measuring general intelligence (g) without formulating a theory about mental structure or process. He thought that all people have abilities in various degrees, except that the gifted excel in them and are, therefore, the most successful in measuring up to the demands of school and society. However, there are strong criticisms of Terman's research methods (Tannenbaum, 1983, 1986). In this, there is a need to adopt a certain approach in identifying the gifted and conduct a longitudinal study and also conduct a retrospective biographical study in order to gain evidence that intelligence is fixed or otherwise (Davis and Rimm, 1989).

There have been many approaches towards defining giftedness that followed Terman's study: for example, Spearman (1927) based his theorising about intelligence on factor analysis, a psychometric technique invented by him. The idea of factor analysis is to identify the latent abilities that underlie scores in a set of mental ability tests. He hypothesised that the general factor (g) might represent individual differences in mental energy. Spearman's view of intelligence is presented in tests such as a single IQ score based on the three mental processes: apprehension of experience, education of relations, and education of correlates. He stated his conclusion as follows:

> *"we arrive at the remarkable result that the common and essential element in the intelligences wholly coincide with the common and essential element in the sensory functions" (Fischer, 1996:134).*

Like Spearman, Piaget (1972) proposed the idea of *general intelligence*. However, he asserted that this intelligence progresses through a sequence of qualitatively distinct forms or stages: the sensorimotor stage from birth to two years old, the preoperational stage from two to seven years, the concrete-operational stage from seven to twelve years, and the formal operational stage from age twelve years to adulthood. He included a general characterization of the mechanisms that produce cognitive growth, and he viewed two intellectual functions as of great important: adaptation, which involves building mental structures through direct interaction with the environment; and organization, which involves the internal rearrangement and linking together of mental structures in such a way that these structures become part of a broad network of structures that can be applied to the external world (Chen and Siegler, 2000).

Many researchers (e.g. Sternberg, 1995; Gardner, 1983) today have started to consider giftedness in different ways when compared to those who were working at the beginning of the last century. Specifically, they have moved away from defining giftedness only in terms of IQ tests. Cognitive science, developmental psychology, and new understandings of how learning takes place have influenced the way giftedness is defined and conceptualized. It is clear that there are different ways of being gifted rather than a definitive list of gifted qualities. Definitions of giftedness added the qualification that giftedness should be perceived as a useful quality, something positive or morally acceptable (Kokot, 1993). The view was accepted that giftedness cannot only be viewed simply as a quantitative entity, as measured by a number, but that some special quality of the personality should play an equally important role. This is reflected, for example, in Tidwell's (1980) pleas for an understanding of giftedness as both a 'qualitative and quantitative expression of personal potential'. Tidwell placed the gifted child's movement within a humanistic psychology framework.

> *"Gifted means having the potential to be verbally creative, while talented means having the potential to be non-verbally creative"* (Walker, 2002:16).

Walker's (2002) definition is an attempt to define words in a clear way. As the word 'gifted' in normal usage carries a much wider range of meanings, the word 'talented' can be used of those who are not verbally creative. However, this definition assumes that not all gifted people are strong in an intelligence test scale. This uncoupling of the ideas of gifted and talented from a measure of an intelligence test is much preferred. A student who scores very high on the Stanford-Binet test is likely to be a student with excellent verbal and reasoning abilities. However, there is the underachieving student, who may be verbally gifted but who performs poorly in situations that do not call for excellent verbal expertise (Kerr, 1991). Those students demonstrate their ability through a wide range of behaviours, while a suitable environment plays an important role in exposing the students' abilities. This perspective was adopted in the new views of giftedness.

Additionally, the more recent views emphasise the individual as a totality within an environment, consider giftedness as a function of rapid development and the ability to reach higher levels of development, and attempt to define giftedness operationally (Kokot, 1993). Thus, giftedness might be conceptualised in terms of speed of development in cognitive or practical ways. Alternatively, giftedness might be seen as a behaviour which is outstanding when compared to a peer group. Furthermore, the definition of giftedness has been broadened and its usage now includes specifying characteristics of what it means to be gifted; some definitions consider the person's contributions to culture and society (Sousa, 2003).

Several different approaches to intelligence have been identified. Attempts have been made to gather these under various general categories. For example, Teele (2000) has suggested four groups or branches:

(1) The *psychometric approach*: acknowledges a single, unitary quantity concept of intelligence. It focuses primarily on two ways to learn: linguistic and logical-mathematical.

(2) *Developmental progression approach*: Piaget offered a developmentally based concept of intelligence and discussed how individuals develop progressively at different ages and continually shift between the assimilation of new information into their existing cognitive structure and the accommodation of those structures to new information.

(3) *The psychobiological approach*: a biological perspective to explore new ideas about what intelligence is and how to measure it. This approach strongly supports a multifaceted view of intelligence rather than a single-factor theory.

(4) *The multiple-forms of intelligence approach*: that individual's process information in multiple interactive and complex ways.

However, there are other ways to describe and categorise giftedness. For example, Kokot (1993) describes giftedness and puts descriptions of it into four broad groupings- she sees giftedness in terms of a totality in function, higher levels of development. Based on her views, giftedness can be defined as an inbuilt potential, latent or realised, far above average achievement, in one or more areas that have value for a specific culture. The potential can only be realised given the right opportunities in the home, school, society, and self throughout life.

The problem with the whole area is the range of words that are used and the lack of clarity of definitions. Gifted and intelligent are the most commonly used words but the word talented is also employed. The range of definitions and understandings is large but there are two general views (traditional views and more recent views) that have probably been the most influential in forming North American and British concepts of the nature of intelligence although it is recognised that these are not the only views that have been advanced. In Kuwait, for instance, the field of gifted education is still new and no particular approach has been adopted. Although there are several approaches in the literature, in this chapter the theme will be considered under two broad headings: traditional views and more recent views, which will be discussed later in this chapter.

## 2.3 Concepts of Intelligence and Giftedness

Intelligence and giftedness can assume different meanings. However, the terms are often used interchangeably. In this section these two concepts are discussed. Terman, in his early genetic studies, was influenced by the term 'genius' Thus, since the 1950s, a number of modern researchers and psychologists (Shea, *et al* 2001; Sousa, 2003) have started to describe the idea of giftedness mainly in terms of intelligence. High IQ was the same as gifted while creativity and motivation were added as other characteristics of gifted performers (Sousa, 2003)·

In addition, Shea *et al* (2001) has brought together the views of many authors by saying that gifted education has shifted the theory and practice from an emphasis primarily on general cognitive ability (general intelligence) to an appreciation of the unique information afforded by verbal and quantitative abilities.

Defining what intelligence is has always had been an area of difficulty. Binet and Simon (1905 cited in: Stanley, 1966), who published the first test to measure intelligence, never analysed the nature and meaning of intelligence but described its action in human behaviour. Binet considered attention and adaptation to be the two most important factors in intelligence and went on to say, "to judge well, understand well, reason well, these are essentials of intelligence" (Shouksmith, 1970) He also indicated that the notion of 'g' as a singular entity was mistaken because two individuals could obtain the same score using quite different knowledge and skills.

Hebb (1966) argued that, in much of the literature, the use of the term 'intelligence', to refer both to the 'original potential' and to the 'ultimate level of development' produced confusion in the discussion of important problems. He suggested that there would be less confusion between the two aspects of the concept of intelligence if two quite different meanings were recognised:

- Intelligence A: an *'innate potential'* for the development of intellectual capacities, beyond measure intellectual functioning.

- Intelligence B: the level of the development in the subject's intellectual functioning; it can be measured by the IQ.

In fact, those two aspects are not wholly separate; these illustrate two different aspects where the term 'intelligence' can be used.

Deary (1999) pointed out that the nature of intelligence also includes measures of information processing, such as reacting to a stimulus and inspecting the similarities or differences between two stimuli.

Very often, the concept of giftedness means a special ability to do something and being gifted is having a special ability in a particular subject or activity. Looking at the meaning of the word 'gifted', we find the root of this word 'gift' (which is mean something given) is defined as:

> *"Any ability possessed by a person to a high degree, frequently manifested by achievement without apparent effort" (Frasier, and Carland 1982: 45).*

In addition, Simonton (2005) shows the concepts of giftedness and talent as both intimately related to each other as well as to the concepts of innateness or natural endowment. Thus, to be gifted means to be 'endowed with great natural ability, intelligence, or talent: a gifted child; a gifted pianist'; similarly, a talent is 'a marked innate ability, as for artistic accomplishment' or 'natural endowment or ability of a superior quality' (Simonton, 2005).

In looking at the definitions of giftedness over years, the concept of intelligence is not all embracing; however, it is the crucial thread that runs throughout the concept of giftedness. Thus, to be gifted is not just to have a high IQ; however, definitions of giftedness based on IQ measurements are used frequently (Freeman, 1979). In addition, Renzulli (1998) drew some general conclusions from early research: there are many kinds of intelligence; it is a complicated concept that cannot be encompassed by a single definition. Besides, it is important to evade the usual practice of believing that knowing a person's IQ score is equivalent to knowing his or her intelligence.

Neisser (1979) suggested that intelligence includes many abilities; it is not a unitary quality and there are no definitive criteria of intelligence. Many of the researchers (e.g Terman, 1919; Spearman, 1927) who define 'giftedness' based on the concept 'intelligence' end up, subsequently, with an array of various terms. Thus, defining 'giftedness' is greatly dependent on the researcher's approach to defining words. Therefore, this suggests that it is important to initially define what a researcher means by 'giftedness' in any research study (see Freeman (1973) who notes that the use of the terminology has changed over the years). For instance, Amidon (1991) regarded as gifted those who achieve well and display creative potential. Most agree that they are also those who may hide (or never discover) their potential because of cultural disregard, disdain, or because of lack of self-esteem based on family or societal circumstances.

There is a problem facing the field of gifted and talented education in developing definitions of giftedness that can guide both programme implementation and curricular development. This study has adopted the view that there is no fundamental difference between the three concepts of intelligence, giftedness, and talent. In addition, Neisser stated that:

> *"The concept of intelligence cannot be explicitly defined, not only because of the nature of intelligence but also because of the nature of concepts"* (Neisser, 1979:179).

Most of the concepts discussed here focused mainly on the concept of intelligence. However, the issue is not simply a matter of which words are used: giftedness or intelligence. Regardless of which term is used, the key point is the idea of an ability (or abilities) manifested by a person which is outstanding in several different ways and these have to be appreciated by society. Thus, for example, in Scotland, giftedness at football is widely esteemed (Thomson, 1992). Thus, areas of giftedness are decided by society, and this is given consideration when looking at various giftedness theories. Some of these theories will discussed in the following section.

## 2.4 Views of Giftedness

There are many theories of giftedness, some arising from psychology and some from educational perspectives. From the giftedness literature, it can be seen that there are many ways of categorising the various theories. Here, the various understandings are divided in several ways: for example: nature-nurture, behaviour-genetic, heredity and environment (Sternberg and Grigorenko, 1997), implicit and explicit theories (Sternberg and Davidson, 1986). Although these categorisation have offered useful insights, the approach adopted here is to look at theories or models under two broad headings:

1. *Traditional views*: which consider giftedness in term of general intelligence (g) as a component of 'g' general factor, such as (Guilford's theory, 1967; Cattel's theory, 1941, 1967; Carroll, 1993).
2. *Recent views*: see giftedness as various components not measured by IQ tests, such as (Renzulli's theory, 1976, 1986; Gardner's theory, 1983; and Sternberg's theories, 1985, 1995).

Both of these approaches (the traditional and the recent theories) are used in different studies for various purposes. Each of these broad approaches is now illustrated by considering some examples from the literature. While one approach deals with the psychometric, the other one tends to be more holistic.

### 2.4.1 Traditional Views

Guilford (1967) developed a model of intelligence that was not hierarchical. In Guilford's '*Structure of Intellect model'*, he identified a large numbers of factors. Each factor consisted of three facets or parameters. The three facets were labelled content, operation, and product. He identified four types of contents, five types of operations, and six kinds of products, yielding 120 independent factors. This may have been comprehensive but the approach is somewhat impractical.

He distinguished four operations: cognition, memory, divergent-production, and evaluation. Each of these operations could be applied to one of four types of contents: figural, symbolic, semantic and behavioural. The application of these processes to these contents could result in one of six products: units, classes, relations, systems, transformations, and implications Figure 2.1 (Guilford, 1967; Guilford and Hoepfner, 1971)

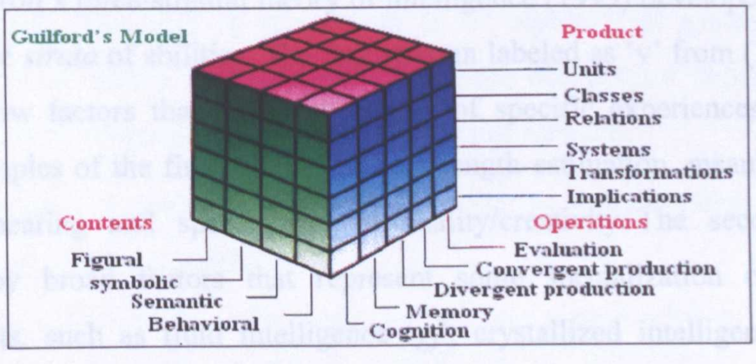



**Figure 2.1 Guilford's Structure of Intellect Model**

In addition, Guilford (1977) subsequently modified the model to distinguish between two types of figural contents, auditory and visual leading to an expansion of the number of independent factors to 150 (Brody, 2000).

Cattell proposed (1963) that intelligence is composed of two separate factors. The first is fluid intelligence ($g_f$), which is '*ability to make meaning out of confusion and usually thought of as being independent of learning*'. It is perceived as from biologically influenced abilities. The second is crystallized intelligence ($g_c$); '*reproductive ability - the ability to regurgitate previous learning'* which is dependent on past experience. In reality, one is not a 'crystallized' form of the other but they are relatively independent components of general intelligence (g).

Such a view is indicating that an individual is learning from experience. Crystallized intelligence depends, in part, on fluid intelligence.

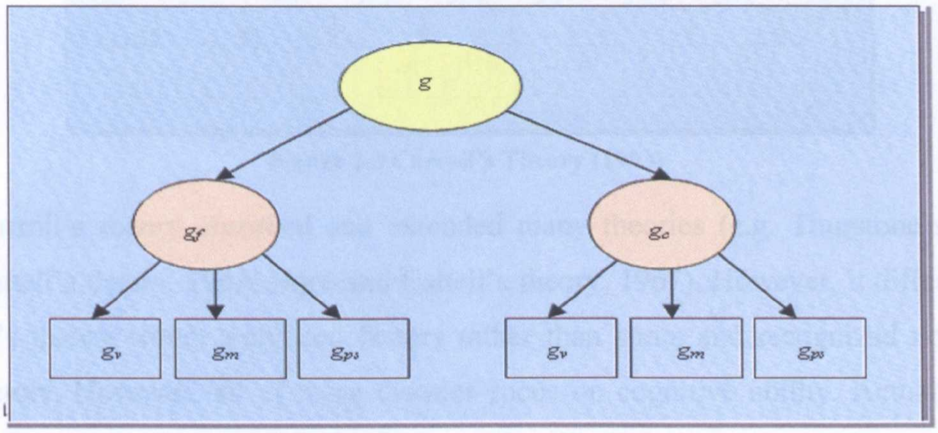



**Figure 2.2 Horn and Cattell's Theory**

Later, Horn and Cattell (1967) empirically tested the $g_f/g_c$ theory. They confirmed the $g_f/g_c$ dichotomy, but also disclosed six additional second-order factors, including Visualization ($g_v$), Working Memory Capacity ($g_m$), and Perceptual Speed ($g_{ps}$) (Figure 2.2).

In addition, Carroll's three-stratum theory of intelligence (1993) developed a hierarchical model with three *strata* of abilities. The first stratum labeled as 'v' from (1 to 8), consists in part of narrow factors that appear reflective of specific experiences, learning, and strategies. Examples of the first stratum include length estimation, meaningful memory, visualization, hearing and speech and originality/creativity. The second stratum is characterized by broad factors that represent some specialization of abilities and established traits, such as fluid intelligence '$g_f$', crystallized intelligence '$g_c$' general memory and learning '$g_{ml}$', broad visual perception '$g_v$', broad auditory perception '$g_a$', broad retrieval ability '$g_r$', broad cognitive speeding '$g_{cs}$', and processing speed '$g_{ps}$', that explain the correlations of the stratum one factors. The third stratum is essentially Spearman's 'g' general factor see ( Figure 2.3) (Embretson and McCollam, 2000).

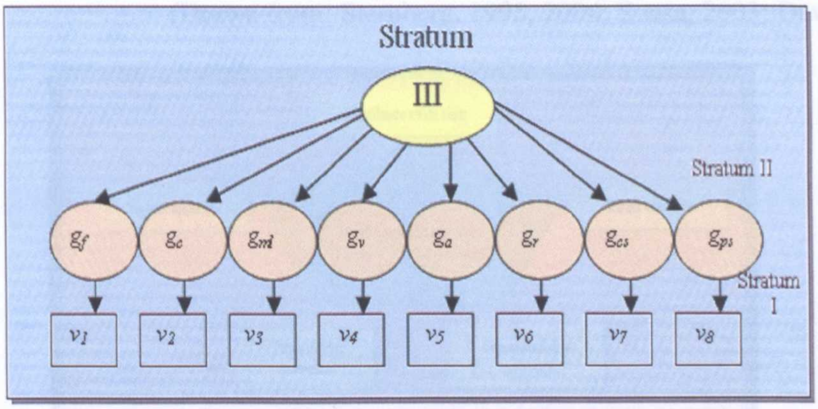



**Figure 2.3 Carroll's Theory (1993)**

Thus, Carroll's theory absorbed and extended many theories (e.g. Thurstone's theory, 1947; Cattell's theory, 1963; Horn and Cattell's theory, 1967). However, it differed from Guilford's theory which contained factors rather than strata and recognized no higher-order factors. However, all of these theories focus on cognitive ability. Actually, these three theories have been used in various studies investigating the working memory in gifted students and this will be discussed later.

### 2.4.2 Recent Views

In Sternberg's pentagonal theory (1995), five conditions are specified (Figure 2.4) and these are claimed to be 'individually necessary and jointly sufficient for a person to be labelled as 'gifted'. The goal of this theory is to capture and systematize people's intuitions about what makes an individual gifted, the designation depending upon the skills of those against whom one is judged. These conditions are:

(1) *The excellence criterion*: the person is superior in some dimension or set of dimensions relative to peers.

(2) *The rarity criterion*: an individual must possess a high level of an attribute that is rare relative to those of peers.

(3) *The productivity criterion*: the dimension(s) in which a gifted individual shows an excellence that leads to productivity.

(4) *The demonstrability criterion*: the superiority of the individual in the dimension that determines giftedness must be demonstrable through one or more tests that are valid assessments.

(5) *The value criterion*: for a person to be labelled as gifted they must show superior performance in a dimension that is valued by his or her society.

(Drawn from: Sternberg, 1995, 2004; Sousa, 2003; Davidson, 2000)

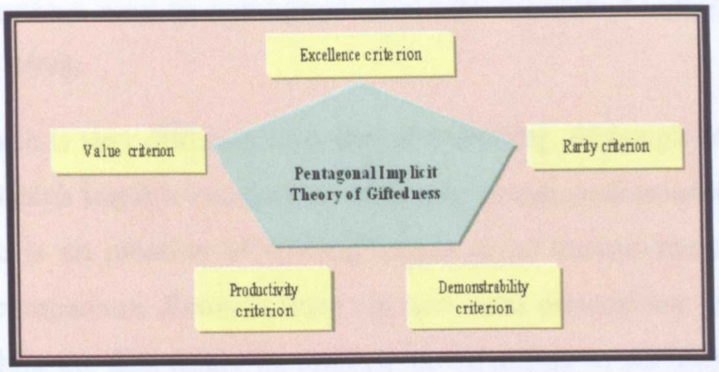



**Figure 2.4 Criteria of the Pentagonal Theory of Giftedness (Sternberg, 1995)**

Sternberg's theory is essentially based on the comparison with peers. The gifted individual excels in some way in comparison to others as well as reaching some kind of objective high standard in that attribute. However, this attribute must be validly measurable as well as being valued by society. This approach seems reasonable but it does assume that what is to be valued has to be measurable. There are many valuable attributes that cannot be measured easily or with certain validity. For example, society can speak of the 'gifted teacher' and every student knows when she/he have been taught by such a teacher. Defining the attribute in such a way that it can be measured is not nearly so easy.

Another theory describes giftedness in terms of three basic clusters of human traits (*three-ring* conception *of giftedness,*). Renzulli, in the early 1970s, began work on a concept of giftedness. He stated that gifted behaviour reflects an interaction among three basic clusters of human traits, popularly known as the three-ring conception of giftedness: above-average general and/or specific abilities, task commitment (motivation), creativity, (see Figure 2.5).

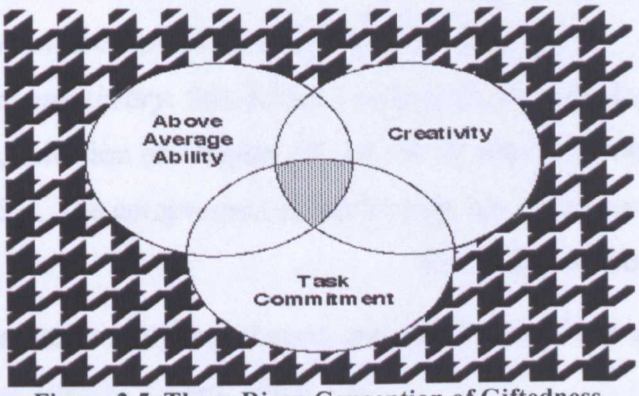



**Figure 2.5 Three-Rings Conception of Giftedness**

Renzulli improved his theory in 1986, when he embedded the three rings in a hounds-tooth check background that represents interactions with personality and environment.

Renzulli was very reluctant to specify any combination rule. According to him, attributes of intelligent behaviour must be considered within the context of cultural and situational factors (Renzulli, 1998).

Renzulli's approach is very different from that of Sternberg. Although both refer to above average ability, which implies comparison with peer group performance related to some attribute(s), there is no mention of societal values or of measurement although this is implied by any comparison. Renzulli draws in two extra dimensions: creativity and task commitment. While the first might be implicit in the ability to perform in a way that is well above the average, task commitment brings in dimensions that are, perhaps, attitudinal and motivational.

Sternberg proposed a triarchic theory (1985) of intellectual giftedness that elaborates three specific sub-theories. This "...relates intelligence to the internal world of the individual, specifying the mental mechanisms that lead to more and less intelligent behaviour" (Amidon, 1991: 93). In Sternberg's Triarchic model of intelligence, there are three interacting aspects to intelligence. According to Sternberg, various combinations of these three areas produce different patterns of giftedness.

(1) *The componential sub-theory*: this relates intelligence to the internal world of the individual through the components or mental processes involved in thinking. It specifies three kinds of information-processing components:
  - (a) Metacomponents;
  - (b) Performance components;
  - (c) Knowledge-acquisition components

(2) *The experiential sub-theory*: this focuses on an individual's ability to deal with novel kinds of tasks and demands, and the ability to automatize information processing, which are seen as an experiential continuum.

(3) *The contextual sub-theory*: this defines intelligence in everyday life as purposive adaptation to, selection of, shaping of real-world environments relevant to one's life and abilities. The components of intelligence are interactive.

(Summarised from: Sternberg, 1986)

Feldhusen (1986) discussed Sternberg theory, and summarised it in a very useful way in the following table [as cited in Valdes, 2003: 19)].

**Table 2.1 Componential Sub-Theory**

| Metacomponents | Performance Components | Knowledge-Acquisition |
|---|---|---|
| *Higher order processes, used in planning, monitoring, and decision making.* | *Processes used in execution of a task.* | *Processes used in learning new things.* |
| ***Examples*** | ***Examples*** | ***Examples*** |
| • Recognizing the existence of a problem.<br>• Defining the nature of the problem.<br>• Generating steps needed to solve problem.<br>• Selecting and ordering strategies to solve problem.<br>• Deciding who present information about the problem.<br>• Allocating mental and physical resources to problem solution: solution monitoring | • Inference (detecting relations between objects)<br>• Mapping (relating aspects of one domain to another)<br>• Application (predicting on the basis of perceived maps )<br>• Comparison (examining a prediction in relation to alternative predictions)<br>• Justification (process of verifying options<br>• Response (communication of a solution) | • Selective encoding (sorting out relevant from irrelevant information)<br>• Selective combination (combining information to form an integrated, plausible whole)<br>• Selective comparison (relating new information to information acquired in the past) |

According to Sternberg, some individuals are strong in one aspect but not necessarily strong in the other two. Some individuals are particularly adept at using the metacomponents, performance components, and knowledge-acquisition components to analyze and compare information, which means some people are demonstrating analytic intelligence while others show creative intelligence and so on. His theory proposes three distinct forms of intelligence: analytic, practical, and creative (Figure 2.6).

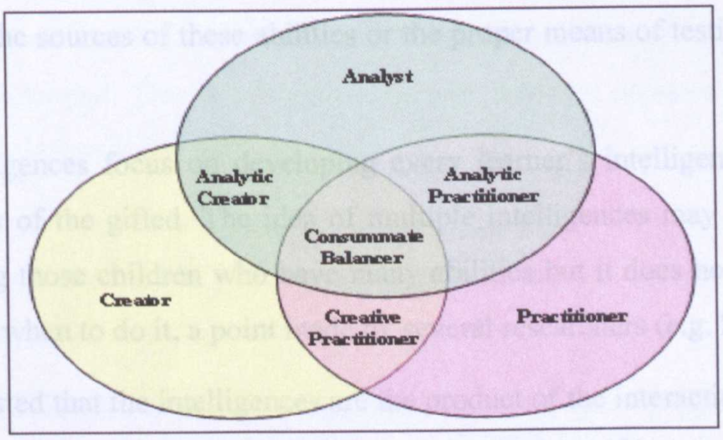



**Figure 2.6 Combinations of the Three Types of Intelligence**

While Sternberg shows a certain appreciation of the multi-dimensional nature of intelligence in terms of his triarchic model, Gardner (1983) goes much further. In his multiple intelligences theory (Figure 2.7), Gardner formulated intelligence as being modular in nature: there are different types of intelligences for different types of behaviour. He defines intelligence as a 'bio-psychological potential' to process information in certain ways. Each type of intelligence can be activated in an appropriate cultural setting.

| Multiple Intelligences Category |
|---|
| **Linguistic**: Mastery, sensitivity, desire to explore, often thinks in words, likes to read and write, learns by verbalizing or hearing and seeing words |
| **Logical –mathematical:** logically analyzes, assesses and empirically investigates objects, abstractions, and problems, discerns relations and underlying principles, carries out mathematical operations, handles long chains of reasoning. Thinks conceptually, manipulates the environment in a controlled and orderly way, likes logic puzzles and strategy games, enjoys computers. . |
| **Musical**: Skill in producing/composing, performing, listening/discerning, and sensitivity to the components of music and sound, likes to sing or hum along to music, may play a musical instrument/melodies |
| **Spatial:** Accurately perceives, recognizes, manipulates, modifies, and transforms tasks or fashions products, thinks in images, likes drawing and designing things, enjoys construction toys, is fascinated with machines |
| **Bodily-kinaesthetic** Orchestrates and controls body motions and handles objects, performs tasks or fashions products, may be good at typing, sewing, carving or other activities that require fine motor skills |
| **Interpersonal**: Is sensitive to, accurately assesses, and understands others" actions, motivations, moods, feelings, and others" mental states and acts productively on the basis of that knowledge, shows leadership, successfully mediates when people have conflicts |
| **Intrapersonal**: Is sensitive to, accurately assesses and understands and regulates self and acts productively on the basis of own actions, motivations, moods, feelings, and other mental states, studies independently; may be nonconformist. |
| **Naturalist:** Shows expertise in recognition and classification of natural objects, sensitive to environmental surroundings, including nature, and observant of how systems work |
| **Existential** Captures and ponders the fundamental questions of existence, shows an interest in and concern with "ultimate" issues. |

**Figure 2.7 Multiple Intelligences (Adapted from Colanglo and Davis 2003, Walker, 2002).**

In his approach, intelligence is the "*ability to solve problems or to create products, problems that are valued within one or more cultural setting*" a definition that says nothing about the sources of these abilities or the proper means of testing them (Gardner, 1983).

Multiple intelligences focus on developing every learner's intelligence rather than the exceptionalities of the gifted. The idea of multiple intelligences may be appropriate for accommodating those children who have many abilities but it does not help them decide what to do and when to do it, a point made by several researchers (e.g. Sousa, 2003).

Gardner suggested that the intelligences are the product of the interaction between genetic predisposition and the environment. He selected intelligence if it met the following eight criteria:

- *"Potential isolation by brain damage;*
- *Existence of idiots savants, prodigies, and other exceptional individuals;*
- *An identifiable core operation or set of core operations;*

- *A distinctive developmental history, along with a definable set of expert "end-state" performances;*
- *An evolutionary history and evolutionary plausibility;*
- *Support from experimental psychological tasks;*
- *Support from psychometric findings;*
- *Susceptibility to encoding in a symbol system."*

(Gardner, 1993: 63-66)

However, Sousa (2003) suggested that there are two potential criticisms of this multiple intelligences theory. The first is that this theory removes the original concept of giftedness by implying that 'everyone' has the potential of some aspect of giftedness. It focuses on developing every person's intelligence rather than the exceptionalities of the few. The second is that theory does not help the gifted people decide what to do and when to do it. However, most theories do not do this.

However, it could be argued that the first criticism is an advantage in that the value of all in society is emphasised. They reflect the suitability of this theory to its application to education and the relevance of what societies should look for in the care of the students who are the future of any country. This led to the development of many models influenced by his theory. For example, Teele (2000) has created a *Rainbows of Intelligence model* that builds upon Gardner's multiple intelligences theory. Her model compares the colours of the rainbow and primary, secondary, and complementary colours to intelligence. According to Teele, the intelligences are like the spectrum of colours: sometimes our intelligences are obvious and sometimes not visible and are waiting to be discovered or activated. This is a bright and elegant analogy; however, it does not offer a clear definition for intelligence.

Another approach was adopted by Feldman (1982) who views IQ as a confining and limited notion of intellectual giftedness. He sees giftedness as movement through the stages or levels of a domain.

- *"The rate at which levels are mastered is one aspect of giftedness.*
- *The depth of mastery is another aspect of giftedness".*

This is a useful insight in that there is emphasis on the speed of the development of skills, knowledge, or attributes while still considering the depth of mastery as important. Those who have truly mastered an area of learning may be able to apply the knowledge in ways that are potentially meaningful and useful in a practical sense.

The whole area of seeing intelligence as a multidimensional concept opens up the concept to a much wider domain. Early work (e.g. Galton, 1869; Terman 1920) was inevitably, too limited. Drawing together the work of many researchers (e.g. Gardner, 1983; Renzulli, 1986; Sternberg, 1995) leads to the suggestion that there might be four broad areas that can be seen in terms of intelligences or domains of giftedness:

(1) Cognitive-academic
(2) Creative-Artistic
(3) Personal-social
(4) Vocational-technical

This way of looking at giftedness has more potential for future developments. It offers a framework under which programmes, methods, and services can be developed for the benefit of the society and of the gifted student (Feldhusen, 2003). Having explored how views about giftedness vary from one approach to the other, it is time to look at how giftedness is, consequently, defined.

## 2.5 Definition of Giftedness

There is no 'correct' definition of giftedness. There are numerous definitions but there are major differences between them (Borland, 2003). Feldhusen (1995) states that a major change is taking place in the field of gifted education, the challenge for educators is no longer seen as knowing how to distinguish between gifted and non-gifted youngsters based upon IQ measures (Milgram, 2000).

In the past, it was assumed that gifted students were born with high intelligence, were identifiable by their high grades and test scores, and were capable of excelling in all areas of school and of life (Stepanek, 1999). In addition, giftedness as a construct was defined as a score on an IQ test but, over many years, understanding of giftedness has expanded to incorporate abilities not easily measured by an IQ test. In addition, consideration should be given to the analytical, linguistic, and knowledge recall skills measured by the IQ test (McCann, 2005). These assumptions are still prevalent, although they are beginning to change. However, Stern (1912: unpaged), who invented the idea of IQ, did not indicate this view in his definition of intelligence.

> *"A general capacity of an individual consciously to adjust his thinking to new requirements, a general mental adaptability to new problems and conditions of life"*
>
> (Stern, 1912: unpaged)

Most definitions, whether they are psychologically or educationally based, have moved away from equating giftedness with intelligence as defined by general IQ tests. Several current definitions are broadened in terms of the constructs consider individual a gifted. Winstanley (2004) considers that the term 'gifted' is used in, for example in USA, England, and Kuwait, both to describe an all-round high level of ability in children as well as specific abilities, and it is, therefore, a relative concept. In some schools, and even in the same field of activity children are called gifted at different levels of an achievement (Freeman, 1979).

Frasier and Carland (1982) reviewed seventeen definitions from 1940 to 1979 (Table 2.2) and interpreted them from an educational perspective. The wide range included in this table (2.2) illustrates the difficulty of defining giftedness. There is no agreed definition and, with such a list of definitions, it seems possible to select any definition that suits and use it. However, this is most unsatisfactory. There is a need to know a purpose for defining the giftedness concept. In addition, there is not only the possibility for an individual to choose a definition, but societies also will vary in their understandings of what it means to be gifted. Social needs and values specify who and how many are deemed gifted and talented.

**Table 2.2 Seventeen Definitions: Source: Frasier and Carland 1982)**

| Definition | Year | Definition |
|---|---|---|
| Those whose performance is consistently remarkable in any potentially valuable area. | 1940 | Witty |
| Any child with an I.Q of 120 or over whose performance is constantly outstanding and has a potential value to the welfare of society. | 1955 | Otto |
| Encompasses those children who possess a superior intellectual potential and functional ability to achieve academically in the top 15 to 20 percent of the school population; and 1 or more talent of a high order in such special areas as mathematics, mechanics, science, expressive arts, creative writing, music, and social leadership; and a unique creative ability to deal with their environment. | 1959 | Fliegler & Bish |
| Refers to those with intellectual or academic capabilities that exceed a majority of their age mates. | 1959 | French |
| Used in reference to extremely gifted, moderately gifted and talented (children) | 1960 | Brain |
| Refers to those who possess a superior nervous system characterized by the potential to perform tasks requiring a comparatively high degree of intellectual abstraction or creative imagination. | 1960 | Sumption and Leucking |
| Refers to a child who is superior in some ability that can make him an outstanding contributor to the welfare of, and quality of living in, society. | 1961 | Havighurst. |
| Refers to a child who has the capacity for superior achievement in some area of human endeavour that has consistently made an outstanding contribution to civilization. Such a broad definition would include academic fields such as music, graphic and plastic art, performing and mechanical arts, and the field of human relations. | 1963 | Passow |
| Applies to those students who have a very high level of academic aptitude, either demonstrated or potential...Terms that will be used interchangeably with gifted include "bright" 'superior", "fast learning" and " academically talented". | 1964 | Durr |
| Refers to a person whose development and behaviour - apart from sheer physical superiority - consistently demonstrates unusual traits, capacities, and achievements for his age. | 1966 | Hildreth |
| (A term) referring to a high degree of general intellectual ability or of high general intelligence. | 1967 | Lavcock |
| Refers to children who achieved 132 or higher on the Stanford Binet intelligence tests. These comprise the top 2 percent of the general population. | 1972 | Syphers |
| Students with superior cognitive abilities include approximately the top 3 percent of the general school population in measured general intelligence and /or in creative abilities or other talents that promise to make lasting contributions of merit to society. These students are so able that they require social provisions if appropriate educational opportunities are to be provided for them. | 1973 | Dunn |
| Refers to a child who is significantly superior in terms of intellectual ability. The actual I.Q score and criteria for determining giftedness vary from state to state and from area to area. | 1975 | L'Abate and Curtis |
| Refers to a group so advanced that they require special attention beyond the usual school provisions. | 1977 | Martinson |
| Refers to people who have developed high levels of intellectual ability or who show promise of such development. | 1979 | Clark |
| Given the total continuum of general "intelligence" the gifted are perceived as falling along the higher range. Refers to those children whose anticipated superior social contribution is primarily a function of their superior conceptualization capacity. | 1979 | Newland |

Definitions of the term 'gifted' can emerge out of the study of individual differences in psychology; definitions are also developed by policy makers, in order to develop and deliver services to gifted children. An example of a definition developed by policy makers is found (Robinson and Clinkenbeard, 1998), in 1972, when the United States Office of Education used what became known as the Marland definition to define a gifted and talented student.

> *Gifted and talented children are those identified by a professionally qualified person, as being those who by virtue of outstanding abilities are capable of high performance. These are children who require differentiated educational programs and services beyond those normally provide by the regular school program in order to realize their contribution to self and society* (Davis and Rimm, 1989:11).

The Marland report went on to describe children capable of high performance as including those with demonstrated achievement and/or potential in any of the following areas:

(a) General intellectual ability
(b) Specific academic aptitude
(c) Creative or productive thinking
(d) Leadership ability
(e) Visual and performing arts
(f) Psychomotor ability

(Robinson, 1998, Davis and Rimm, 1989)

This seems to go back to some of the models of multiple intelligences and it was criticized for presenting unparallel categories and for possible misinterpretations. A few years later, in 1978, the United States Congress revised Marland's definition (Robinson, 1998). The main difference is that psychomotor ability was excluded because it could be included under performing arts. A few years after the Marland Report, Renzulli (1978) noted that a definition of giftedness must include characteristics of gifted individuals, must involve a guide to the identification process, must be related to programming practices, must consider the validity of the definition.

According to Renzulli, gifted and talented children are those who possess or are capable of developing this composite of traits (general performance areas and specific performance areas) and applying them to any potentially valuable area of human performance.

Children who manifest or are capable of developing the interaction among the three clusters (above-average, task commitment and creativity) require a wide variety of educational opportunities and services that are not ordinarily provided through regular instructional programs (Renzulli, 1978). Renzulli recommended use of the *three-ring conception* in conjunction with his 'Revolving Door Identification Model' (Figure 2.9) (RDIM) which is three types of activities model: the first activity has the goal of general activities to create an opportunity for students to discover high level interest and abilities.

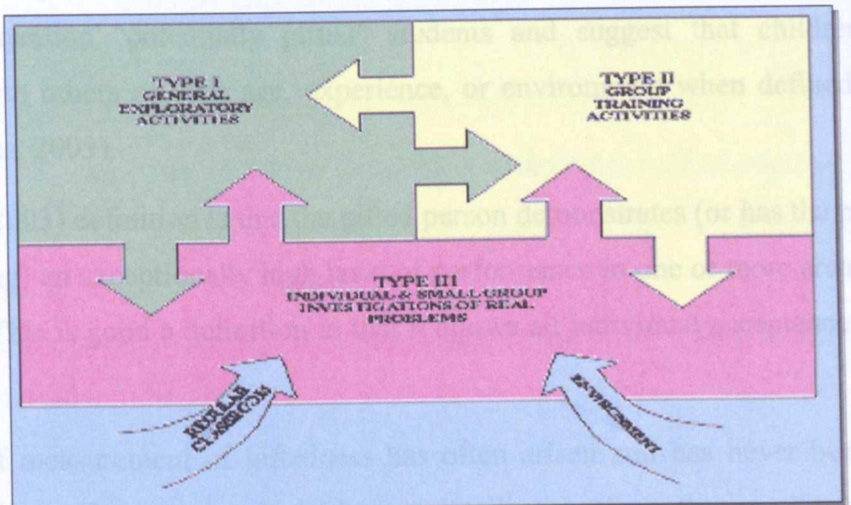



**Figure 2.8 Revolving Door Identification Model**

The model is designed to enable teacher to capture children's interest and enhance motivation. The second provides students with the specific skills that they need to pursue independence individually. The third type is individual and small group independent projects on topics agreed and identified by the students with the teacher's agreement. In this model, the students can move from type to type when they have had experience and success with the appropriate activities related to a type or perhaps need to remain with the previous type if the student feels unable to move on to the next type of activities (Clark, 2002). Renzulli's definition has two advantages:

- It focuses on a combination of traits that may help identify the children who are the most likely to lead creative, productive lives.
- It eliminates the need to identify categories of giftedness; at the same time, it extends the applications of gifted potential to any area valued by society.

Both the definitions from the Marland Report and from Renzulli affected the development of educational programmes for gifted students in USA with the concentration being on developing services that provide general academic or creative enrichment (Robinson and Clinkenbeard, 1998). In fact, while the identification of the gifted in the State of Kuwait is still dependent on their IQ scores and academic achievements, the provision offered in the enrichment is much influenced by these definitions.

Eventually, Feldhusen and Jarwan (1993) reviewed the definitions of giftedness and talent and noted that they fell into six categories: psychometric definitions, trait definitions, definitions focussed on social needs, educationally oriented definitions, special talent definitions, and multidimensional definitions. Their categories are not particular; some definitions of giftedness could be classified in more than one way. More recent definitions mention "potentially gifted" students and suggest that children must be compared with others of their age, experience, or environment when defined them as a gifted (Valdes, 2003).

The Sousa (2003) definition is that the gifted person demonstrates (or has the potential for demonstrating) an exceptionally high level of performance in one or more areas of human endeavour. This is good a definition in that it allows all individual acceptances according their ability.

The issue of measurement of giftedness has often arisen and has never been resolved. Still, there is many more issues in human intelligence than the psychometric or the biological tests attempt to measure (Kellogg, 1993). There are four broad approaches to this measurement:

1. *Subject-based tests*: measurements of knowledge, skills, thinking, critical thought, problem solving and so on, related to a specific subject area;
2. *Generic tests*: the testing of thinking skills, mental ability, links in long term memory, processing power and so on, in problems not specifically related to a subject discipline;
3. *Practical tests*: skills, creativity, versatility related to practical areas of life like music, sport, physical activity, technical skills.
4. *Emotional and social observation*: wisdom, self-conception, confidence, leadership, mentoring.

Additionally, children and young people should be defined by more than one of those categories, for example: behaviour, motivation, production, needs and skills. Children change frequently when they are young, but as years pass there will be fewer abrupt changes and they may settle into one or two profile areas. This view provides a new understanding of the gifted and new opportunities for developing techniques and strategies for facilitating the cognitive, emotional, and social growth of these children (Betts and Neihart, 2004).

It is essential to recognize the nature of the purposes to define giftedness, and the pivotal role that definitions play in structuring the entire field. Definitions are open to both scholarly and practical scrutiny. Stankowski (1978) outlined five categories of definitions of gifted:

- *"After-the-fact definition emphasizes prominence in one of the professions as the criterion of giftedness.*
- *IQ definitions set a point on IQ scale.*
- *Percentage definitions set a fixed proportion of the school (or district) as gifted.*
- *Talented definitions focus on students who are outstanding in art, music, math or other specific aesthetic or academic area.*
- *Creativity definitions stress the significance of superior creative abilities as a main criterion of giftedness."*

(Davis and Rimm, 1989: 9)

Of course, these definitions are not fixed. Different societies put emphasis on different aspects. For example, countries in the Middle East tend to place considerable emphasis on academic abilities, especially related to the recall of information while the United States places much more emphasis on personal and social development. Such different emphases will influence the kind of attitudes toward giftedness and this, in turn, will influence the kind of programme that is offered to those deemed to be gifted. There are three general organisational approaches, which various societies have chosen to adopt:

- *Segregation*: providing various organizational structures so that students of a similar ability can work together: for example, full-time homogeneous classes (e.g., a magnet school, special school, etc), full-time heterogeneous classes (e.g., combined grades in a regular class, mainstreaming in the regular class. etc), part time or temporary groups (e.g., pullout programmes, resource room plans, special classes, etc)
- *Acceleration*: implies moving faster through academic content. This might include, for example, early admission, 'grade-skipping', 'subject-skipping', college courses in high school, telescoped programmes, etc.
- *Inclusion and enrichment*: for example independent study and independent project, field trips, summer programs, academic competitions, mentors and mentorship.

(Drawn from: Davis and Rimm, 1985; Moltzen, 2006)

The 'segregation, acceleration, inclusion' issue is very real. Moltzen (2006) presents clear evidence that various forms of segregation have major advantages for all individual although not all agree on segregation. However, if there is to be special provision for those who are gifted in any way, it must not be offered in such a way for the minority only to benefit. There is an issue of equity here.

Moreover, it is important for programme planners as they decide on using any of these approaches to follow some rules, that would, at least, give equal considerations for all candidates' needs. Treffinger (1986) has suggested in his *individualized programming planning model* to follow four core components. The programme planners must make sure those components are present (see Table 2.3).

**Table 2.3 Treffinger's Programming Planning Model**

- Programme philosophy and goals:
  a. What is our attitude toward gifted children?
  b. Why are we doing that?
  c. What do we wish to accomplish?
- Definition and identification.
  a. What do we mean by gifted
  b. Which categories of gifted will this programme serve?
  c. How will select them?
- Instruction – grouping , acceleration, and enrichment
  a. What are the students" needs?
  b. How can we best meet those needs?
  c. How van we implement our instruction plans?
- Evaluation and modification.
  a. Was the program successful?
  b. What did we do right?
  c. What did we do wrong?
  d. What changes shall we make?

The whole issue of defining giftedness is considered as a part of the differentiation agenda: of selecting to providing services to only those who meet the set criteria. This has always been a problem: how to meet the needs of all, given the wide range of different abilities. Several arguments are presented for inclusion as a potential solution:

(a) This is the way most education is offered;

(b) Avoids definition and premature labelling;

(c) Avoids the rest being seen as '*non-gifted*';

(d) Few are holistically gifted-most need mainstream;

(e) Avoid resentment at being '*different*'.

(Moltzen, 2006)

Reviewed definitions of giftedness are important because the definition will influence the procedures used to identify gifted children. Whatever the definition used to describe the students, method and tools are needed to identify them and this is discussed.

Various definitions of giftedness have been discussed and it is clear that there can be no one agreed definition which suits all circumstances. However, it is possible to think of giftedness in terms of outstanding ability in some area, ability that exceeds the ability of most in the peer group, the ability being valued by the society in some way. How to identify such giftedness is now considered.

## 2.6 Identifying Gifted Students

Probably there are as many different strategies and policies for defining gifted students as there are programmes for their education. Before planning any type of programme for gifted students, it is important to know at the start which tools should be used to identify the gifted students and the key criteria to select those students for this programme. In fact, the way the educational programme is run should be clearly and logically related to the definition of giftedness being used:

**Definition of giftedness → Measurement technique → Educational Provision**

There are major arguments about whether it is necessary or desirable to select the gifted at all. Gross (2006) has noted that it seems quite acceptable to give special treatment to those who are specially gifted in music, the arts or sports. However, there is a resistance to special treatment for the academically gifted. Thus, those who are gifted in music, the arts or sports can enjoy competition with others of the same abilities. They are often accelerated and they may enjoy mentorship, often at considerable public expense, as well as being offered sustained and rigorous practice. Society offers them value, giving pride in achievement. Academically gifted are not always treated in such ways.

Heller (2005) argues that the identification of gifted children and adolescents generally occurs in a procedure involving several steps:

(1) The *first step of screening*: is based on first, teachers or parents' nomination of a student, and the second use of teacher checklists. In such a way, as broad range of cognitive and motivational aspects are included.

(2) The *second step selection*: continues to be based on individual intelligence test scores.

However, this approach is sometimes referred to as a '*multicriteria smoke screen*', because it gives the impression of examining a broader range of indicators of potential ability (Renzulli, 2004).

Logically, several measures should be made to reflect the many types of abilities and diverse characteristics of each student. Teachers and schools should use multiple tools in order to identify gifted students effectively. In addition to grades and test scores, there are a variety of other forms of assessment that provide a richer and more accurate picture of students' strengths and abilities, such as interviews conducted with students, information from parents, and portfolios of student work (Smutny, 1997).

There are many different identification methods used in different countries. Table 2.4 exhibits some of these methods:

**Table 2.4 Some Formal and Informal Identification Methods (summarised from Davis and Rimm, 1998)**

| | |
|---|---|
| (1) | Intelligence tests, as example Wachsler intelligence scales, Stanford Binet intelligence. |
| (2) | Achievement tests; such as standardized tests produce scores based upon national norms (grade-equivalent, percentile), Stanford Achievement tests. |
| (3) | Teacher nominations, peer nominations, or parent nomination, self-nominations. |
| (4) | Rating scales, as example Renzulli's scales for rating behavioural characteristics of a superior student, Rimm's group achievement identification measure. |
| (5) | Creativity tests, as example Torrance Tests of creative thinking. |
| (6) | Product evaluations. |

Identification methods will be grouped in two categories corresponding with previously presented categorisation of defining giftedness, in next section.

### 2.6.1 Traditional Approaches

Traditional approaches to assessment are linked strongly with the traditional conceptions of intelligence seen as a single quality that affects abilities across all domains, an inherent trait that does not change over time. Programmes and strategies for teaching the gifted often reflected such paradigms of thought.

Alford Binet and his co-worker Hanerial Simon developed the first measures of intelligence and they describe the new measures of intelligence as being:

> *" inspired by the desire to serve the interesting cause of the education of the subnormal"*
>
> (Cited in: Shuksmith, 1970: 54)

The concept of an Intelligence Quotient or IQ, suggested by Stern (1912), was influenced by the work of Binet and his studies of intelligence in children. He reviewed the principal findings in the field and developed a formula expressing the relation between an individual's mental age and chronological age, this idea expressing intelligence test results in the form of a single number, the intelligence quotient:

$$IQ = \frac{\text{Mental Age}}{\text{Chronological Age}} \times 100\,\%$$

So if the Mental Age = Chronological Age, IQ = 100, the national average. The distribution of IQ supposedly follows a normal distribution curve (also known as bell curve), and assessment of 'superiority' and 'inferiority' is determined by the number of statistical Standard Deviations above and below the mean.

The normal distribution curve (the bell curve), was first introduced by Moivre (1756) in an article in '*The Doctrine of Chances*'. The importance of the normal distribution as a model of quantitative phenomena in the behavioural sciences is due to the central limit theorem and many psychological measurements can be approximated well by the normal distribution.

Terman (1916) revised Binet's test and adapted some items, added other items, established new age norms, and extended the upper age limit to 'superior adults'. This became the Stanford-Binet revision. In this revision, the Intelligence Quotient first appeared after Terman developed the original notion of IQ and proposed this scale for classifying IQ scores (Figure 2.9), Thus the deviation IQ compares people of the same age or age category and assumes that IQ is normally distributed, that the average (mean) is 100 and that the standard deviation is agreed (typically it could be 15, some time less or more).

- Over 140 - Genius or near genius
- 120 - 140 - Very superior intelligence
- 110 - 119 - Superior intelligence
- 90 - 109 - Normal or average intelligence
- 80 - 89 - Dullness

- 70 - 79 - Borderline deficiency
- Under 70 - Definite feeble-mindedness

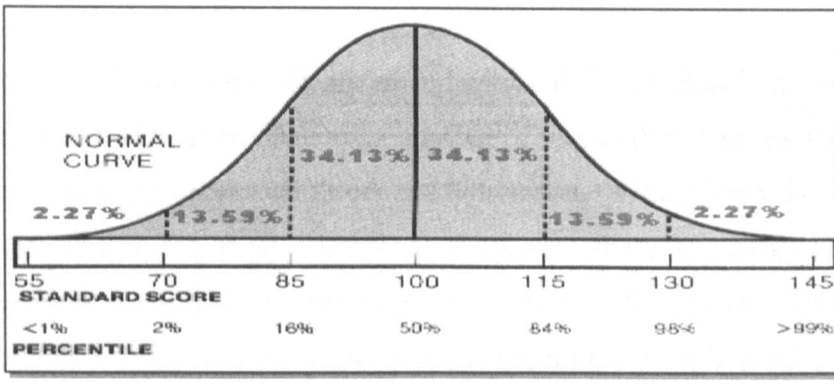



**Figure 2.9 The Normal Distribution Curve**

Otherwise, he recommended its use with children of all intelligence levels and stressed the practical advantages to be obtained by its application to normal and gifted children (Shuksmith, 1970).

However, it has been found that IQ scores have been rising over time, so that the initial norm of 100 no longer applies. This is, of course, problematic because of different approaches to measurement and the need to establish the standard of the measurement every few years (Herrnstin and Murray, 1995). The reason for this are may be simple: teachers or parents are preparing students to do better, or the knowledge been wider and easy to find from multiple sources.

The Stanford-Binet Test (1986) examines four broad areas of intelligence, which are *supposed to be* independent of each other, and not culture bound:

(1) Verbal reasoning
(2) Abstract/visual reasoning
(3) Quantitative reasoning
(4) Short-term memory

(Atherton, 2004)

However, there is considerable argument as to whether these are simply more specific manifestations of a more general underlying feature, known as the (g) factor.

Kline (1992) reviewed much of the research investigating the correlations between intelligence test scores and academic performance. Thus, he found that academic performance could be predicted by tests of intelligence because the origins of intelligence testing lay in the effort to select people worthy of education. This arises because intelligence tests are essentially testing the same kinds of skills as typical school examinations and tests. School tests are based on specific content while intelligence tests are not.

Thus, high scores in IQ measurements are an indication that a student is gifted in school tests and examinations. However, there are a number of ways other than test scores where students can demonstrate their abilities and strengths. When schools limit their identification efforts only to these traditional measures, there are many unidentified students whose needs will not be acknowledged or addressed. In addition, there are many high-ability students who do not meet the 'official requirements' (Stepanek, 1999). For example, in Kuwait the students who achieve high marks are labelled 'gifted'. However, there are those who are capable of exemplary work and who need higher levels of challenge. Furthermore, for example, an Australian aborigine who can track a kangaroo over rocky ground might be seen by his society as gifted, but may well perform poorly on an IQ test (Whitehead, 2006). The same applies to the Bedouins in the desert: there are those who can find their way at night by looking to the stars and those who are able to follow a trace in the desert and even identify a time and a number of those who left this trace.

Halsey (1977) saw distinguished performance in intelligence tests as a particular kind of intelligence. He believed this to be only a sample of what is potentially measurable and, even so, considered the sample to be biased because tests are specifically designed to predict educational success. Thus, he noted that children who do well on intelligence tests should be expected to have an educationally supportive background and this most often proves to be the case. According to Bodmer (1977), intelligence must not be confused with IQ as measured by an IQ test. Over the years, psychologists have devised many types of tests, various combinations of which are used in any given situation to assign an IQ to an individual. This one number can hardly be considered the complete definition of intelligence though it presumably measures some component of intellectual ability.

The problem is how to measure something called giftedness, but we do not know whether what has been measured is predictive of performance in an academic setting.

### 2.6.2 Recent Approaches

Over the last 30 years, understandings of giftedness have expanded to incorporate abilities not easily measured by an IQ test (McCann, 2005). In terms of identifying this giftedness, researchers such as Sternberg (1990, 2004) have been critical of any tests that have no 'real-world' validity, which he explains as a form of giftedness that balances the theory of wisdom, which in turn is a series of processes that he referred to as metacomponents.

> *"Wisdom tends to occur in practical contexts. It is applied to solving real-world problems, not to the (sometimes) trivial problems one might encounter in an ability test or an achievement test."*
>
> (Sternberg, 1990: 234)

This new view started in 1972 with Marland's definition of giftedness and the US Federal Government moved beyond the exclusive use of IQ scores in the identification of gifted students. Later, Kline (1992: 71) cited a number of points:

- *"It is not true that intelligence tests measure only ability at intelligence tests. If this were so, there would be zero correlations with academic success.*
- *The correlations between intelligence tests and educational success cannot be explained away as reflecting some common personality or motivational factor which affects both scores. The spheres of ability, personality and motivation are largely separate.*
- *These correlations cannot be explained by some common content shared between educational criteria and intelligence tests."*

Kline's observations are open to criticism. It is perfectly possible that intelligence tests are simply like school tests with little emphasis on subject content. It is, therefore, unsurprising that they correlate with each other. They may all be measures of academic skills.

Research shows that intelligence tests measure academic background (Radford, 1991). Therefore, the use of IQ is no longer meaningful for the identification of gifted students and can therefore be dispensed with, as it is a specific score for certain mental abilities-a point that has been raised by many educators. Examination of the tests shows that components indicated by the previous studies (e.g. Freeman, 1973) often measure academic background. The modern orientation is to reduce dependence on IQ tests scores (Rimm, 2004). Here, educationalists rely on lists of gifted characteristics that might be detected in students. Such listed characteristics must meet certain criteria to be acceptable to identify students for special programmes for the gifted.

- The identification process must match the goals of the particular gifted programme.

- A selection procedure must be objective enough to be considered fair by parents and teachers and flexible enough to compensate for the limitations of educational measurement.
- A test used for identification must meet the standards of valid educational measurement.
- Cultural fairness or the indication that the test predicts validly for both minority and majority groups within a population is a consideration which is vitally important.
- Results from the test should be used for purposes beyond identification.

(summarised from Rimm, 2004)

Gifted students are identified through a variety of measures. Some educational systems (Al-Mashaan *et al,* 1999) require the use of both objective and subjective measures in the identification process. For decades, standardized achievement tests have been most often used in many states of America and recommended for use in the State of Kuwait as an objective measure (Gillespie, 1982; Al-Ashwal *et al,* 2002). In addition, teacher checklists are usually used as a subjective measure. In fact, Gillespie found that achievement scores, teacher recommendations and grades were the three most prevalent criteria employed in selecting students for gifted programmes. All three of these criteria are effective for identifying the gifted auditory-sequential learner (Choice, 2003).

The majority of the literature on identification of giftedness supports the use of multiple criteria for enrichment programmes including scores on standardized measures of cognitive ability, academic achievement, classroom performance, teacher reports, and parent nomination (Rizza, 2001). However, according to Birch (2004), identification of gifted students, as generally practiced in the United States is neither desirable nor necessary. Moreover, in the State of Kuwait, the enrichment programmes use multiple criteria to identify the gifted student and find them for special programmes that suit them best.

In addition, Johnsen (2004) explains that many schools use a variety of measures of students' capability and potential when identifying gifted children. These may include portfolios of students' work, classroom observations, achievement measures, and IQ scores. Scores should not be used as a single number for 'cut-off' purposes, but should provide information that is useful for planning instruction and/or counselling for gifted students. Most educational professionals accept that no single measure can be used in isolation to identify a gifted child accurately.

Available models of adaptive, individualized education offer alternatives that are more compatible philosophically and are more profitable and appealing educationally. Maddux (1983), while criticizing certain views of identification, pointed out that some progress toward educational individualization can be seen, particularly with gifted students, although there still is a tendency to teach all children the same subject at the same level in the same way. Birch (1984) points out that, in identification:

> *"We need to explore the broader context within which the child functions and which included social, personal and cultural factors which contribute much to the shaping of academic abilities, limitations, special interests and potentials."*

(Birch, 1984: 158)

Likewise, Callahan (2004) pointed out that the gifted student should be identified through 'a defensible identification process' in order to avoid any criticism of unfair selection and provision of extra help. The key issue is not whether a child is gifted or not gifted. Those labels are useful to us only in the sense that they:

- *"Create an awareness that there exists a population of students whose exceptional abilities differentiate them from the rest of the student population;*
- *Suggest some characteristics that we should attend to in planning educational programmes for those children."*

(Callahan, 2004: 15)

Of course, culture is very important. A culture may influence what is considered as giftedness: different cultures may value different attributes. In addition, a society may have it as a priority that the gifted are developed to the maximum extent for social or economic reasons.

The identification clearly is a crucial part of any gifted programme. Students who are identified as gifted academically are grouped in any of the following types of grouping:

- *Special school*: private schools for gifted students.
- *Full-time classes*: class for academically gifted exist in regular school or in an enrichment centre
- *Pull-out or "withdrawal" programmes*: gifted students leave their regular classroom for a resource room for a specified number of hours per week.
- *Cluster grouping*: identifying the top six to ten students at a grade level and gather them in same classroom with a teacher who developed a curriculum differentiated in level and pace for them.

- *Regrouping for specific subject instruction*: the student work with ability peers from other classes at the same grade level given subject at the same time.
- *Cross-grade grouping*: all participating grades grouped to take subject at the same time.

(Drawn from: Gross, 2006)

If a society considers it as important to offer enrichment programmes, then clearly and agreed definition of giftedness and an acceptable method of identification are both vital.

## 2.7 Characteristics of the Gifted

Understanding the characteristics of gifted children and adolescents is important. It helps in the recognition and identification of gifted students in school. The students differ from each other in language ability, interest, motivation, personality, and cognitive styles. They differ in their patterns of educational needs. Clark and Callow (2002) defined high ability with regard to certain qualities, recognising these by characteristics or skills. They divided gifted characteristics into five categories:

(1) Cognitive
(2) Affective
(3) Physical
(4) Intuitive
(5) Societal

Sousa (2003) has summarized the first indications to help to recognize students as gifted as probably coming from observation of high performance in one or more of the following areas:

- *"General intellectual ability: Have high intelligence test scores on individual and group measures.*
- *Specific academic aptitude: student shows outstanding performance in a specific area, and scores above the 95th percentile in achievement tests.*
- *Leadership ability: student can direct individuals or groups to a common decision; can negotiate and adapt in difficult situations.*
- *Creative and productive thinking: student can produce new ideas, and has the aptitude for developing new meanings that have social value.*

- *Psychomotor ability: student has outstanding motor abilities such as practical, mechanical, spatial, and physical skills.*
- *Visual and performing arts: student demonstrates talent in visual art, dance, music, drama, or related studies".*

(Sousa, 2003: 247)

It is clear that this set of criteria is influenced by the Marland definition outlined previously.

The intellectual characteristics described are mostly those selected by intelligence tests. For example, in the United States, a researcher often takes a baseline of IQ 130 (about 2% of the population) for the gifted while, in Britain, it is more often taken as IQ 140, (about 0.4% of the population) and, in Kuwait, for enrichment programmes, about the top 5% in performance are about (IQ of 120) (Freeman, 1979; Al-Ashwal *et al*, 2002).

The literature on gifted education offers several lists of characteristics relevant to the gifted. There is no one clear-cut correct set. However, most of the sets have many common features and the general features can be summarized, providing the following outline of gifted characteristics:

- Having a natural talent and interest in one or more areas;
- Having a great learning capacity within that area;
- The capability of learning quickly in their area of talent(s) and requiring little repetition when learning new information in that area;
- Ability to synthesize many sources of information;
- Viewing the world or situation holistically or globally;
- Having strong opinions and intense emotions;
- Possessing a variety of learning styles;
- Taking on the problems of the world;
- A finely-tuned nervous system which responds quickly to multiple sensory and affective stimuli;
- Seeking more knowledge, deeper meaning, opportunities to use their talents and gifts;
- Possessing a variety of personality profiles.

In order to detect such characteristics, teachers and parents need to know what they are looking for and then have a mechanism to offer identifications.

In addition, the 'Gifted Development Centre', a resource centre for developmentally advanced children and their parents, and for gifted individuals of all ages, in the United States has used a list of descriptors of the characteristics associated with giftedness for a long time to predict successfully the performance in the gifted ranges of the Stanford-Binet Intelligence Scale and other standardized intelligence tests, which have been widely used recently. The descriptors were selected according to the following criteria:

- *"Representative of the majority of children assessed;*
- *Descriptive of children with various talents;*
- *Appropriate at varying degrees of ability;*
- *Applicable to a wide age range;*
- *Generalizable to children of different socio-economic and cultural backgrounds;*
- *Easily observed in the home environment;*
- *Brief and clearly worded for ease of interpretation by parents."*

(Silverman *et al*, 1986)

Furthermore, several studies (e.g. Davidson, 1986; Renzulli, 1984, 1986; Kelly and Colangelo, 1984; Tidwell, 1980; Renzulli and Smith, 1978; Diessner, 1983;Farley,1986; Rimm, 1984; 1986; Torrance, 1981) were conducted between 1981 and 1986 to determine the validity of this set of characteristics, and the list has been refined to incorporate the research findings. ( Table 2.5) summarised this list.

**Table 2.5 Characteristics of Giftedness (cited in Valdes, 2003:23)**

| *Traits of intellectually gifted children* | *Affective characteristics* | *Characteristics of the creatively gifted* |
|---|---|---|
| Precocious language and thought<br>Early advanced comprehension<br>Logical thinking<br>Early writing, mathmetics, music, art ..<br>Motivation, persistence, advanced interests | Low anxiety and depression, better self –concepts<br>Independence, self-confidence, internal control<br>Learning styles<br>Superior humour<br>High moral thinking, empathy, perspective taking | High energy, adventurousness<br>Curiosity<br>Good sense of humour<br>Artistic and aesthetic interests<br>Sees relationships<br>Full of idea, imaginative, enjoys pretending |

However, the characteristics are also usable for identifying children who are gifted in different domains, including those considered gifted in one specific area, such as the performing arts; they usually exhibit the majority of these traits in addition to advanced skills in their main area of competence.

As a matter of fact, children who frequently demonstrate combinations of these traits or who consistently exhibit the characteristics, require 'profiling' to bring together information from academic performances, student cumulative records, service and/or psychological assessments, teacher and parent recommendations, student self-appraisals, portfolio assessments, intelligence and achievement scores, interviews with students and parents.

The definitions of giftedness used by a society or culture reflect the values of that culture. This strongly influences approaches to identification. Perhaps these definitions can be reduced to four broad areas:

1. Intellectual giftedness
2. Skills giftedness
3. Social giftedness
4. Ethical-moral giftedness

(Stankowsk, 1978; Diessner, 1983; Reid and Elsawaf, 2006)

Although, these four aspects of giftedness are all important, the focus of the current study is academically gifted students based on criteria of selection and identification set by the Ministry of Education in Kuwait.

## 2.8 Summary

Terms gifted and intelligent can be used almost synonymously when thinking in terms of academic giftedness. The concept of giftedness abounds in the literature although a wide variety of words and ideas are used to clarify the meaning. Furthermore, the nature of giftedness and the methods of its identification have been in a continuous state of development and change for over a hundred years. Numerous theorists have raised concerns about using traditional intelligence tests to measure intelligence.

On intelligence testing, the accuracy of an IQ test is still questionable. There are questions about what it measures and why measures change with time. Nevertheless, it is often still regarded as the single best predictor to test general intelligence. However, this is a cyclic argument in that IQ tests are claimed to measure intelligence and intelligence is often defined in terms of what is measured in IQ tests!

This chapter has considered some theories and definitions of giftedness, such as Renzulli's three rings theory, Sternberg's triachic theory, Gardner's multiple intelligences theory, and Teele's Rainbows of Intelligence model. The chapter has also reviewed some current issues and practices that are accepted in identifying gifted students.

Gifted individuals have different abilities, talents, and personalities. Even so, a sizeable proportion of the individuals categorized as academically gifted are distinguished from their non-gifted counterparts by virtue of superior general intelligence, which is thought to be measured by intelligence tests. This is how giftedness becomes associated with intelligence.

Overall, there are three main issues which have been addressed in this chapter.

(a) The problem of definition

(b) The problem of measurement

(c) The nature of educational provision

For *definition*, it has to be accepted that human abilities are so diverse that a simple definition is probably unrealistic. A possible way forward is illustrated in Figure 2.10.

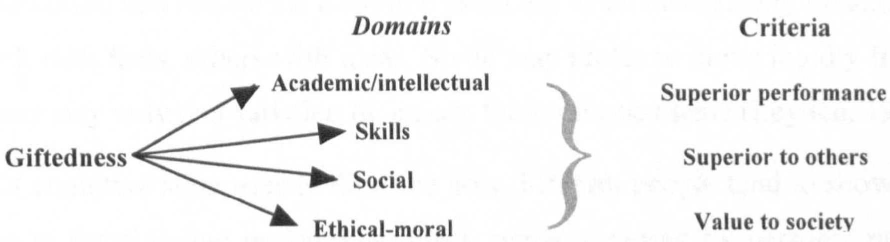



**Figure 2.10 Areas of Human Giftedness**

In this study only the academic/intellectual domain will be considered while the approach in Kuwait emphasises superior performance and evidence of superiority to others, the value to society being implicit or not fully considered.

For *measurement*, a multiple indicators approach seems always to be preferable although it has to be recognised that this does open up a measure of subjectivity. In Kuwait, the approach has been to rely only on examination marks and IQ measures, sometimes for research purpose with some input from teacher recommendations.

For *educational provision*, there are arguments for inclusion, segregation (in various forms) and acceleration (by various routes). In Kuwait, the emphasis has been on segregation seen as additional enrichment programmes offered to those considered as 'gifted'.

# Chapter Three

# Cognitive Characteristics

## 3.1 Introduction

Recently there has been increasing attention given to the idea that schools should be less concerned with what is learned and more concerned with encouraging the kind of teaching which pays attention to the way children learn (Coles,1989). Johnstone (1993) notes that information processing models suggest the presence of 'mechanisms in the learning process'. This type of approach offers one avenue of insight, showing the way students learn in a general overall sense. However, while all learning requires some kind of information processing, students' ways of learning may differ according to their particular personality, their learning styles and their varying abilities. Some learn quickly with little apparent need to practise what they learn. Others take a long time and may need constant repetition and revision if ideas and skills are to be successfully understood. Some like to work with facts, others with ideas. Some may prefer to move rapidly from topic to topic. Others may only feel satisfied by steady focus on one theme (Leyden, 1990).

The idea of cognitive style tries to describe how different people tend to show patterns of approaches to learning and undertaking tasks, perhaps caused by personal preference or by the way their brain works best. Consequently, a consideration of such styles contributes to clarifying why some people achieve a high performance in some tasks while others do not (Kirton, 1989). For example, Taylor has said, "*Everyone has both strengths and weaknesses all the way across the totem poles*" (Taylor, 1986:317).

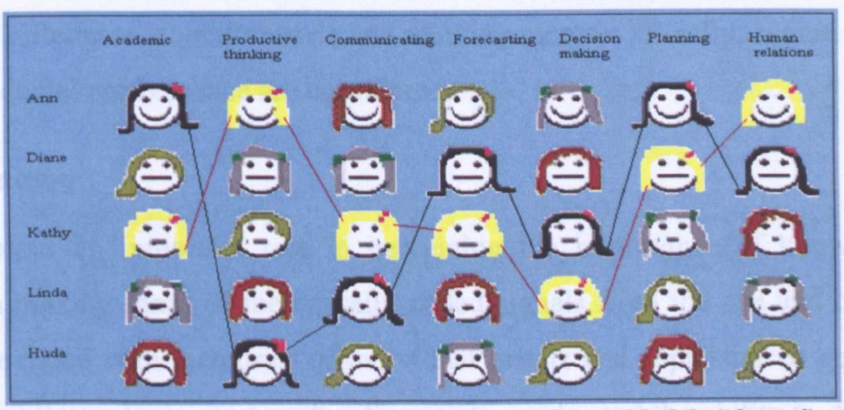



**Figure 3.1 Taylor's Multiple- Talent Totem (Seven Model, Adapted)**

Taylor's (1988) in the concept '*multiple-talent totem pole*' (Figure 3.1) highlighted nine original talents (academic, creative, planning, communicating, forecasting, decision-making, implementing, human relations, discerning opportunities) and this flexible concept can be used to define people, and select them according to the special skills or talents they possess (Davis and Rimm, 1998). Thus, cognitive style may be considered as important as intelligence and certain personality traits in describing giftedness and high performance in many areas (Sternberg, 1987).

According to Shouksmith (1970), the investigation of cognitive functioning in research into the nature of thinking should be considered from both a theoretical and a practical point of view, through the study of intelligence. However, the data collected so far and the conclusions that have been reached suggest that, if a study of cognitive processes is to be true to life, it cannot isolate any factor for independent investigation, but must concern itself with the many and various aspects of an individual's responses and adjustment to problem situations (Shouksmith, 1970).

Hayes and Allinson (1996) cited evidence of the value of cognitive style in relation to personnel selection, careers guidance, task design, team composition, conflict management and training and development.

Cognition is one of many human brain functions. This chapter outlines some aspects of cognitive style, focussing specifically on areas which seem to be directly relevant to giftedness. This chapter discusses in five sections what is meant by cognition, how cognitive styles are defined in the literature, what differences exist between style and ability, cognitive style dimensions with the last section discussing in more detail the three cognitive styles involved in this current study. These are field independency/dependency, convergence/divergence and visual-spatial. There is then a discussion of cognitive styles as related to giftedness, cognitive style and working memory. Finally, cognitive styles and issues of students' performance are considered.

## 3.2 Cognition

Cognition plays an important role in perceiving the importance of knowledge based processes in making sense of the neurally coded signals from the eye and other sensory organs. Associated with memories of individual events and sophisticated generalization, they allow subtle analogies and explanations to be made, and the ability to draw pictures, to speak, and to write (Gregory and Zangwill, 1987).

There are many processes encompassed by the term 'cognition': thinking, knowing, imagining, perceiving, remembering, recognizing, abstracting, and generalizing: all of these processes refer to the intellectual activities of the mind (Pulaski, 1980).

Frasier and Carland (1982:17) refer to a definition of cognition as "*in general, the process of knowing; in particular, the process of knowing based upon perception, introspection, or memory*". In addition, Guilford (1977) in the same book (Frasier and Carland, 1982) defines cognition as something that "*involves the act of structuring information.*" According to Meeker (1969), cognition is "*immediate discovery, awareness, rediscovery, or recognition of information in various forms, comprehension or understanding*". However, Neisser (1967) views cognition as an inclusive term that refers to all the processes by which sensory input is transformed, reduced, elaborated, stored, retrieved and used.

Vernon (1972) investigated cognition and intelligence and has pointed out that many researchers (e.g. Witkin *et al*, 1977; Crandall and Sinkeldam, 1964) investigated field independence with above average students. Moreover, Dubois and Cohen (1970) suggested that field independence should be regarded as part of intelligence rather than separate from intelligence. However, this could simply mean that field dependency correlates with intelligence tests.

Carroll (1993) claims the cognitive process 'is therefore one in which mental contents are operated on to produce some response', and every operation should be have a style which is 'toward the way in which he or she processes information and experiences' or, in other word, the measurement of a characteristic mode of operation in terms of typical performance, with the emphasis upon process (Messick and Associates 1976). Thus, the cognitive process has a style that could be called cognitive style: this will be discussed in the next section. Furthermore, a view heavily influenced by the 'information-processing' perspective claims human cognition can be understood largely in terms of "*the ways in which people process information mentally*" (Sternberg and Salter, 1982: 3).

Having looked briefly at cognition, the next section considers the nature of cognitive style.

## 3.3 What is Cognitive Style?

A number of different labels have been given to cognitive styles and it has been argued that many of them are just different descriptions of the same characteristics (Tennant, 1997). For example, phrases like 'cognitive styles', 'learning style' and 'personal style' have all been used and, although not identical, have often been used interchangeably (see Sadler-Smith *et al* , 2000; Panikolaou *et al*, 2006). This section seeks to summarise some of the different cognitive styles that appear in the literature with a review of what research has revealed about these styles. The whole area of cognitive styles, personal style, and learning styles is very large and space only permits a limited discussion here.

There are many different cognitive styles with the possibility of even more being identified through research and theory. According to Witkin (1973, unpaged):

> *In the earliest view, when observations of these styles were limited to the cognitive domain, cognitive styles were conceived as the self-consistent modes of functioning an individual shows throughout his perceptual and intellectual activities. Today, we know that cognitive styles are, in fact, manifestations, in the cognitive domain, of still broader dimensions of functioning, which cut across other psychological domains, including personality and social behaviour.*

This illustrates one fundamental difficulty. Cognitive styles can often be seen by the observer in terms of the characteristics that the learner shows when learning. The origin and nature of these is not so clear. Are they inbuilt, genetically determined characteristics, that is, aspects of the way the brain is wired up? Are they ways of working that have been taught or learned through experience? Are they ways of learning which the individual chooses to employ because they suit the learner's personality, or because the learner has simply found them to be useful and helpful? Of course, learning characteristics could be a combination of all three in any proportion. Indeed, different characteristics might different in their nature and origin.

The number of definitions in the literature is large and some are discussed below. Witkin (1976:39) noted that a cognitive style is a "*Characteristic mode of functioning that we reveal throughout our perceptual and intellectual activities in a highly consistent and pervasive way.*" However, according to Riding and Rayner (1998: 8), a cognitive style is "*an individual's preferred and habitual approach to organising and representing information*".

Several other definitions also exist:

> *"Consistent individual differences in these ways of organizing and processing information and experience" (Messick and Associates , 1976:5).*
>
> *"An individual's characteristic and consistent approach to organising and processing information" (Tennant, 1997:80).*

*"A fairly fixed characteristic of an individual, in contrast to strategies which are the way that may be used to cope with situations and tasks" (Riding and Pearson, 1995: 413).*

Many of these definitions are similar. They speak of the way individuals organise, process, and represent information. They emphasise that these ways have some kind of permanency. This, perhaps, could be taken to imply a genetic predisposition or it may simply be that the individual adopts a consistent approach.

On the other hand, other definitions have used the phrase 'learning style' and Al-Kindi (2005:39) has drawn some of these together:

*"People's consistent ways of responding to and using stimuli in the context of learning". (Claxton and Ralston, 1987:7)*

*"Variations among learners in using one or more senses to understand organise and retain information." (Dunn and Dunn, 1979, cited in Reid, 1987: 89)*

*"Cognitive and affective traits that are relatively stable indicators of how learners perceive, interact with and respond to the learning environments." (Keefe, 1979:4)*

*"Preferred or habitual patterns of mental functioning, and dealing with new information." (Ehrman and Oxford, 1990: 311)*

While the phrase '*cognitive style*' might suggest a broader perspective when compared to '*learning style*', the two sets of definitions have many common features. Both frequently refer to ways of handling information. However, some of the descriptions of learning style have brought in the idea of preference. This raises the idea that learners have adopted certain styles of learning, by preference. It could imply that they are capable of using other styles but have chosen to adopt a certain approach, perhaps because they find it more agreeable or more effective or efficient.

It is clear that the definitions used for '*cognitive style*' are very similar in meaning as those used to define '*learning style*'. This supports the earlier suggestions that these terms can be employed interchangeably (Panikolaou *et al*, 2006). When we look at studies that investigate learning styles, very often the same style appears with different names (e.g. Dunn and Price, 1980).

There is a huge range of learner characteristics described in the literature. Many researchers (e.g. Riding and Cheema, 1991; Sternberg, 1988; Vernon, 1973) have developed various models in attempts to describe and explore such styles. Other (e.g. Riding and Rayner, 1998) have tried to rationalise the area by defining four areas of psychology where cognitive styles might be related, and these are summarised:

*(1) Perception*: emerged from Witkin (1971)

*(2) Cognitive process*: is related to the way in which individuals adapt to their environment (e.g. Keefe, 1979).

*(3) Mental imagery*: is related to the way in which people represent an idea in their mind, in verbal thought or in images or visual forms (e.g. Paivio, 1971).

*(4) Personality constructs*: involves some models of style that seem closer to personality traits and are classified under the personality-centred approach (e.g. Riding and Rayner , 1998; Sternberg and Grigorenko, 1993).

The four areas make some kind of sense in the context of learning. The first relates to the relationship between the learner and what is to be learned. The second offers insight into the way the learner handles the material to be learned while the third illustrates the variations in the way the learner 'sees' things mentally. The fourth is very different and it is arguable if this is really an aspect of learning.

While it is possible to group cognitive styles into such categories, it is also possible to consider ways researchers have approached the whole area of study. Thus, Sternberg and Grigorenko (1995) examined the literature relating to cognitive style; they found three general approaches to stylistic aspects of learning:

*(a) Cognition-centred*: deals with cognitive styles, the researchers (e.g. Witkin *et al,* 1971; Messick, and Associates 1976) investigated the characteristic, self-consistent modes of functioning,

*(b) Personality-centred*: distinguished between two attitudes, namely, extroversion and introversion, and two perceptual functions (e.g. Jung, 1923; Myers and Myers, 1980)

*(c) Activity-centred*: tends to focus on styles of learning and teaching (e.g. Dunn and Dunn, 1978).

Furthermore, Sternberg and Grigorenko (1995) show that these three approaches differ. They classify them into three major traditions (e.g, Davidson, 1986; Renzulli, 1984, 1986; Kelly and Colangelo, 1984; Tidwell, 1980; Renzulli and Smith 1978; Diessner, 1983; Farley, 1986; Torrance, 1981) referred to as:

(a) The cognition-centred approach
(b) The activity-centred approach
(c) The personality-centred approach.

Entwistle (1988) argued all of these three approaches use three different concepts (cognitive styles, personal style, and learning styles) to investigate what is, in reality one concept. Gorham (1986) also suggested three broad categories: what he called '*instructional preferences*', '*information processing styles' (e.g .convergency-divergency) and 'cognitive personality elements' (e.g.* field-dependency). In this analysis, cognitive styles, personal style, and learning styles are not neatly separated. This illustrates the problem. Some have developed analysis which bring things together more as broad personal styles (e.g. Bertini, 1986).

However, Riding (2002: 23) emphasises that style needs to be seen within the context of other variables associated with personality and intelligence:

(a) "Style appears to be distinctly different from other individual differences such as personality and gender.

(b) The origins of style may be where there are two competing ways of processing information and the individual uses the one of the pair that they are best".

In fact, Douglase *and Riding* (1993) also suggested cognitive style reflects the way individuals organise information.

> " ...*many researcher working within the learning /cognitive style research fail(ed) to mention the existence of other type*s of styles" (Riding and Cheema, 1991: 193).

In addition, Riding and Cheema (1991) brought many aspects of cognitive style together and grouped them into two principal cognitive style families:

*(1) "Wholist-analytic*: affects cognitive style in terms of thinking, thinking about, and viewing and how, in responding to information and situations, an individual tends to process information as a whole or in parts.

*(2) Verbal-imagery:* affects the characteristic mode in which people represent information, either by thinking verbally or in images."

Riding and Cheema (1991) divided these two cognitive style families into two dimensions (wholist-analytic and verbal-imagery). Every dimension has two ends (wholist, imagery, analytic and verbal), one of which may overlap (integrate) with one of the end on the second dimension, thus giving four styles. Each of the four broad groups of styles has its own distinguishing characteristics (see Figure 3.2) which might have the following general descriptions.

Unfortunately, Riding has used his terminology in several ways. Sometimes the word denote families of cognitive styles, sometimes a dimension, and sometimes referring to a specific style.

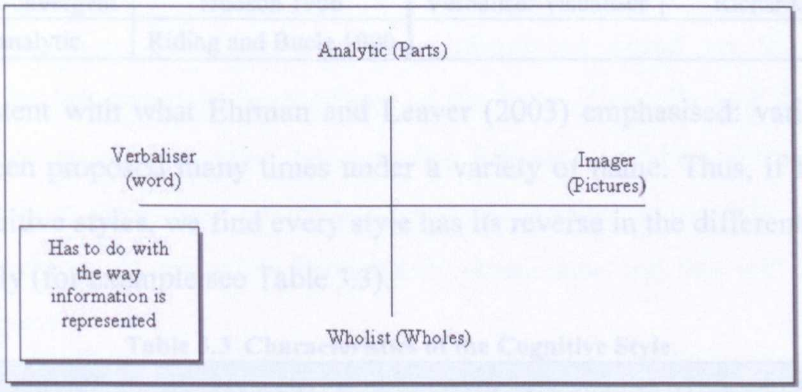



**Figure 3.2 The Cognitive Style Dimensions (Riding, 2002: 24)**

Esmaeel (2001) notes that Riding and Cheema have discussed four cognitive styles (two dimensions: wholist-analytic and verbal-imagery) and they suggested that these styles absorb a number of other learning characteristics (see Table 3.1).

**Table 3.1 The Labels of the Cognitive Style Families (Adapted from: Esmaeel, 2001)**

| **Wholist-Analytic Dimension** | | **Verbal-Imagery Dimention** | |
|---|---|---|---|
| *Wholists* | *Analytics* | *Verbally* | *Imagery* |
| Field dependent | Field independent | Abstract thinker | Concrete thinker |
| Levellers | Sharpeners | Verbaliser | Visualiser |
| Implusive | Reflective | | |
| Divergent | Convergent | | |
| Holists | Serialistis | | |

According to Riding and Rayner (1998) these labels, defined as cognitive styles, are better regarded as aspects of cognitive functioning, which refer to abilities and cognitive controls. In addition, Messick (1976) provided a summary of nineteen different 'cognitive-style' dimensions. Each dimension of cognitive style is viewed as a bipolar contrasting mode of functioning and indicates a different set of interacting attributes referred to as 'dynamic gestalt'.

It is possible to allocate various specific learning characteristics into one or other of the broad families described by Riding. (see Table 3.2).

**Table 3.2 These two Families with Some Styles and Authors (after Riding and Cheema, 1998)**

| Wholist-Analytic Cognitive Style Family | | Verbaliser-Imager Cognitive Style Family | |
|---|---|---|---|
| Field dependence-Field independence | Witkin1962 | Verbalisery-Imagery | Riding and Tayler 1976 |
| Divergent –Convergent | Hudson 1966 | Verbaliser-visualiser | Richardson 1977 |
| Wholist-analytic | Riding and Bucle 1990 | | |

This is consistent with what Ehrman and Leaver (2003) emphasised: various cognitive styles have been proposed many times under a variety of name. Thus, if looking in the family of cognitive styles, we find every style has its reverse in the different dimension of the same family (for example see Table 3.3).

**Table 3.3 Characteristics of the Cognitive Style.**

| Analytics or Field independents | Wholists or Field dependents |
|---|---|
| Tend to organise information into clear-cut conceptual grouping | Tend to organise information into loosely clustered wholes. |
| See information as collection of parts | See information as whole |
| Focus on one or two of these a time | Able to have an overall perspective and appreciate total context |
| Possibility of getting the one aspect out of proportion to the total situation | Very difficult to distinguish the issues that make up the whole of apiece of information |
| The positive strength they can analyse information into the parts this allows them to come quickly to the heart problem | The positive strength can have a balanced view, extreme view or attitudes. |

There is another problem. Even with some agreement on what constitutes a cognitive style and some agreement on what some of the styles actually are, it is not easy to separate the various styles neatly from each other: one style may have an impact on another. For example, Worley and Moore (2001) have investigated how colour impacts learners of different cognitive style, particularly how colour influences field dependency. The results show that performance scores are not influenced for students classified by cognitive style when images are presented using colour or black and white. However, it was predicted that use of highlight colour would assist the field-dependent students by directing their attention to the relevant information in the image. However, this is rather obvious.

Riding and Cheema (1991) argued that most individuals are capable of using either a visual or verbal mode of representation, but that individuals will prefer to use one rather than the other (Riding and Rayner, 1998). This illustrates a difficult area. Are cognitive styles matters of choice, or preference, or do they indicate that the person is much better equipped in one way than in another?.

There is some research relating to the genetic aspect of cognitive styles. It is thought that cognitive styles cannot neatly be separated from the nature of the brain in the way both hemispheres function. This will be discussed in more detail in the next chapter. Zenhausern and Gebhardt (1979) notes that hemispheric dominance is often referred to as a cognitive style: how a person processes information based on the differential capabilities of the left and right hemispheres of the brain. Gadzella and Kneipp (1990) found differences in reaction time between the left-and right-hemispheric groups in processing sentences structured. Gadzella (1999, 1995) investigated differences among cognitive-processing style related to hemispheric dominance and this will be discussed further in Chapter 4.

Levy (1974) agrees that the integration of both hemispheres is necessary for the most effective thinking processes: both hemispheres are in use but not with equal facility. Some individuals show a high level of integration of sequential and spatial function, but most seem to naturally favour one or the other mode of learning.

It is sometimes thought that cognitive styles are unconsciously preferred ways of learning but this assumes that such styles are not genetically predetermined or are learned patterns of behaviour. It is also stated that no one cognitive style is better than another (Al-Kindi, 2005; Reid 1998) but there is clear evidence that certain styles are almost always of benefit in learning (e.g. being field independent: see Danili, 2004).

The following section reviews the literature concerning the importance in education of understanding the cognitive style.

## 3.4 Cognitive Style or Ability

There is a problem in the way cognitive styles are conceptualised. For example, Carroll (1993:554) considered a number of style measures and concluded that many of them are, in reality, aspects of ability. However, McKenna (1984) considers the nature of cognitive style as distinct from ability and he points out four distinguishing characteristics, as outlined below:

(a) Two words are important: *level* and *manner*. Thus, ability focuses on level of performance while the manner of performance is the focus on style.

(b) Conventionally, styles are seen as bipolar (e.g. field dependent–field independent) while abilities are unipolar. However, this distinction is not as clear as might be supposed in that the opposite of ability is simply lack of ability in the same way as lack of field independence is field dependence;

(c) Ability tends to have value attached to it. Thus, one end of an ability dimension is valued and the other is not. Usually, style is presented as value-free with neither end of the dimension being seen as *better* or *worse* than the other. In fact, this is an ideal and, very often, one pole or other is seen as having an advantage in specific situations. Thus, field independence and divergency are very frequently seen as correlates of higher examination performance and, thus, gain a perceived value (e.g. Bahar, 1999; Danili and Reid, 2005).

(d) Ability has a narrower range of application than has style. However, this need not be so if ability is set free from its academic context, which is so dependent on test and examination performance.

In an attempt to distinguish ability from style, Messick (1976) summarizes his views, as shown in Table 3.4. Many of his descriptions are similar to those of Mckenna above.

**Table 3.4 Distinctions Between Styles and Abilities (Messick, 1976:7-8)**

| Abilities | Styles |
|---|---|
| • Ability dimensions essentially refer to the content of cognition or the question of what - what kind of information is being processed by what operation in what form?<br>• Implies the measurement of capacities in terms of maximal performance, with the emphasis upon level of accomplishment.<br>• Generally thought of as "unipolar"<br>• Value directional: having more of an ability is better than having less.<br>• Delineates a basic dimension underlying a fairly limited area. | • Cognitive styles, in contrast, bear on the questions of how – on the manner in which behavior occurs.<br>• Implies the measurement of characteristic modes of operation, in terms of typical performance, with the emphasis upon process.<br>• Considered to be "bipolar".<br>• Value differentiated: each pole has adaptive value in different circumstances.<br>• Cut across domains; appear to serve as high-level heuristics that organize lower-level strategies. |

Riding (2002: 22) also describes the nature of cognitive style to distinguish it from ability:

1. "The distinction between style and ability is that performance on all tasks will improve as ability increases, whereas the effect of style on performance for an individual will be either positive or negative depending on the nature of the task.

2. Style is in-built, habitual in use and fairly fixed, while learning strategies may be developed by the student to help in situations where their style does not suit the task being done."

Riding's ideas are interesting. However, if field dependency (field dependence/independence) is considered as a cognitive style, then it is known that it affects performance: being field dependent never improves academic performance (Danili, 2001). Also, if style is considered as "*in-built, habitual in use and fairly fixed*" then that implies that cognitive styles are essentially genetic. This seems unlikely.

There is much in common in these contributions and this can be summarised. Perhaps the key distinction between style and ability is found in McKenna's (1984) notion of *level* and *manner*. Abilities tend to focus on levels of performance emphasising minimum performance and final outcomes while styles consider the manner of performance, with the emphasis on the processes involved in completing a task. In general, high ability is uni-directional and valued while, at least in general terms, styles are bipolar and both ends of the spectrum have value in certain contexts. Another useful distinction, which is described by Riding (2002), is the observation that styles tend to have some measure of permanence: they seem to be the typical ways by which an individual operates. This is very different from learning strategies and, perhaps, even ability which may fluctuate, increase, and decrease or vary across different domains.

Thus, cognitive style refers to different characteristics relating to the way in which people tend to perceive, remember, think, solve problems, organize and represent information in their minds (Usama, 2002).

### 3.5 Cognitive Style Dimensions

The first formulation of cognitive style was provided by Thurstone (1944) who identified two different perceptual attitudes, which he called '*speed and strength of closure*' and '*flexibility of closure*', these patterns being seen as rather similar to Witkin's work in psychological differentiation theory (Messick, 1993).

An early interest in cognitive style as a construct is associated with the work of several areas of psychology. Some writers, for example, have approached style as:

*(a)* *Processes and abilities in cognition:* (e.g. Witkin, 1966; Furnham, 1995; Grigerenko and Sternberg, 1995; Riding, 1997),

*(b)* *Organising perspective*: (e.g. Jonassen and Grabowski, 1993; Messick, 1996).

One of the most influential works on cognitive style has been by Witkin and his colleagues (Witkin *et al.*, 1962). These cognitive styles were referred to as '*ability*' to overcome an embedding context: to experience an item independently of on organized field of which it is a part. Scores for these two measures were related to a variety of other variables, conclusions being drawn about the nature of these thinking modes. However, their work, while important, does not encompass all learning styles.

Cognitive style is an individual's preferred and habitual approach to organising and representing information. Riding (2002) has suggested two dimensions: the wholist-analytic and the verbal-imagery. People differ in two basic ways:

(a) Whether they take a whole view or see things in parts: the wholist-analytic dimension;

(b) Whether they are outgoing and verbal, or more inward and often think in mental pictures or images; the verbal-imagery dimension.

The style dimensions act in combination and individuals habitually use the most appropriate features of each of their styles in doing tasks.

Biggs (1978) investigate a relationship between learning outcome, the formation of learning strategy and the cognitive structures. He suggested the existence of two domains of cognitive processes-cognitive skills and cognitive strategies (style) and explored the way in which both contribute to the learning task.

In considering cognitive styles and the possible dimensions, there are several fundamental issues:

(a) Are cognitive styles essentially fixed genetically or are they open to learning or they mainly matters of choice?

(b) If the learner can choose a learning strategy, is there any limit to the range of choice available?

(c) The phrase 'cognitive style' seems appropriate if such styles are essentially genetic, learned or gained by experience; the phrase 'learning strategy' may be more appropriate of choice is the key feature.

It does seem that genetics plays a major role. However, learning and experience may play a considerable part in the style eventually developed. Indeed, the way genetic disposition, learning and experience interplay may be highly complex and may vary considerably from style to style. Nonetheless, it is possible to suggest that a person will tend to operate in a fairly constant way with regard to any particular style, there being only a limited room for movement. This can be illustrated in Figure 3.3. Here, the cognitive style of being field dependent or independent is used simply to illustrate the idea. The student, arising from genetic disposition, learning and/or experience, is seen to hold a particular position on the scale. However, there is some freedom for choice around that position.

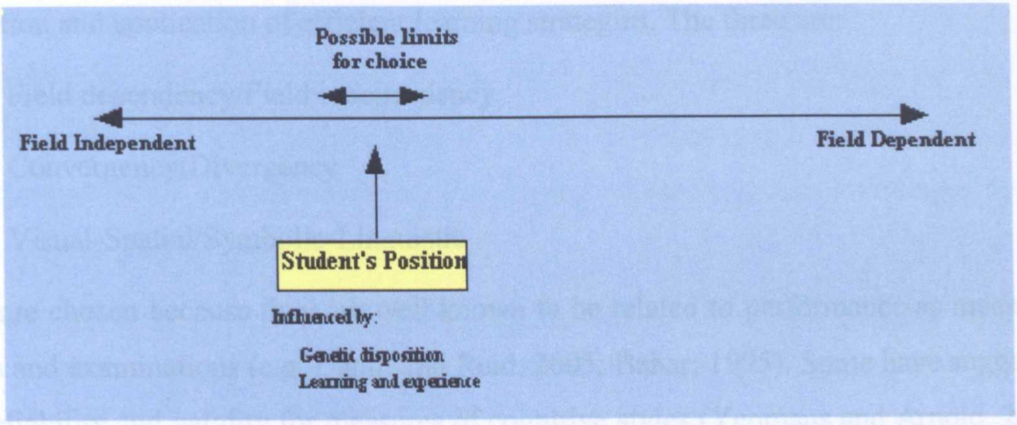



**Figure 3.3 Scope for Choice in Cognitive Styles**

It is highly likely that the relative importance of each of genetic disposition, learning/experience and choice will vary from style to style. This may influence subsequence learning and affect performance considerably. It is even possible that students can choose to adopt a particular style for a particular task or topic and this is illustrated in figure 3.4

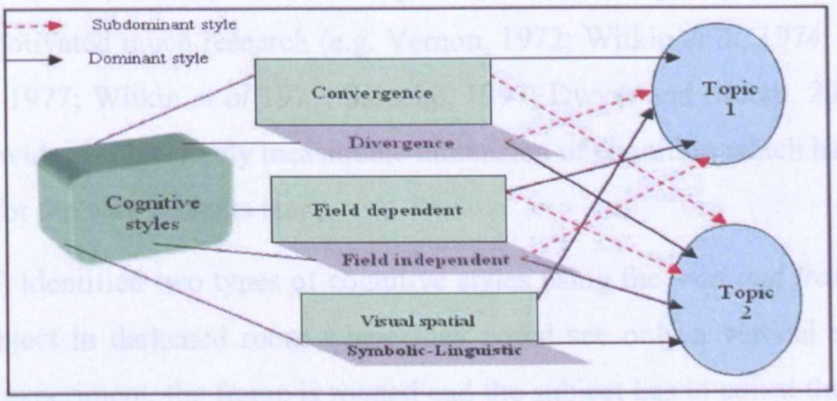



**Figure 3.4 How the Cognitive Styles Work Together**

Looking at figure 3.4, is possible that a student in studying topic 1 find greater success in being convergent, field independent and being visual-spatial in approach. Of course, this assumes that such choices are open to the student. Different characteristics might be advantageous with topic 2. This might involve one styles or another becoming dominant.

This might be related to hemisphericity. Thus, Springer, and Deutsch (1998) argue that the hemispheres differ in style of thinking, and they concluded that hemisphericity - *the idea that a given individual relies more on one mode or hemisphere than on the other-* may influence the dominant style.

## 3.6 Three Cognitive Styles

A review is now offered of three specific cognitive styles which may influence the acquisition and application of efficient learning strategies. The three are:

(1) Field dependency/Field independency

(2) Convergency/Divergency

(3) Visual-Spatial/Symbolic-Linguistic

These are chosen because they are well known to be related to performance as measured in tests and examinations (e.g. Danili and Reid, 2005; Bahar; 1995). Some have suggested poor reliability and validity for measures of cognitive styles (Yeomans and Arnold, 2006) but it has to be recognised that reliability is often being seen as internal consistency and this may not be appropriate (see chapter 6).

## 3.7 Field Dependence-Independence

It is intended here to explore in more detail field dependence/field independence as a cognitive style. For simplicity, the phrase field dependency will often be used here.

Witkin's *et al* (1962) concept of field dependence/field independence attracted great interest and motivated much research (e.g. Vernon, 1972; Witkin *et al*, 1974; Witkin and Goodenough, 1977; Witkin *et al* 1977; Saracho, 1997; Dwyer and Moore, 2001) since it appears to provide an objectively measurable dimension of cognition which has important implications for the way students learn.

Witkin (1949) identified two types of cognitive styles using the *'rod and frame test'*. He tested the subject in darkened room where they could see only a vertical rod inside a frame. In the experiment, the frame is rotated and the subject has to adjust the rod so that it is vertical. The subjects may be influenced in their judgments by the position of the frame as well as relying on their own sense of balance and other bodily cues affecting their sense of the vertical. He assumes those subjects who perform the task accurately can be classified as what is known as *'field-independent'* and those who are influenced by the frame are *'field-dependent'* (Govier and Govier, 1992).

The theory of field-dependence or independence is considered to be a bipolar expression of individual differences: one end is not better or worse than the other (Witkin, 1978). At one end is the global mode of the field-dependent, and at the other end is the articulate mode of the field independent (Goodenough, 1976; Witkin, 1978; Witkin &Goodenough, 1981; Witkin, *et al*, 1977).

Witkin describes as field-dependent (FD) an individual who has difficulty in separating an item from its context. Moreover, an individual who can easily break up an organized field and separate relevant material from its context or discern signal (what matters) from noise (the incidental and peripheral) in a confusing background is field-independent (FI) (Johnstone and Al-Naeme, 1991).

At a perceptual level, field independent personalities are able to distinguish figures as discrete from their backgrounds compared to field dependent individuals who experience events in an undifferentiated way. In addition, field dependent individuals have a greater social orientation relative to field independent personalities. Studies have identified numerous connections between this cognitive style and learning (see Messick, 1978).

In addition, numerous factors have been considered as possible determinants of the cognitive style of field dependency. Tinajero and Paramo (1997) classify these factors into three main groups, summarized here:

*(a) Biological*: investigations have attempted to relate field dependency with genetic factors; essentially, the question is whether individuals are genetically determined as field dependent or independent (to varying degrees);

*(b) Psychological*: investigators working in various fields have attempted to track down the processes that bring the field dependency construct into play; is the style developed in certain contexts, is it demonstrated in certain contexts?

*(c) Socio-cultural*: analyzed through a series of contexts, with particular emphasis on cultural, interpersonal, educational, and family: for example, are there situations where independence is developed?

In simple terms, this is an aspect of the nature-nurture debate. Is the field dependency cognitive style simply a matter of genetic disposition, is it developed through experience and learning or is it a bit of both?

Saracho (1997) argues that field dependency characterises one dimension of perceiving, remembering, and thinking when an individual takes in, stores, transforms, and processes information. However, it could be argued that the construct really relates primarily to perception. As Johnstone *et al.* (1993) argues, the field independent person is able to select the 'message' from amongst the 'noise'.

Furthermore, Worley and Moore (2001) found that field-independent learners tend to score higher on *criterion measures* than field-dependent learners when information is presented visually. This is seen in the suggestion by Felder and Soloman (1996) that visual learners highlight material on each topic in a different colour, while verbal learners annotate or outline the material.

In addition, James (1973) reports that most field independent teachers gave field independent students higher grades than they did to field dependent students and most field dependent teachers gave the higher grades to the field dependent students. It might be thought that a teacher who is field independent, say, might encourage their students also to become more field independent. However, it is equally possible that such a teacher, being aware of the problems which arise from being effective in selecting the 'message' from the 'noise', tend to overcompensate and, inadvertently encourages greater field independence with the students.

Many researchers (e.g. Wayss, 2002; Ramirez and Castaneda, 1974; Saracho, 1997; Esmaeel, 2002), have offered descriptions of the characteristics of those who are field dependent and those who are field independent. These are summarised in Table 3.5.

**Table 3.5 Characteristics of Field Dependence/Independence (source: Esmaeel, 2002)**

| Field Dependent | Field Independent |
|---|---|
| • Global | • Analytic |
| • Accepts structure | • Generates structure |
| • Externally directed | • Internally directed |
| • Attentive to social information | • Attentive to social cues |
| • Conflict resolvers | • Philosophical, cognitive |
| • Sociable and gregarious | • Individualistic |
| • Affiliation oriented | • Distant in social relations |
| • Interpersonal | • Intrapersonal |
| • Need friendship | • Reserved, aloof |
| • Conventional, traditional | • Experimental |
| • Influenced by the salient features | • Generates own hypotheses |
| • Factually oriented | • Conceptually oriented |
| • Acquires unrelated facts | • Acquires information to fit conceptual scheme |
| • Accepts ideas as presented | • Represents concepts through analysis |
| • Influenced by format/structure | • Less affected by format/structure |
| • Gets feelings/decisions from others | • Impersonal orientation |
| • Sensitive to others | • Insensitive to social undercurrents |
| • Affected by stress | • Ignores external stress |

However, lists like this may be comprehensive but are not very helpful in defining field dependency clearly.

## 3.8 Convergence/Divergence

> *No one was, or was ever expected to be, consistently convergent or consistently divergent"..... "I have never seen why someone should not drift slowly over a period of years from divergence to convergence, or vice versa. Nor why someone should not be divergent in some moods and convergent in others. Nor why someone might not be convergent (or divergent)* (Hudson, 1968:91).

Guildford (1965) introduced a model of the structure of the intellect in which he differentiated between a number of cognitive operations including convergent and divergent thinking. Hudson (1968) realised Guildford's distinction and suggested that tests of divergent were not so much a measure of creativity as a sampling of the individual's preferred style of thinking (cited in Lovell 1980:105). In addition, the idea of convergence/divergence was further developed by Hudson (1966), and its implications for the process of teaching and learning more fully explored.

Hudson reported that learners who were convergers preferred formal problems and structured tasks demanding logical methods. In contrast, learners who were divergers preferred more open-ended tasks which required creativity. The divergent thinker was far more likely to react negatively to routine or to the task involving the familiar or expected and requiring a correct answer (Riding and Rayner, 1998).

Messick (1976) notes that convergence and divergence have been studied by different researchers (e.g. Getzels and Jackson, 1962; Hudson, 1966; Wallach and Kogan, 1965) and argue the convergence ability helps in intelligence tests. Each style is now discussed.

### 3.8.1 Convergent Style

Hudson (1968) concluded that there were two different forms of cognitive style. The first is called 'convergent' in which the person is good at bringing material from a variety of sources to bear on a problem, in such a way as to produce the 'correct' answer. This kind of thinking is particularly appropriate in science, mathematics and technology. Because of the need for consistency and reliability, this is really the only form of thinking which standardized intelligence tests (and even national examinations) can test (Atherton, 2004). Convergent thinking means that someone has to focus on, or converge on the one idea or answer in order to find the solution of a problem. Convergent thinkers score highly in problems requiring one conventionally accepted solution clearly obtainable from the information available (as in intelligence tests), while at the same time obtaining low scores in problems requiring the generation of several equally acceptable solutions. According to Hudson:

> *"The converger is the boy who is substantially better at the intelligence test than he is at the open-ended tests; the diverger is the reverse" (*Hudson, 1966: 55*).*

The Frasier and Carland (1982) summarise two other definitions:

The first: refers to the process whereby the student takes a large number of facts or associations, and puts them together in certain predictable combinations to come out with one right possible answer. The clearest academic illustrations of convergent thinking can be found in arithmetic reasoning problems, where the student takes a variety of facts and pulls them together to come out with the right answer. All instances of deductive reasoning involve convergent thinking (Gallagher, 1975).

The second: refers to a type of thinking appropriate for closed-solution-type (one answer) problems whereby the individual attempts to operate according to prescribed and tested forms of analysis, method and judgment. Reissman (1962) defines 'convergent' in the following way:

> *"Convergent creativity: this is the kind of creativity that is called forth by our best examination when they require the bringing together of ideas from many sources in order to answer the test question. At its best, this demand does stimulate the reorganization of concept".*
>
> (Reissman 1962:79 cited in: Frasier and Carland, 1982)

In addition, Hashway (1998) notes that, in convergent thinking the information leads to one right answer, to a recognized best or conventional answer. This view is demonstrated in Figure 3.5.

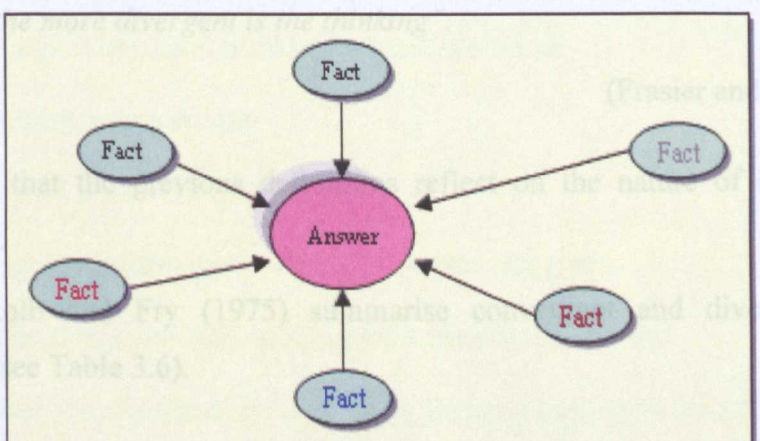



**Figure 3.5 Convergence**

### 3.8.2 Divergent style

Hashway (1998) describes the other style as 'divergent' thinking. The student's skill is in broadly creative elaboration of ideas prompted by a stimulus, and is more suited to artistic pursuits and study in the humanities (see Figure 3.6)

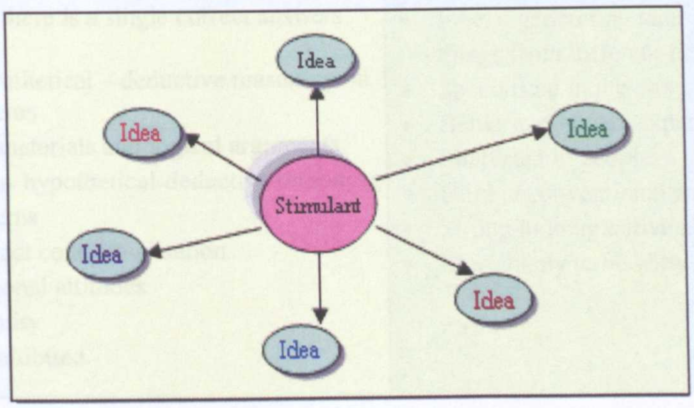



**Figure 3.6 Divergent**

In order to investigate this kind of thinking, Hudson (1966), Sacks and Eysenck (1977), and Lloyd-Bostock (1979) used open-ended tests.

Frasier and Carland, (1982) summarise other definitions for divergent thinking:

> *"Owen, Blount and Moscow (1978): the development of more than one possible response to a problem or question. Believed to be a central characteristic of creativity.*
>
> *Gallagher (1975): A much more free and open type of intellectual operation, in which the distinguishing characteristic is the large number of possible associations or problem solutions.*
>
> *Good (1973): Mental activity directed to open-end kinds of problems for which there is no one correct answer; the more infrequent statistically a response is under these conditions, the more divergent is the thinking".*

(Frasier and Carland, 1982)

It can be seen that the previous definitions reflect on the nature of convergent and divergent styles.

In addition, Kolb and Fry (1975) summarise convergent and divergent thinkers' characteristics (see Table 3.6).

**Table 3.6 Summary: the General Characteristics of Convergence and Divergence (source: Kolb and Fry, 1975)**

| Convergers Characteristics | Divergers Characteristics |
|---|---|
| • Higher performance in the practical application of ideas when there is a single correct answers (e.g, IQ test)<br>• Can focus hypothetical – deductive reasoning on specific problems<br>• Prefer formal materials and logical arguments<br>• Ability to focus hypothetical-deductive reasoning specific problems<br>• Better in abstract conceptualisation<br>• Hold conventional attitudes<br>• Like unambiguity<br>• Emotionally inhibited | • Higher performance in open-ended tests<br>• Fine at generating ideas and seeing things from different perspectives<br>• Specialised in the arts<br>• Better in concrete experience<br>• Interested in people<br>• Hold unconventional attitudes<br>• Strong in imaginative ability<br>• More likely to be witty |

Table 3.6 shows that convergence is different from divergence. Cropley (1967) suggested that there are two different styles of learning. Sak and Maker (2005) conducted an interesting experiment in relation to mathematics problem solving where they set problems which favoured a convergent approach and others which favoured a divergent approach, finding significant correlation between the performance in the two sets.

From the literature reviews (e.g. Davis and Rimm, 1998, Doherty and Evans, 1990), some important thinking skills have been summarized. The convergent style learner tends to use, for example: determining cause and effect, analyze, reasoning by analogy, making inferences, determining relevant information, recognizing relationships and applying spatial relationships, deductive thinking skills, using logic and analyzing syllogisms, spotting contradictory statements. Doherty and Evans (1990) noted those students who use these thinking skills need an actual sequential learning style, as they are useful organizers. They have deference ability, like to know limits, and want to have a procedure to accomplish things. They need thinking processes such as:

(a) Understanding relationships

(b) Collecting all the relevant information

(c) Organizing the information using a list, table, and graph

(d) Finding the relationship by looking for a pattern or keyword

On the other hand the divergent learner tends to use thinking skills processes such as: listing attributes of objects/situation, generating multiple ideas (*fluency*), generating different ideas from multiple viewpoints (*flexibility*), generating unique ideas (*originality*), generating detailed ideas (*elaboration*), and synthesizing information.

The learning style of the student who uses these thinking skills involves sensing a problem, formulating hypotheses or guesses, revising and retesting the hypotheses and communicating the results (Davis and Rimm (1998). They need thinking processes such as:

- Exploring
- Questioning
- Experimenting,
- Testing ideas
- Problem solving

Hudson notes that assessment of *'convergency'* can usually be inferred from success on tests that may be based on verbal or numerical input (such as the items on intelligence test) while the assessment of *'divergency'* is based on the ability to *'generate'* answers.

### 3.9 Visual-Spatial Style

Visual tools are now becoming key teaching, learning and assessing tools in many classrooms. Together, students and teachers are generating mental models of how they perceive the world (Hyerle, 1996).

Through the visual learning system, the child or adult recognizes objects, distinguishes sizes and shapes, perceives depth, notes colour, and uses visual-spatial awareness to estimate where he is. In school, visual-spatial learning underlies such varied disciplines as reading, mathematics, science, art, and athletics. Vail (1989) focuses on the connections among visual learning, reading, and writing. She considers three components of visual learning: vision, visual perception, and visual memory.

Some research (e.g. Levin *et al.*, 1987; Paivio, 1986) suggests that images increase the level of learning when applied to specified tasks. In addition, Hyerle (1996) noted three interrelated reasons why more and more teachers and students are using visual tools:

(a) Teaching and learning in a constructivist-cognitive paradigm.

(b) New technologies and visual designs are guiding information flow.

(c) Student-centered learning and '*interactivity*' are emerging as the new structures for classroom relationships.

Human visual perception starts with two-dimensional arrays of light falling on our retina. The task of the visual perception is to enable us to use the information provided in the array of light in order to react appropriately to the objects surrounding us. One way to try and view the process of vision is to divide the problem into three parts:

(a) How the visual information is encoded.

(b) How it is represented

(c) How it is interpreted

(Wagemans *et al*, 2005)

In the early 1980s Silverman discovered an over-arching division of learning characteristics into two categories, which she termed '*auditory-sequential*' and '*visual-spatial*'. Her findings were based on extensive research.

> *...(We) have amassed data on learning modes, behaviour patterns, and personality characteristics that appear to be correlated with high visual-spatial abilities. We have found clusters of traits appearing with such regularity that we have come to believe that they are directly related to a visual-spatial orientation to learning.*

(Silverman, 1989:15)

According to Silverman, the concept of the '*visual-spatial learner*' is:

> *"Visual-spatial learners are individuals who think in pictures rather than in words"*

(Silverman, 2003)

Hass (2003b) found that about one-third of the general population (not just the gifted) from age nine to thirteen are strongly visual-spatial while a little under one-fourth are strongly auditory-sequential. Of the rest in the middle with more balanced strengths, those who show a tendency toward visual-spatial outnumber their auditory-sequential classmates two-to-one.

In anther study, 750 fourth, fifth and sixth graders in Spanish schools used as a visual-spatial identifier a simple, 15-item checklist to help parents and teachers find visual-spatial children. One-third of the school population emerged as strongly visual-spatial. An additional 30% showed a slight preference for the visual-spatial learning style. Only 23% were strongly auditory-sequential (Silverman, 1999).

In addition, Posner and Keele (1968) used three random nine-dots '*prototypes*' in an experiment to show how powerful the brain is as a classifier of visual information. To perceive an object, one must segregate if from the other visual information available in a scene that composes the background of the figure.

> *"object recognition begins with separating the figure from the background and with the grouping of sensory features in accordance with principles of Gestalt psychology."*
>
> (Kellogg, 1995: 59)

The best way to identify the visual-spatial learner is by taking a comprehensive history that includes the early and current health of the child, using a checklist of characteristics and asking the child to complete tasks involving auditory sequential processing and those utilising visual-spatial abilities and comparing the results (Golon, 2004).

Silverman (2002), in her book '*Upside-down brilliance*' notes that visual-spatial learners are individuals who think in pictures rather than in words (Figure 3.7).

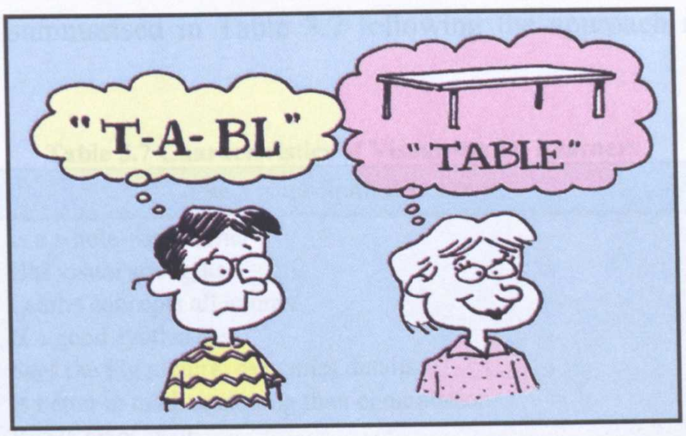



**Figure 3.7 Visual-spatial Learners think in Pictures**
**(Buck Jones, 2005. source: www.visualspatial.org)**

They learn better visually than auditorally. The learning is permanent. They do not learn from repetition and drill. They are whole-part learners who need to see the big picture first before they learn the details. They are non-sequential, which means that they do not learn in the step-by-step manner in which most teachers teach. Furthermore, she mentions they could find correct solutions without taking independent steps. Thus, the instruction to '*show your work*' may be impossible for them. They may have difficulty with easy tasks, but show amazing ability with difficult, complex tasks. They are systems thinkers who can orchestrate large amounts of information from different domains, but they often miss the details. They tend to be organizationally impaired and unconscious about time. They are often gifted creatively, technologically, mathematically or emotionally.

Kerr (1991) suggested a few points which may help to pick out the visual-spatial student, summarised below:

(1) Draws models or builds with technical skill and imagination;

(2) Surpasses peers in ability to create cartoons, painting, sculpture or architectural or mechanical models;

(3) Has high scores on the Raven progressive matrices or other test of spatial/visual reasoning;

(4) Has high scores on the figural section of the Torrance tests of creative thinking (measure creative abilities of fluency, flexibility, originality and elaboration);

(5) Has high scores in any engaging work-based activities that requires spatial/ visual ability such as art, mechanical drawing, architecture designing, etc.

There are many researchers who have offered lists of visual-spatial characteristics (e.g. Silverman,1999; Golon, 2004; Pittelkow, 2003; Codd, 2006). Some of these characteristics are summarised in Table 3.7 following the approach adopted by Penny (2003).

**Table 3.7 Characteristics of Visual-spatial Learners**

| The Visual-Spatial Learner |
|---|
| • Is a whole-part learner<br>• Has visual strengths<br>• Learns concepts all at once<br>• Is a good synthesizer<br>• Sees the big picture; may miss details<br>• Is better at math reasoning than computation<br>• Reads maps well<br>• Learns sight words better than phonics<br>• Must visualize words in order to spell them<br>• Learns best by seeing relationships<br>• Has excellent long-term memory<br>• Prefers keyboarding to writing<br>• Creates unique methods of organization<br>• Learns difficult concepts easily; struggles with easy skills<br>• Develops own methods of problem solving<br>• Learns concepts permanently: is turned off by drill and repetition<br>• Performs better in untimed situations<br>• Arrives at correct solutions intuitively<br>• Masters other languages through immersion<br>• Is very sensitive to teachers' attitudes<br>• Generates unusual solutions to problems<br>• Develops quite asynchronously<br>• May have very uneven grades<br>• Enjoys geometry and physics<br>• Is creatively, mechanically, technologically, or emotionally gifted |

Silverman (2002) compared the visual-spatial characteristics with the auditory sequential characteristics. She found they possessed characteristics different than each other. In a traditional classroom setting, the visual-spatial learner faces a number of disadvantages. School is mostly an environment based on language and number in which the curricula, textbooks, classroom management techniques, teaching methods are based on the verbal and symbolic (Haas, 2003a).

In addition, Silverman (2002) offers several ways used to identify the visual-spatial learner, these constituting a multi-trait, multi-factor, multi-method study incorporating:

(a) Self-rating by students

(b) Observer reports by parents

(c) Observer reports by teachers

(d) Subjective assessment by teachers

Towards the end of the 1970s, research on the visualizer-verbalizer cognitive style dimension began to generate educational literature (Kozhevnikov, *et al* 2005). In addition, Paivio (1971) was designing an 'individual differences questionnaire' to evaluate the extent to which different people habitually use imagery versus verbal thinking.

Krutetskii (1976) proposed that individuals could be classified into groups according to how they process mathematical information. Krutetskii found the first group was the 'analytic type', consisting of people who prefer verbal-logical modes when attempting to solve problem, and the second group was the 'geometric type': those who prefer to use imagery.

According to Vail (1989), visual perception allows human beings to organize and understand, and can be seen in the following ways: they recognize visual images, remember their connotations, and distinguish the familiar from the unfamiliar. Children who exhibit strong visual-spatial abilities combined with auditory sequential weaknesses are considered visual-spatial learners. Visual-spatial learners are excellent visualisers and must visualise in order to learn. The visualisation is a key element in the mental processing of visual-spatial learners. They think primarily in images or pictures. Visual thinking is very fast, complex and not sequential.

> "*Words are like a second language to me. I translate both spoken and written words into full-color movies, complete with sound, which run like a VCR tape in my head. When somebody speaks to me, his words are instantly translated into picture*"
>
> *(Grandin, 1996)*

It is possible to relate the visual-spatial characteristic to the ideas suggested by Riding and Cheema (1998) (see Table 3.8).

**Table 3.8 Characteristic Differences of Visualer/Verbaliser (Source: Jonassen and Grabowski, 1993:192)**

| Visualiser | Verbaliser |
|---|---|
| • Image oriented | • Word oriented |
| • Fluency with illustrations | • Fluency with words |
| • Has vivid dream | • Seldom dreams |
| • Prefers to have someone show them | • Prefers to read about the idea |
| • Enjoys Jagsaw puzzles | • Enjoys word games |
| • Subjective self-oriented | • Objective task oriented |
| • Left eye movement | • Right eye movement |
| • Understands visuals | • Understands semantic complexity |
| • Manipulates and transforms images | • Manipulates and transforms symols |

Visual memory is a part of memory preserving some characteristics of our senses pertaining to visual experience. The human is able to place in memory information that resembles objects, places, animals or people in some kind of a mental image. Some authors refer to this experience as an 'our mind's eye' (West, 1991)

During the period from the late 1950s through to 1980, many experiments on short-term or working memory were published. Most of these studies dealt only with verbal materials (e.g. Sperling, 1960 Klemmer, 1963; Philips, 1974).However, Pascual-Leone (1970) used a visual test to measure working memory. In addition, Baddeley and his co-workers (e.g. Baddeley, 1986) have proposed separate stores for verbal (phonological) information and visuo-spatial information. Some studies have provided some evidence for the distinguishing visual from verbal (Smith, 1997).

Visual memory has the capacity to store large amounts of details from visual information (Standing, Canezio and Haber, 1970). Individuals will perform with high recognition when they recall details from pictures. A number of studies (e.g. Hitch *et al.*, 1989; Snodgrass *et al.*, 1972) investigated the effect of visual and verbal materials on human memory, and they found that visual information is stronger than verbal information in facilitating recall. This is a very important observation given the high dependence of the verbal in school learning.

Pavio (1971,1986), in his '*Dual-code theory*', suggests that visual and verbal information is each processed differently along distinct channels with the human mind creating separate representations for information processed in each channel. He assumed that pictures have superiority for encoding information in the memory over concrete words or abstract words and he indicates that verbal and visual information are encoded by different systems, one system for visual images and the other for verbal language. The two systems are interconnected in that, when stimuli are represented as an image in the visual system, they can be represented as verbal language in the other system.

Baddeley and Hitch (1974) in their *'working memory model'* proposed the *Visuo-spatial Sketchpad* as one of three components for working memory. It holds the information it gathers during the initial processing of it and if it is retrieved later from the long-term memory, to produce the recollection of an image. However, some people use their visuo-spatial sketchpad often in normal thought processes, while others use it very little (see chapter 4).

### 3.10 Cognitive Style and Giftedness

*"The cognitive differences can lead to high levels of career success in many fields".*

(Tolan, 1994:135)

This discussion faces a very real problem. Many researchers have assumed that intelligence tests (which can measure IQ) actually measure intelligence. In other words, they imply that intelligence testing defines intelligence. They then relate outcomes from intelligence testing to measures of various cognitive styles. On this basis, it is possible to draw conclusions about intelligence and specific cognitive characteristics. However, it is equally possible to argue that intelligence tests are simply like any other kind of school tests and merely measure performance but that the performance is not related to any specific discipline like mathematics, history, language or physics. It is then possible to conclude that certain learning characteristics are related to school testing outcomes. The following discussion needs to be interpreted with this in mind.

Students vary enormously in the way they learn but sometimes education does not take account of these differences. This is largely because most educational systems have developed in ways which are dependent on linguistic and logical-mathematical emphases and thus learners who cope well with such approaches have benefited most. In particular, schools have not reflected many of the different and creative ways by which the student can learn (Teele, 2000).

Sadler-Smith and Riding (1999) argued that cognitive style has an important role to play in determining an individual's instructional preferences and that this may affect learning performance. In addition, Rogers (1986) concludes that the gifted generally differ in *degree* and not *kind* of cognition. Thus, gifted students tend to acquire and process information and solve problems better, faster or at earlier ages than other students (Robinson and Clinkenbeard 1998). Witkin and Goodenough (1981) emphasised that:

> *Intelligence is something one has 'more' or 'less' of, but this does not apply to cognitive style: the field-dependence-independence dimension is bipolar with regard to level, in the sense that it does not have clear "high" and "low" ends. Its bipolarity makes the dimension value-neutral, in the sense that each pole has qualities that are adaptive in particular circumstances.*
>
> (Witkin and Goodenough, 1981:59)

Also, cognitive style has been defined as *"cognitive characteristic modes of functioning that we reveal through our perceptual and intellectual activities in a highly consistent and pervasive way"* (Hashway, 1998: 51).

Lovecky (1994) focused on the cognitive differences between two groups of gifted children: those described as 'moderately gifted' (IQ 140-159) and the group described as 'highly gifted' (IQ 170 and above). She concluded her finding that highly gifted children tend to make simple tasks more complex, have a need for extreme precision, understand complex patterns quickly, reason abstractly at an earlier age, and have exceptional memory.

There is a difficulty in relating cognitive styles to any concept of intelligence. For example, Riding and Pearson (1995) and Riding and Agrell, (1997) reported that no significant relationships were found between cognitive styles and intelligence. However, it is known that field dependency is strongly related to examination performance which is often linked onto idea of intelligence. Much depends on how intelligence is seen.

According to Saracho (1997) the *"term cognitive style conveys a consistent way in which individuals process information. It reveals the individuals mode of responding and functioning in a variety of situations"* (Saracho, 2003: 161).

Saracho (1997) suggests understanding (gifted and non-gifted) cognitive styles and their relationship to learning could be reduced to a few points:

(a) Cognitive style identifies the ways individuals react to different situations.

(b) Cognitive style influences how abilities develop.

(c) Cognitive style describes consistencies in using cognitive processes.

(d) Cognitive style does not describe the content or cognitive level of an individual's performance.

Saldler-Smith and Riding (1999) considered important an individual learner's cognitive style and their instructional and assessment preferences such as:

*(a) "assist in the design of learning programmes which acknowledge learners' style and preferences;*

*(b) contribute to the development of models of individual differences in learning and cognition;*

*(c) provide directions research into the validity of matching instructional methods to learners' style and preferences".*

(Sadler-Smith and Riding, 1999:359)

Diseth and Martinsen (2003) analysed the relationship between approaches to cognitive style and academic achievement in a sample of 192 students. They found style had indirect effects on achievement, (possibly by means of, examination procedures and the nature of the curriculum) Furthermore, from a study of sixth-form science and arts students (aged about 17-18) in England, Hudson (1966) found that science students, specially those specializing in physics, tended to prefer a convergent style of thinking while art students specializing in English literature, history and modern languages were found to be more likely to be divergent.

Riding, and Al-Hajji (2000), in considering studies of secondary school students in the UK and Canada, have shown that cognitive styles are independent of IQ tests. The independence of style and intelligence is important since low ability can be a contributory cause of problem behaviour.

Davidson (1986) measured the performance of gifted students on mathematical and verbal insight problems. Insight was defined as the selective or novel encoding, combining, or comparing of information. Gifted middle school students not only scored better than others on the insight problems but they were more likely to employ selective encoding, combination, and comparison spontaneously in solving the problems. Other children were more likely to need cues in order to use these processes.

Milgram, Dunn, and Price (1993) investigated cognitive styles of gifted adolescents in nine countries. They compared gifted adolescents in one specific area, in different culture. They found that young people who were gifted in the same area shared some cognitive style preferences even though they lived in very different cultures (see Milgram, 2000).

Burns *et al* (1998) investigated the differences between the cognitive style preferences of high academic achievement students in same-age students with average or below average academic achievement. They found that cognitive style inventories should be used as they were originally intended: as informative diagnostic instruments to measure the learning style preferences of an individual student.

Usama (2002) found that intellectually gifted students have a cognitive flexibility to move from one mental process to another. His study also showed that cognitive style in combination with intelligence plays an important role in academic performance.

Getzels and Jackson (1962) studied 449 boys and girls, in age between 12 and 17 years, with high IQ. They found that:

- The high creativity group equalled the high IQ group in scholastic achievement.
- There was not any motivational difference
- Teachers preferred the convergers to the divergers.

Getzels and Jackson (1962) realised that there was a large number of creative students whose actual scholastic performance shows them to be gifted and that these students are being ignored by schools as not gifted because they did not perform well on an IQ test (Bireley, 1991).

Hasan and Butcher (1966) investigated 175 Scottish children, forming two groups: high creativity and high IQ. They found that the high IQ group was preferred by teachers as in Getzels's and Jackson's study. However, the high creativity group was lower in attainment, and there was a considerable overlap between convergent thinking and divergent thinking.

Silverman (1989, 2002) identifies two types of gifted visual-spatial learners. The first is children identified as gifted who score extremely highly on an IQ tests because of their great ability both with tasks using visual-spatial processing and those requiring auditory sequential thinking processes. The second is children who have great ability in visual-spatial processing and marked weaknesses in auditory sequential processing.

Gardner (1985) in his theory of *multiple-intelligences* pointed out that a visual-spatial intelligence is one of seven intelligences that the brain can have. It lends itself not only to the visual arts but also to mathematics and science.

## 3.11 Cognitive Style and Working Memory

There have been many claims by cognitive psychologists that working memory plays a role in learning. This is supported by numerous studies demonstrating close links between working memory capacity and measures of learning and academic achievement (Gathercole, *et al.* 2006). Baddeley and Hitch (1974) suggested a multi-component approach to working memory that aims to understand the way in which information is temporarily stored and maintained in the performance of complex tasks.

> *Working memory has been conceptualised as a thinking-holding space. It is where new information is placed temporarily and previously learned information can be taken from long term memory. It is where the person thinks, interprets, seeks to understand and where problems are solved. Its finite and fixed capacity makes it the "bottle-neck" for all learning*
>
> (Johnstone, 1997).

There are several important aspects which might relate to giftedness. Firstly, those who have higher working memory capacities have a clear advantage in learning and testing (Johnstone, 1991, 1997). This might assist in enabling a school student to perform well above average and might be a contributor towards giftedness. Secondly, if academic giftedness is assessed by traditional school tests and examinations, then the evidence is very clear that those with a higher working memory capacity perform better. This is known to be a function of the type of testing most commonly used (Reid, 2000).

Thirdly, a rarely explored aspect is speed of processing. It is possible that those with a higher working memory capacity might be able to process information faster. This would also give such learners some advantage. There is a fourth aspect: if working memory capacity is fixed, then it is important to consider how the use of that finite space can be enhanced and made more efficient. This is mainly through the process of chunking (see Miller, 1956a). Is it possible that those who are found to be gifted have developed more effective and efficient ways to chunk information.

Miyake *et al* (2001) proposed the performance on field independence/dependence tasks primarily reflects the operations of the visuo-spatial and executive components of working memory. Their results support the finding that there is a relationship between field independence/dependence and working memory components.

Studies carried out by a number of researchers (e.g. El-Banna, 1987; Al-Naeme, 1988; Danili, 2001; Christou, 2001) found that there are differences in performance among learners with the same working memory capacity but with different levels of field dependency. These who are field independent select more efficiently and, therefore working memory is less likely to be overloaded.

Finke *et al* (2006) investigated 18 subjects to clarify the role of the left and right hemisphere lobes for pattern and spatial visual working memory. They found that human left and right hemispheres are differentially involved in visual pattern and spatial working memory. While for spatial working memory the right hemisphere lobe seems to play a specific role, pattern working memory seems to depend critically on both hemispheres.

Marios and Ivanoff (2005) reviewed the cognitive and the neurobiological literature and they found that the capacity limit of visual working memory storage primarily localized to the posterior parietal and occipital cortex. They noted that the visual cognition is limited by the rate and a mount of information that can be stored in visual working memory.

According to Baddeley (1986) a visuo-spatial sketchpad is one of the working memory components. The visuo-spatial sketchpad subsystems are responsible for the temporary maintenance of verbal and visuo-spatial information, respectively (Lawrence, *et al.* 2001).

Miyake *et al* (2001) indicated that involvement of the visuo-spatial sketchpad appears to be very important in visual tasks. For example, the hidden figures test (a test to measure the extent of field dependency) requires the temporary maintenance of some visual-spatial information. It is clear that the role of the working memory is important.

### 3.12 Cognitive style and Performance

The way we learn things in general and the particular approach we adopt when dealing with problem depends on a somewhat mysterious link between personality and cognition: this link is referred to as cognitive style (Wayss, 2002).

Hebb (1972) notes that learning is not something we see or observe directly. Instead, it is something inferred from behaviour: a presumed change in the nervous system that produces changes in changes in performance. Also, research on student learning has increasingly recognized the influence of all these domains on academic performance (Entwistle, 2001; Sadler-Smith *et al,* 2000). In addition, Sadler-Smith and Riding (1999) investigate the cognitive style in 240 business studies university students and found there was a significant main effect of cognitive style.

Biggs (1979: 381) conceived student learning in terms of three stages:

- "Input: include curriculum content and other features in the teaching context;

- Process: ways a particular student has of going about selecting and learning from the input;
- Output: the quality and quantity of subsequent performance."

Gellel (2005) investigated 731 students, of average age of 13, on the Island of Malta, and detected a significant interaction between cognitive styles (wholist-analytic and verbaliser-imager) and scholastic performance in 6 subjects (Religion, English, Maltese, Maths, Science, and Information Technology) and he found there is a distinction between the components of scholastic ability and cognitive style.

Riding (2002) suggest that the learning performance of an individual is likely to be affected by an interaction between cognitive style, and:

- The way the instructional material is structured
- Its mode of presentation
- Its type of content

However, results from studies (e.g. Witkin *et al*, 1977) suggest that cognitive style affects the teachers' instruction and the student's choices of preferred subjects. However, a study by Jolly and Strawitz (1984) revealed that the matching of students to that of the teachers' cognitive style did not necessarily produce the best achievement in students. They found that field independent students achieved equally well with either field independent or field dependent teachers. On the other hand, field dependent students performed better with field independent teachers than with field dependent teachers. Mahlios (1990) argued that the match of teachers and students increases positive effects on interpersonal attraction.

Gul *et al* (1992) found that the field independence/dependence dimension of cognitive style affected accounting students' performance in multiple-choice examination. Many studies (e.g. El-Banna, 1987; Al-Naeme, 1988; Ziane, 1990; Christou, 2001) found that learners who are field independent and with high working memory capacity tend to produce the best performances in academic achievement. They also show that field independent students prefer sciences and mathematics, while field dependent students prefer social subjects. Indeed, Danili (2004) shows that, in a review of many studies, those who are field independent always perform better in school and university examinations although the difference is not always significant statistically. Later, she shows how the type of questions being asked is one factor influencing the extent of the effect (Danili and Reid, 2005). This might lead to the conclusion that field dependency is just a measure of intelligence but such a conclusion assumes that school and university tests and examination performance reflects intelligence.

Goodenough (1976) asserted that field independent/dependent persons differ in the way they learn but that they achieve the same performance. However, the evidence does not support his view. The problem is resolved by the work of Danili and Reid (2005): the type of testing is important. That explains why, for example, Ghani (2005) found there was no significant difference in the performances shown by the three field dependency categories in a statistics examination. Nonetheless, the general finding is that being field dependent never seems to be an advantage in any test or examination.

Hitch *et al* (1989) suggested that, when the information is presented both verbally and visually, students give attention to visual information and ignore the verbal. The visual-spatial style of learning is not well suited to school tasks. The school curriculum is sequential; the textbooks; the workbooks, the teaching methods, thus the visual-spatial learners need a gestalt approach to learning (Silverman, 1989).

## 3.13 Summary

This chapter has reviews some aspects of the place of cognitive styles in an educational setting. There is a very large problem in finding agreed definitions and descriptions. It does appear, however, that certain styles do have advantages in learning and assessment. Thus, it is possible that giftedness might be related to certain combination of learner characteristics which might include cognitive styles. The next chapter will discuss the process of learning in some detail and offer further insights on how this might work.

# Chapter Four

# Information Processing

## 4.1 Introduction

Until the 17th century, it was thought that the heart was the seat of mind and emotions. Wundt established the first dedicated psychology laboratory in 1879 and this was the start of modern experimental psychology. However, he was not concerned with the unconscious processes involved in responding to a simple stimulus but focused on observable responses to stimuli. He considered the unconscious processes to lie in the dominion of physiology rather than of psychology (Braisby and Gellatly, 2005). However, it was appreciated that mind and emotions were centred in the human brain. Indeed, consistent with the work of the Gestalt psychology and behaviourism in the early twentieth century, it was not thought admissible to explore what actually went on in the brain as learning took place (Armstrong, 1993).

The work of Piaget (1920s, see Evans 1973) demonstrated that learning went through stages and that the learner was actively seeking to make sense of the world around him or her. His followers (e.g. Pascual-Leone, 1970) tried to find *explanations* for his observations and they started to appreciate that the explanations lay in understanding the way the learner processed information. There were limits in how much information could be processed by a person at one time.

At the same time, there was a very large amount of research in the 1960s and 1970s exploring why secondary school students and university students were finding certain themes in the sciences (especially chemistry and physics) so difficult (Johnstone *et al*, 1971). By 1983, Johnstone was beginning to realise that the '*amount of information to be held at one time*' was what was causing the problems (Johnstone, 1983). Quite separately, Miller (1953) had been exploring memory and found ways to measure the capacity of what he called 'short term memory'. Later, it was appreciated that the so-called 'short term memory' was better re-named as 'working memory': this is the part of the brain where thinking, understanding and problem solving take place.

On encountering any information or input from the outside world, the human brain deals with it through three basic mental functions: acquisition, processing and storing, and retrieval. The first two are concerned with executing some cognitive processes, like for example, perception, ordering, relating, processing. Retrieval is an important part of the memory system (Eysenck, 1993)

Research started to show that working memory and cognitive styles are two of the vital mediators that affect the way the brain handles information (Johnstone and Al-Naeme, 1995). They, therefore, are of great interest to this study with its specific emphasis on the 'gifted' brain. Accordingly, both are discussed in this review. The focus of this chapter is on the memory system in general and working memory in particular. This is a major area of study for cognitive psychologists attempts to describe the mind and how it works (Yeomans and Arnold, 2006).

Figure 4.1 seeks to illustrate some of the possible connections between aspects of the functioning of the human brain during learning. The arrows do not necessarily imply any flow process but indicate some kind of connection.

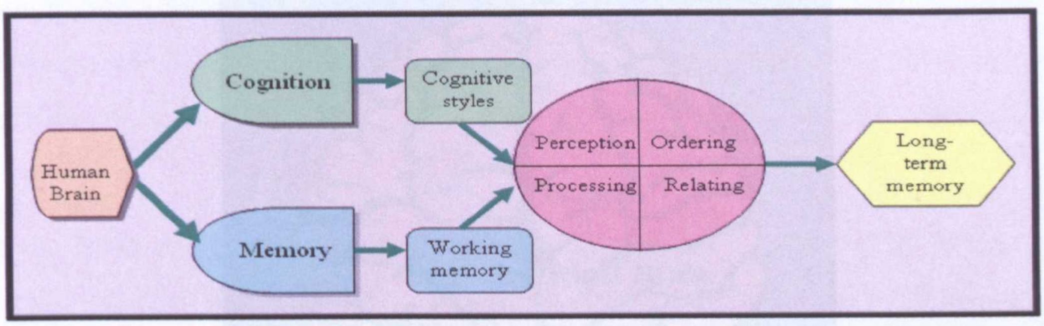



**Figure 4.1 Outline for Two Human Brain Functions**

All this thought led to the ideas which became known as information processing models and the findings will be discussed here, with a specific emphasis on the insights they offer to the world of different abilities and, hence, giftedness. Figure 4.1 aims at representing visually the relationship between cognitive styles (previously discussed in chapter 3) and memory as both are considered two important functions of the human brain.

This chapter, therefore, will address first how the human brain works. Second, an overview of the human memory and its functions is discussed. Then, a review of the short term memory, the working memory and the information processing model is finally presented.

## 4.2 How the Human Brain Works

Inside the human brain, 100 billion neurons work together and this number remains more or less constant throughout life. The brain is divided into two hemispheres (left side and right side), each of which has four lobes, which are associated with cognitive functions (Hall, 2005). In the middle of the last century, a significant amount of research evidence (e.g. Sperry, 1960) began to suggest that this duality in modes of thought reflects a concentration of different mental abilities in the right and left cerebral hemispheres of the brain. The left hemisphere absorbs through the senses those stimuli that originate primarily from the world on the right side of the body, and the right hemisphere senses the world on the left. However, in the lowest levels of information processing, the two hemispheres perform the same function. The two hemispheres operate differently in complex cognitive processes (Russell, 1982).

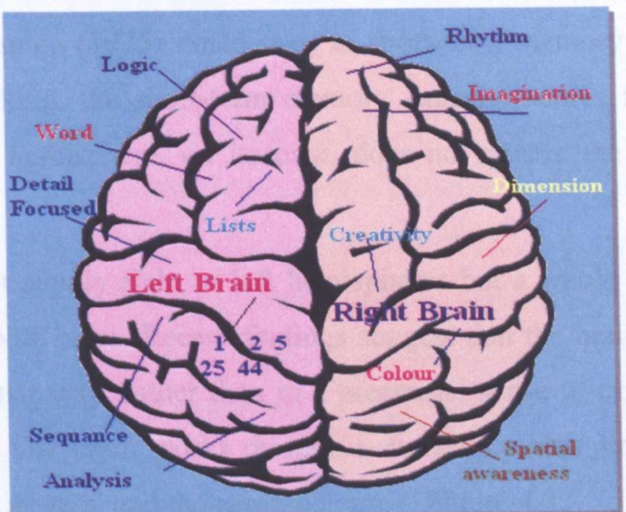



**Figure 4.2 The Human Brain (Left and Right Sides)**

Figure 4.2 shows Sperry's 'split brain' idea, illustrating how human functions are divided in the left and right and what each hemisphere has as its focus: the left part of the brain is heavily involved in the processing of language, rational planning behaviour, mathematical concepts, linear-sequential reasoning, and the convergent production of ideas, discrimination, differentiation and classification. On the other hand, the right hemisphere is dominated by the appreciation of spatial relationships and patterns, imagery, fantasy, dreams, music, control in divergent thinking processes requiring multiple solutions of problems for which there is no single right answer (Tannenbaum, 1983).

In addition, Zaidel (1983) has shown that the range of cortical skills is much more widely distributed. He demonstrated that both cerebral hemispheres seem to have a latent ability to perform the full range of cortical skills. In other words, both hemispheres can carry out the entire range of processes although each hemisphere has the capacity to specialise.

Sperry's studies of 'split brain' divided the skills into the left and right hemispheres as shown in Table 4.1.

**Table 4.1 The Lift and Right of the Cortex Processes**

| The left side | The right side |
|---|---|
| Logic<br>Words | Rhythm<br>Imagination |
| Lists | Daydreaming |
| Number<br>Sequence | Colour<br>Dimension |
| Linearity<br>Analysis | Spatial awareness<br>Whole picture |
| Purposefulness | Playfulness |
| Verbal | Visual |
| Reason | Emotions |

Nakamura and Gazzaniga (1975) noted that, in short-term memory studies, when both hemispheres are working, the short-term memory capacity scores fell into the normal range although each hemisphere, on its own, does not enable the full capacity to be reached.

Thus, the brain is not simply right or left hemispheres but a whole entity with constant interaction between both sides. Recent findings suggest that the brain's organization can be viewed in a modular way, rather than in a hierarchal sense of organization (Springer and Deutsch, 1998). The brain works through a constantly changing interaction of the brainstem, the limbic system, and the cerebral cortex. Figure 4.3.

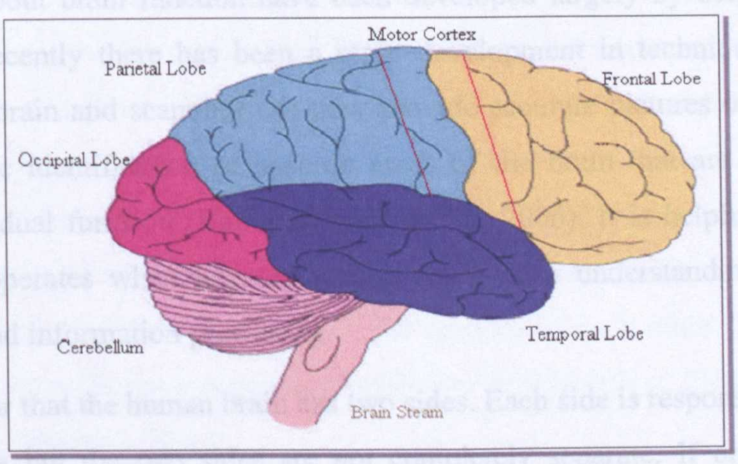



**Figure 4.3 The Frontal Lobe is Place of the Working Memory**

In general, the left and right hemispheres of the brain process information in different ways. Everybody tends to process information using the dominant (or preferred) side.

However, the learning and thinking process is enhanced when both sides of the brain participate in a balanced manner. Sperry *et al.* (1952) found that the more people use both sides of their brains together, the more the use of each side benefits the other.

Diamond (1988) discovered that the human brain could change and improve. In the theory of the '*Plasticity of the Brain*', it is implied that environmental conditions, interpersonal stimulation, and the way in which individuals think and behave actually changes the body, the brain, and giftedness (intelligence). Since then, the capacity of the brain to respond to environmental input, specifically 'enrichment' has become an accepted fact among neuroscientists, educators, and others. In fact, the demonstration that environmental enrichment can modify structural components of the rat brain at any age altered prevailing presumptions about the brain's plasticity (Diamond, 2001).

> *"Brain research indicates that higher order brain centers that process complex, abstract information can activate and interact with lower order centers, as well as vice versa."*
>
> *(Genesee, 1994: 2)*

Wolfe and Brandt (1998) drew these ideas together and suggested some features which they argue are 'well established': the brain changes physiologically because of experience and the environment; it is not fixed at birth but is shaped by experience and learning; some abilities are acquired more easily during certain sensitive periods; and learning is strongly affected by emotion. These are important ideas in considering giftedness, how it arises, how it can be developed and enriched. Indeed, these ideas are important in looking at learning in a school setting in general.

The structures about brain function have been developed largely by being able to look inside brains. Recently there has been a rapid development in technique which allow scanning of the brain and scanning can now provide accurate pictures of brain activity. This helps in the identification of specific areas of the brain that are responsible for aspects of individual function (Yeomans and Arnold, 2006). It is helpful to understand how the brain operates when learning and to relate such understandings to cognitive characteristics and information processing.

Overall, it is clear that the human brain has two sides. Each side is responsible for specific mental processes but the two sides are not completely separate. If one or other side dominates, then certain characteristics appear. Thus, for example, the person who shows high levels of creativity as a way of thinking is right side dominated while the nature of the left side tends to lead to logical thinking.

There is a particular feature related to this that influences the understanding of academic giftedness. The tendency is to define giftedness in terms of high performance in examinations or tests, including IQ type tests. Most of these are based on the three "Rs" (reading, writing, and arithmetic) and all of these skills are essentially left-hemisphere functions. Thus, there is a real danger that right-hemisphere giftedness is neglected, this being more often seen in activities related to art lessons, music lessons and sports. These are often perceived as less important (Russell, 1979). Thus, giftedness is too often being defined in practice in terms of only a limited range of skills and abilities, those being associated mainly with left-hemisphere functions.

## 4.3 Human Memory

Memory is essential for all human activities and everyday life is more or less impossible without a memory. In our lives, many different types of demands are placed upon us. We use our memories when we receive any information like friends' names, telephone numbers, our home address, important lectures, and shopping lists, or in a multitude of events in life, from birth until death. Information learned from the surrounding environment, whether public or academic, is a source of knowledge and is also dependent on memory although the written word has given humanity a wonderful way to store information. Memory is a fundamental mental process; thus, learning and memory are among the most intensively studied subjects in the field of neuroscience. Okano, *et al* (2000:12403) described memory as '*a behavioural change caused by an experience, and define learning as a process for acquiring memory*'.

In thinking about how to develop memory, it is vital that we understand what is actually taking place and how the memory works. There are various function-specific areas of the brain (Markowitz and Jensen 1999) (see Figure 4.3). This is very much a biological or medical way of considering the way the brain works and the nature of memory. Memory can also be studied in terms of behaviour and this is the psychological approach. Equally, memory in the context of learning (in formal and informal settings) is the province of education. However, the three approaches offer insights to each other. Memory, as it is studied in psychology, is not a mental faculty-power or function of the mind that can be examined by introspection. Thus,

> *"The term memory embraces a collection of activities, including both physiological and psychological processes, which can only happen now because certain things that occurred earlier, in the recent or remote past, have had a lasting effect on the organism."*
>
> (Flores, 1964: 216)

Indeed, there is a major distinction between storage and retrieval among the memory researchers. It is important not only to consider how information is stored but also the mechanisms by which it can be recalled (and why these sometimes fail), a point noted by Eysenck (1993).

This study focuses on giftedness. Clearly, memory functions are likely to be related to being gifted. These functions will now be discussed in terms of process and behaviour.

## 4.4 The Memory Function

In thinking of how the memory functions we recognize that there is a wide variability in what is to be remembered, the contexts and learning situations where material is being studied, the many possible ways by which information can be coded and stored as well as the way recall is sought. There are also individual variations. Nonetheless, research has shown a considerable amount of common ground in the way the memory functions.

There are three basic conceptions of memory, summarized as:

(1) The multiple system view emphasizes the structure of memory, dividing it into separate but related systems.

(2) The processing view focuses on the cognitive processes that are used, both at encoding and at retrieval.

(3) The functional view stresses the role of memory, addressing the question of how memory works and what its fundamental characteristic are.

(Neath and Surprenant, 2005)

It seems, in the field of memory research, that there are two general approaches. One of the views sees the memory as a unity and as an indivisible complex entity (e.g. Melton, 1963; Crowder, 1993; Laming, 1999).

The second view involves multiple systems (e.g. Baddeley and Scott, 1971; Shallice and Warrington, 1970). In this view, memory is formed from different components its multiple processors and multiple systems (Tulving, 1999). The evidence supports both approaches but the latter approach offers useful insights into the learning situation (Hutton, and Towse, 2001). This is discussed further in this section.

One well-supported understanding sees two major components in human memory: one store specializes in holding information briefly and temporarily. This system has been called primary memory (e.g. Broadbent, 1958), short-term store (e.g. Atkinsons and Shiffrin, 1968), short–term memory (e.g. James, 1890; Higbee, 1977) and working memory (e.g. Baddeley and Hitch, 1974). The other store specialises in holding information permanently.

Atkinson and Shiffrin (1968) have drawn the general theoretical framework in categorizing the memory system along two major dimensions: one categorization distinguishes permanent, structural features of the system from control processes that can be features of the system, and that can be readily modified or reprogrammed in the subject.

Furthermore, Sousa (2003) notes that, over the years, general memory models have evolved to distinguish between the types of memory and the stages of memory. For example, Russell (1979) divided the memory into several type of memory as illustrated below:

- Episodic memory: memory for past episodes and events.
- Factual memory: memory for facts;
- Semantic memory: memory for meaning;
- Sensory memory: memory coming through the five sensors;
- Memory for skills;
- Instinctive memory: genetic memory present at birth, and which automatically features physical and mental characteristics;
- Collective memory: appears in dreams, thought outside the normal experience of life;
- Past life memory: some people appear to be able to remember events from before their birth.

On the other hand, it is usually considered that there are three stages of memory, as Neath and Surprenat (2005) state:

1. *"Encoding: refers to the acquisition and initial processing of information;*
2. *Storage: refers to the maintenance of the encoded information over time;*
3. *Retrieval: refers to the processes by which the stored information is accessed and used".*

(Neath and Surprenat, 2005:221)

In addition, Sousa (2003) describes the stages of memory as stages dealing with the temporal nature of memory, and the length of time a memory can be operating to influence behaviour or thought.

Today, neuroscientists agree that there are three types of temporal memory: immediate memory and working memory for temporary interactions, and long-term memory for permanent storage. Figure 4.4 illustrates how the person can gather information from the environment around them. Then, the information goes through immediate memory to reach the working memory, before (possibly) being transferred to long-term memory. The diagram also illustrates how the information may be forgotten at each stage.

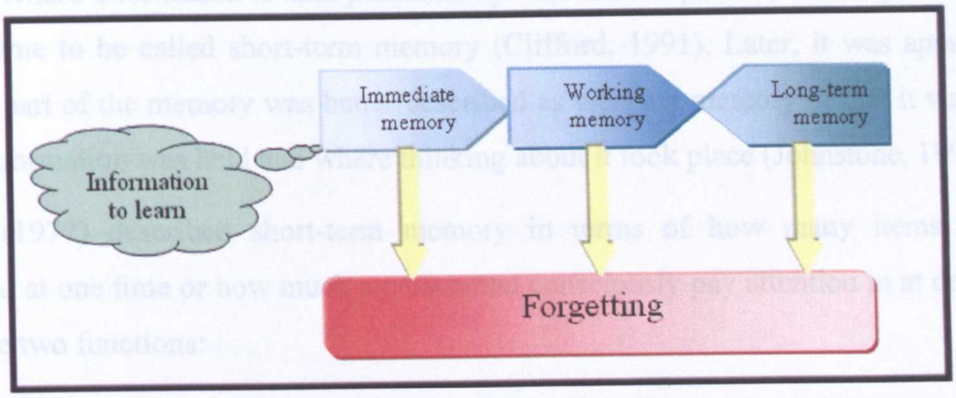



**Figure 4.4 The Human Memory Stages**

Higbee (1977) agrees that the process of remembering is generally viewed as consisting of three stages:

> *(1) "Acquisition or encoding: learning the material in the first place.*
>
> *(2) Storage: keeping the material until it is needed.*
>
> *(3) Retrieval: getting the material back out when it is needed."*
>
> (Higbee, 1977:12)

According to Higbee, memory operates at least two different processes: short-term memory and long-term memory.

In the psychological studies of memory (e.g. Atkinson and Shiffrin, 1968), there is considerable agreement that it can broadly be divided into sensory memory, short-term memory or working memory, and long-term memory. It is clear that the short-term memory (or working memory) refers to the temporary storage of material necessary for performing a range of complex tasks such as comprehension, reasoning, and preparation for long-term storage (Baddeley, 1999; Atkinson and Shiffrin, 1968).

After the publication of Miller's very important articles (1956a, 1956b) and book *"Plans and the structure and behaviour"* (Miller *et al*, 1960), the idea of dividing memory took serious hold. However, researchers use the terms 'short-term memory' and 'working memory' with a certain ambiguity of meaning. Specifically, the working memory or short-term memory is a function of the front lobe in the brain, and this area is responsible for information processing. The ambiguity of meaning will be discussed later.

### 4.4.1 Short-term Memory

James (1890) was one of the first psychologists to make the distinction between primary memory, as one type of memory that endures for a very brief period, and secondary memory where information is held permanently. The idea of primary memory changed so that it came to be called short-term memory (Clifford, 1991). Later, it was appreciated that this part of the memory was better described as working memory in that it was place where information was held and where thinking about it took place (Johnstone, 1997).

Higbee (1977) described short-term memory in terms of how many items can be perceived at one time or how much a person can consciously pay attention to at once. He noted the two functions:

- *"Can keep the information in short-term memory.*
- *Can help us transfer the information in to long-term memory by giving time to code it."*

(Higbee, 1977:14)

While the psychological space in short-term memory is fixed, the effective capacity of short-term memory can be increased by grouping things together so that they occupy only one space. Miller (1956a) describes this process as "chunking": grouping separate bits of information into larger chunks. Miller describes the short-term memory and chunking by use of a simple story:

> *"It is as if we had to carry all our money in a purse that could contain only seven coins. It does not matter to the purse, however, whether these coins are pennies or silver dollars".*

(Miller 1956a: 131)

For example, if the coins are 'pence', then the capacity of the purse is only seven pence, but if the seven coins are 'coins of five pence' (each representing a 'chunk' of five pence) then the capacity is 35 pence. If they are pounds, the chunking is increased to seven hundred pence. The process is related with organizing and reorganizing and chunking skills are based on previous knowledge and experience. Miller measured the capacity and found it be 7±2.

However, Cowan (2000) argued that Miller offered his 'magical number' working memory seven, only as an a 'rhetorical device' and that the number seven estimates a commonly obtained, compound capacity limit rather than a pure capacity limit in which chunking has been eliminated. According to him there are four basic conditions in which chunks can be identified and capacity limits can accordingly be observed:

- "*When information overload limits chunks to individual stimulus items;*
- *When other steps are taken specifically to block the recoding of stimulus items into larger chunks;*
- *In performance discontinuities caused by the capacity limit;*
- *In various indirect effects of the capacity limit.*"

(Cowan, 2000: 87)

Nonetheless, Miller's measurement of 7 spaces has stood the test of time, fits observations, and is consistent with the studies by Johnstone (1997) on difficulties with assessment tasks in chemistry.

Baddeley and Hitch (1974) found that short-term memory does more than store information briefly until it can be coded into long-term memory. Short-term memory is also the psychological space in which mental calculations take place, operations of the sort needed in reasoning, problem solving, and language understanding. Hence, short-term memory is a working memory, *a "mental blackboard that is used in the service of higher cognitive processes"* (Smith, 1997).

Cowan (1988, 1995) made an important conceptual distinction between short-term memory and working memory. He argued that there is a single memory storage system that consists of elements at various levels of activation. Cowan's view is that the working memory system consists of the contents of short-term memory plus controlled attention. On the other hand, Baddeley and Hitch (1974) claim the short-term memory is a simple storage component, whereas working memory is a storage component as well as an attention component.

According to Atkinson and Shiffrin (1968), the basic structural feature of episodic memory consists of three memory stores: the sensory register, the short-term store, and the long-term store. The three stores are structurally distinct because they preserve information in different forms, for different duration and for different purposes, and because they lose information in different ways.

Ormrod (1989) notes that the short-term memory is where new information goes after attention have been paid to it. He claims that three possible activities might take place:

- Thinks about new information just received from the environment;
- Thinks about something have retrieved from long-term memory;
- Thinks about how new information is related to old information.

It is possible to focus on memory structures or on memory processes. However, these two approaches interrelate.

### 4.4.2 Working Memory

Originally, the psychological space was described as 'short term memory' emphasising its function in holding a limited amount of information for a limited time. Later the phrase 'working memory' was widely used, as it was appreciated that the space was also used to process information. For example, Atkinson and Shiffrin (1968) argued that *"the short-term store may be regarded as the subject's working memory"* (p 92), and elsewhere, regarding the processes of information transfer, they claimed, *"the copying of selected information from one store into next...without the transferred information being removed from its original store [lead to] a subject-controlled scan of the information in the register; as a result...selected information is introduced into short-term store."* (Atkinson and Shiffrin,1968: 94).

In essence, the terms 'working memory' and 'short-term memory' describe the same psychological space but seen in functionally different ways (Anderson, 1990: 150). Many definitions or descriptions exist in the literature, for example:

> *"A system that can keep active only a limited amount of information (say, 7 ± 2 items").*
>
> (Smith, 1997: 73)

> *Short-term memory is the type of memory we use when we wish to retain information for a short time to think about it. The short-term memory store has a working memory component, a sort of mental workspace or sketchpad in the mind that is used to manipulate information in consciousnesses*
>
> (Seamon and Kenrick, 1994: 220).

This concept, which includes both processes and storage, can be contrasted with the theories (e.g. Broadbent, 1975; Miller, 1956) where working memory is more commonly labeled short-term memory (Daneman and Carpenter, 1983).

Bringing it altogether, it is important to appreciate that short-term memory and working memory are the same psychological (and, indeed, physical) space. It is that part of the brain where information from the world around us is held temporarily and into which information from long-term memory can be drawn. It can be thought of as the place where a person thinks, understands, and solves problems. Equally, it is the place where the *control* of thinking, understanding, and problem solving rests. Whatever way the evidence is interpreted, the finite size of the space is known to be rate-controlling for much learning and problem solving (e.g. El-Banna and Johnstone, 1986, 1989). The question then arises about the size of the space. Is this a factor in enabling a person to function is such a way that her/she can be described as gifted? This will be discussed later.

It has been recognised that working memory may be conceptualised as a structure or space, or it can be conceptualised in terms of the process undertaken or controlled by it. Some of the most widely used models are now discussed.

**Baddeley's working memory**

Baddeley and his colleagues (see Baddeley, 1986, 2000, 2002; Baddeley and Hitch, 1974; Baddeley and Logie, 1999) developed what is currently the most influential view of working memory. His work is based on evidence he gained working as a clinical psychologist. Part of the goal was to examine more closely the idea of immediate memory as a place where mainly basic cognitive operations are carried out.

***Multi-component approach to working memory***

Much research has suggested that the working memory system comprises three components: the central executive, and two slave systems namely, the visuo-spatial sketchpad and the phonological loop (Baddeley and Hitch 1974, Baddeley, 1986, Baddeley, 2002). This multi-component approach to working memory aims to understand the way in which information is temporarily stored and maintained in the performance of complex cognitive processing. Thus, according to Baddeley, working memory can be defined as "*a memory system that has both storage and a processing component*". (Baddeley, 1986).

A key feature of this model is the existence of specialised components for dealing with different aspects of working memory activity. As mentioned above, at least three major components are thought to contribute to the functioning of working memory. These include a central executive, which is involved in the control and regulation of the working memory system, and two domain specific '*slave systems*' responsible for dealing with information that is in either phonological or visuo-spatial form (see Figure 4.5)

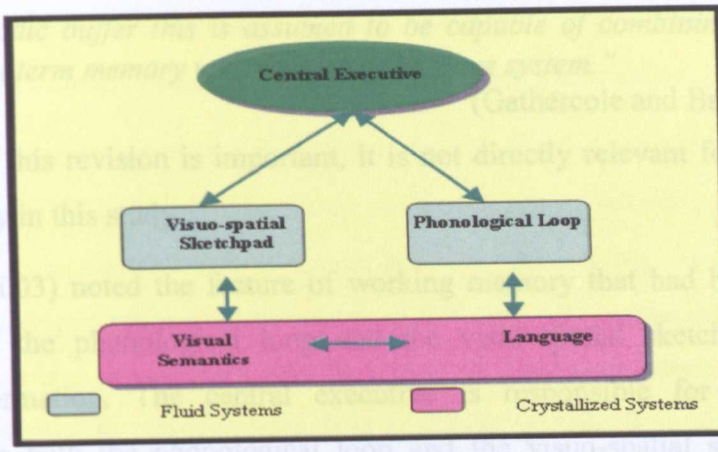



**Figure 4.5 .The Working Memory Revised to Incorporate Links with Long-Term Memory**

***The central executive***

The central executive is considered to function as a control system. It is a limited capacity attentional system, responsible for co-ordinating the input and output of information to and from the subsidiary slave systems, and for selection and operation of the two slave systems, the phonological loop and the visuo-spatial sketchpad.

***The phonological loop***

The phonological loop is a system specialised for the storage of verbal information over a short time. According to Baddeley (1986, 1999, 2002) the phonological loop is assumed to comprise two components:

- Temporary store, assumed to decay over a period of about two seconds unless refreshed by rehearsal
- An articulator: rehearsal control process, which serves to maintain decaying representations in the phonological store; it was proposed to give an account of the word length effect, whereby immediate serial recall is a direct function of length of the items being retained.

***The visuo-spatial sketchpad***

The third component of the working memory system is the visuo-spatial sketchpad. It is a "*slave system specialised for the processing and storage of visual and spatial information, and of verbal material that is subsequently encoded in the form of imagery*" (Gathercole and Baddeley, 1997).

The multi-component model was revised to differ from the initial model in two ways:

"(1) *An explicit link is proposed between the two subsidiary systems and verbal and visual long-term memory.*

(2) *The episodic buffer this is assumed to be capable of combining information from long term memory with that from the slave system."*

(Gathercole and Baddeley, 1997: 17)

However, while this revision is important, it is not directly relevant for the meaning of working memory in this study.

Riding *et al.* (2003) noted the feature of working memory that had been described by Baddeley: both the phonological loop and the visuo-spatial sketchpad are used in processing information. The central executive is responsible for the control and integration from both the phonological loop and the visuo-spatial sketchpad. This is suitable to the way the brain functions as explained previously.

### 4.4.3 Information Processing

Human brains constantly receive information through the five senses. According to Carroll (1993), a *process* refers to any action or series of actions by means of which something is operated on to produce some result. Information processing models of memory have developed out of work on selective attention carried out by Broadbent (1958), among others. Perceptions are treated as being incoming information, which has to be processed.

The essential feature of Broadbent's theory (1958) is that we are unable to analyse all the information that is received by our sensors. He proposed that in our brain there is a mechanism or 'filter' that limits the amount of information that has to be analysed to a very high level and he identifies the higher levels of analysis as being where this process occurs. The message is selected for high-level analysis.

Indeed, cognitive psychologists (see Lachman, *et al.* 1979) adopt what is often referred to as the information-processing approach. Some of the assumptions of the information-processing approach are as follows:

- *"Information made available by the environment is processed by a series of processing systems (e.g. attention, perception, short-term memory)*
- *The aim of research in to specify the processes and structures (e.g. long-term memory) that underlie cognitive performance;*
- *Information processing in people resembles that in computers."*

(Eysenck, 1993: 3)

The work of a number of researchers is now discussed, the aim being to see the common ground they share in their understanding of the way memory functions.

Working from the perspective of difficulties in learning in the sciences, Johnstone (1983) developed a model to help to think about the processes of learning. It comes in three parts: perception, working memory space and long-term store. It is analogous to a computer in which perception, working space and long term store can be considered as being: *Perception* is a filtration process by which we choose to attend to certain parts of our sensory input and to ignore others. It is controlled by our long-term store where we decide on importance, interest, and attention, based upon previous experience and knowledge.

*Working Space* is where the filtered input goes for processing. This space is limited as to how much information can be stored and processed at a given time. Johnstone (1983) describes this as a 'trade-off' between the two functions:

- *Holding information*
- *Processing it into an understandable form*

Long-term store or long-term memory is a vast store of information inter-linked in huge association networks (see Figure 4.6).

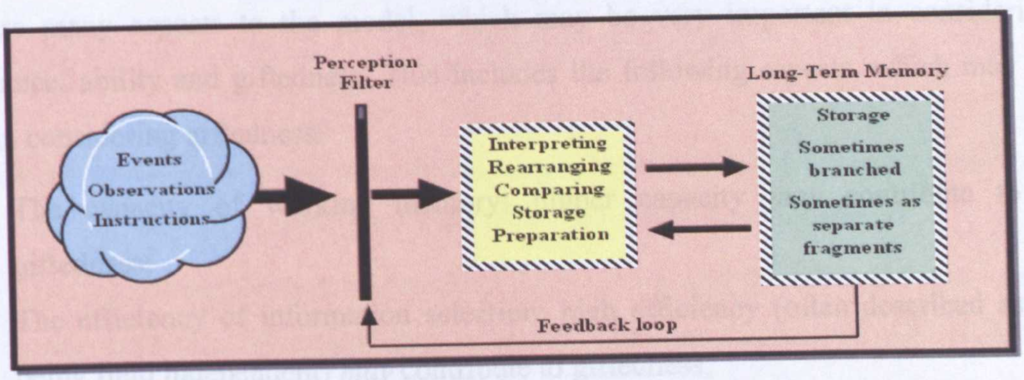



**Figure 4.6 Model for the Processing of Information (from Johnstone, 1983)**

Johnstone (1983) notes that the store contains information of two kinds:

- *Semantic* knowledge, which is shared by most people, and is usually second-hand (essentially information or facts)
- *Episodic* knowledge which is made up of personal knowledge and experience. It contains likes and dislikes, beliefs and prejudices, interests and aversions.

When new information seeks to enter this store, it can find an attachment in several ways (Johnstone 1997). These are summarized here.

1. New information can connect correctly into the existing network, and increase and enrich the complexity of the whole information network.
2. New information can make a misconnection and this is the likely origin of misconceptions. Such misconnections can often originate in language.
3. New information may find no point of attachment, but the student places it (not consciously) in a space where it may be difficult to retrieve. This can be seen as being stored in an unconnected way and so gets lost easily.

The model (Johnstone, 1983) has been used extensively in a predictive sense. Thus, for example, the importance of the feedback loop predicted that 'pre-learning' would bring about improvements in conceptual understanding. This was found to be so in both lecture type learning (Sirhan and Reid, 2001) and laboratory learning (Johnstone *et al,* 1991). It also predicted that re-casting learning so that it made less demand on working memory would bring about large improvements in conceptual understanding. This has been tested recently and quite remarkable improvements in performance were observed (Danili and Reid, 2005; Hussein, 2006).

There are many aspects to the model, which may be very important in considering performance, ability and giftedness. This includes the following aspects, which may be factors in considering giftedness:

(a) The capacity of working memory: higher capacity *may* contribute to giftedness;

(b) The efficiency of information selection: high efficiency (often described as being field independent) *may* contribute to giftedness;

(c) The way information is coded and stored: being able to code and store in such a way that future access is fast and efficient *may* contribute to giftedness;

(d) The speed of processing of information: being able to process rapidly *may* contribute to giftedness;

(e) The way the working memory controls access to long term memory stores: little is known about this but fast, efficient control *may* contribute to giftedness;

(f) The form in which information is stored (e.g. in terms of pictures or symbols): perhaps those who stored in both forms *may* have an advantage in terms of giftedness.

These possibilities arise from the work of Johnstone although he does not consider the theme of giftedness. He has already demonstrated that performance is related to working memory capacity and extent of field independency (see Johnstone and Al-Naeme, 1995). He has referred to different ways by which new information may be stored (Johnstone, 1997). The latter three points are implicit in his work although he has generated some evidence relating to the use of the visual (Johnstone, Hogg, and Ziane, 1993). The idea of speed of processing may also be very important.

Another researcher is Riding and his approach (2002) focuses on the learning process and deals with working memory, cognitive style and long-term memory. These are essential to an understanding of individual differences. A schematic view of the information processing components of the learning process follows (see Figure 4.7 ). His emphasis is much more on the differences between learners and the nature of cognitive styles.

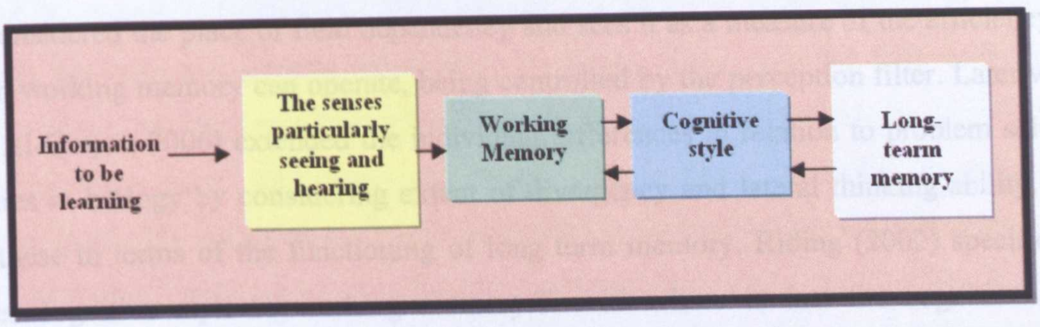



**Figure 4.7 Information-Processing Components of the Learning Process**

In this model the information is received by the senses in terms of pictures and written words to the eyes and of sounds and speech to the ears. This information is then transferred to working memory. In summary, his approach has the following features:

- Working memory is where information is temporarily stored while we work out the meaning of what we see and hear;
- Long-term memory is where the analysed information is finally stored for future;
- The organisation and form of the information is determined by the student's cognitive style. It is an individual's preferred and habitual approach to organising and representing information.

- The meaning of information in working memory is determined in terms of the previously learned knowledge structure already in long-term memory.
- The information then is linked to what is already known in the large capacity long-term memory.

The amount of common ground with the Johnstone model is considerable but he does not locate cognitive style in relation to working memory. It seems that cognitive style very much focuses on the way information is stored and accessed and this may relate to working memory in some way. However, this is largely speculative.

Different models (Johnstone, 1983; Riding, 2002; Newell and Simon, 1972; Entwistle, 1988) were developed in different contexts and yet they show remarkable similarities. They may use different terms but the functions are essentially the same. They all have the existence of a link between working memory and long-term memory and the way they deal with the information that has been received from the environment through the senses, especially hearing and vision.

The models all consider that all learners operate in essentially the same way. Johnstone has considered the place of field dependency and sees it as a measure of the efficiency by which working memory can operate, being controlled by the perception filter. Later work (e.g. Al-Qasmi, 2006) extended the individual differences in relation to problem solving abilities in biology by considering extent of divergency and lateral thinking ability. She saw these in terms of the functioning of long term memory. Riding (2002) specifically relates cognitive style to working memory.The idea here is that the cognitive style modifies the processing in the working memory in some way.

The problem is that cognitive style is not one thing. There are numerous styles to reflect the diverse ways that learning takes place. It seems that all learning relates to the function of a perception filter, working memory and long term memory (as with all the models) but, within this commonality, there are numerous variations. This will be discussed later.

## 4.5 Working Memory and Giftedness

In this section, the literature about the relationships between the working memory and giftedness is considered in two parts:

(1) Review of working memory with various learning skills.

(2) Review the relationship between working memory and general intelligence.

Numerous studies have demonstrated strong relationships between working memory with a wide variety of skills: for example, in reading comprehension in Daneman and Carpenter (1980, 1983), language comprehension in King's study (1991), and reading comprehension in Engle *et al* (1992). Overall, working memory capacity positively correlates with performance success in a wide variety of educational tasks. It is particularly marked in the mathematics-science area (see, Al-Enezi, 2004). Indeed, in study after study, its importance in the mathematics-science areas has been shown consistently (e.g. Johnstone and Elbanna, 1986, 1989; Johnstone, 1991; 1997; Danili and Reid, 2004, 2006).

There is also evidence of a strong association between working memory and general intelligence (e.g. Conway *et al,* 2003). To be more accurate, there is a strong association between working memory capacity and the test that claims to measure intelligence. Caution, therefore, must be maintained in deducing that working memory capacity and intelligence are correlated. It could simply be a function of the testing procedures adopted.

Earlier, Kyllonen and Christal (1990) carried out an early study looking at working memory capacity and general intelligence measures. They reported high correlations between these two measures: reasoning ability (which they considered to be 'the ability to make meaning out of confusion') and reproductive ability ('the ability to regurgitate previous learning') and measures of working memory capacity. They described reasoning ability as highly indicative of fluid intelligence which they defined as the 'the ability to make meaning out of confusion' and saw this as usually being independent of learning.

Conway *et al.* (2002) found that working memory was a good predictor of general fluid intelligence (the ability to make meaning out of confusion) with 120 young adults. Furthermore, in the study by Engle *et al.* (1999), 133 participants performed 11 memory tasks that demonstrated that working memory shows a strong connection to fluid intelligence.

Süß *et al.* (2002) tested 128 young adults, using a battery of 17 working memory tasks, which were administered together with a test for structure of abilities in the '*Berlin Intelligence Stricter Model*', to investigate the relationship between working memory and intelligence. The result showed that working memory is highly related to intelligence as measured by the 'Berlin Intelligence Stricter Model'.

All these studies might suggest that the working memory capacity is a predictor of intelligence; however, there is an issue of validity here as well as of definition. The validity of tests like the digit span backwards test to measure working memory capacity is well established. However, what do intelligence tests actually measure? It is perfectly possible to see these as similar to school tests but covering a wider range of subject matter and mental skills. There is no certainty that they measure intelligence.

Nonetheless, it is reasonable to suppose that working memory capacity may well be related to ability in academic tasks. It certainly seems to correlate with performance in a wide range of test situations. If such test situations are used, at least in part, to identify those who are gifted, then working memory measurement will be important.

Süß *et al.* (2002) highlighted an important point in reviewing the literature. They found that:

> *Similarly, studies relating working memory to intelligence constructs usually focused on a single mental ability, such as reasoning or reading ability, as the criterion. This does not provide a clear picture of how working memory relates to the structure of intelligence, in other words, which abilities depend to what degree on working memory.*
>
> (Süß *et al.* 2002:262)

Furthermore, most of these studies investigated fluid intelligence, that is, intelligence as it is viewed in the traditional intelligence theories such as Spearman's 'g' factors theory, Carroll's theory, or the *Berlin Intelligence Structure Model* (BIS) formulated by Süß *et al.* (2002) which shares some similarities with Guilford's *structure of intellect model.* (Guilford, 1967).

Jackson and Butterfield (1986) noted that efficient use of working memory in relation to giftedness "*is necessary for the solution of complex problems that require simultaneous attention to and integration of many elements*" (Jackson and Butterfield, 1986:162). This is completely consistent with Johnstone's findings (Johnstone, 1997). Working memory is the place where ideas are held and processed in order to reach understanding or to obtain an answer to some problem. The larger the space, the greater the capacity for successful problem solving. The more efficiently the space is used (perhaps one aspect of cognitive style), the chance of successful problem solving is increased. Jackson and Butterfield (1986) conjecture that intellectually gifted children may have more efficient memory processes, surpass other children in the speed at which they retrieve semantic information, and are more efficient in the use of both long- and short-term memory processes.

Jackson and Butterfield suggest that gifted children might spontaneously use strategies typically utilized by older individuals and that they might engage in disciplined self-management of the problem-solving process of insight (Valdes, 2003) This raises the question that giftedness might simply be related to *speed* of cognitive development.

Engle *et al.* (1999) proposed a theory of working memory capacity and general fluid intelligence in which they argue that working memory capacity and fluid intelligence reflect the ability to keep a representation active. The result of this study provided very strong evidence that working memory capacity is related to the ability to solve novel problems and adapt to new situations and is thought to be nonverbal and relatively culture free.

Goldberg *et al* (1977) were among the first to study information-processing models of cognition related to individual differences. The main advantage in this study is that the use of information-processing tasks appears to be more suitable in assessing the influence of individual differences upon cognitive functioning. In addition, Cohn *et al.* (1985) found that academically gifted students differ from their non-gifted age-peers fundamentally in speed of information processing on extremely simple cognitive tasks. This is another dimension: it moves from a simple consideration of capacity to that of the speed by which the capacity can be used (and then perhaps, re-used).

In his much earlier work, Miller (1956a:131) considered that what he called the 'span of immediate memory' (working memory capacity in today's language) was "*not a perfect measure of intelligence, however, since a long span does not necessarily indicate high intelligence*".

In addition, Case *et al* (1982) formulated a hypothesis regarding the 'operating space' (the amount of space that a subject has available for executing intellectual operations). They assumed that the speed of mental operations reflects the efficiency of processing and that operations that are more efficient require less working memory capacity leaving more space free for storage.

There is remarkable consistency arising from these many studies. Working memory capacity is consistently related to academic performance in various tests, including intelligence tests. Nonetheless, this may not necessarily indicate that working memory capacity is a correlate of intelligence. However, there needs to be caution. Working with large samples in the area of mathematics, Reid (2002) deliberately designed test material (of considerable difficulty) so that it made no demand on working memory and she found no correlation between performance and measured working memory capacity. The relationships may simply reflect the test materials. This is a point which Johnstone found in his early work (see Johnstone and El-Banna, 1986, 1989) and is raised by Danili and Reid (2004). In simple terms, if a test (of anything) uses a style of question where a demand is made on working memory, then a correlation will be obtained between working memory capacity and performance.

Thus, the fact that working memory capacity correlates with an intelligence test does not necessarily imply that working memory is a facet of intelligence (even if an intelligence test actually measures intelligence). Working memory capacity will correlate with performance in *any* task where demand is made on working memory. This was the point made so clearly by the Johnstone and El-Banna study (1986, 1989).

Despite many studies of working memory with gifted students there is still a need for more research in general, and especially in the State of Kuwait, where, so far, there have been no studies conducted on the working memory of gifted students. However, there is one study on the working memory of students who have difficulties in mathematics (Al-Awad, 2000). This study found a relationship between the performances of students with learning disabilities in mathematics on the subscales of the measure of working memory (two Arabic measurements) and he found there were correlations between achievements in mathematics in two groups of students who demonstrated having a large working memory capacity.

At first sight, it might be thought that high working memory capacity is a good predictor for giftedness. However, it is more likely that high working memory capacity is a good predictor of success in tasks which make a high demand on working memory. If achievement in such tasks is considered to offer evidence of high intelligence than working memory capacity may be a good predictor of intelligence. Indeed, it may be speed of processing which may be more important in relation to intelligence. However, the importance of working memory in academic tasks is very clear and the role of working memory in relation to intelligence needs much more exploration.

## 4.6 Information Processing and Cognitive Style

Cognitive science defines an information processing system as a system for receiving, manipulating, storing, transmitting, and executing information. Cognitive psychology focuses on the human information processing system with the goal of developing information-processing models of human cognitive behaviour (Nelson, 2003).

Gathercole (2003) investigated the functional organization of working memory and related cognitive abilities in young children. He identified a complex structural organisation to working memory and related cognitive abilities in children in their first year of school. The data are consistent with a multiple component working memory system consisting of a central executive, phonological loop, and episodic buffer. This multicomponent model provides a useful framework within which to understand subsequent academic development.

Riding's (2002) present approach focuses on the learning process and deals with the key elements of working memory, cognitive style and long-term memory which lead to an understanding of individual differences.

The information processing model can be used in an attempt to make sense of some aspects of cognitive characteristics.

(a) ***Field Dependency***: Being field independent means that the person is more efficient in selecting what is important and relevant for a particular task or situation: selecting from a field of information (Witkin, 1977). This suggest that, in some way, the perception filter is working more efficiently and effectively (see Johnstone, 1997). However, this is controlled by what is held in long term memory. These suggest that the way the information is stored in long term memory enables a person to select better. This could be because of brain structure or it could be because of the way the working memory has influenced the way information is stored.

(b) ***Convergency-divergency***: The learner who is divergent is able to access more effectively more links between ideas in long term memory (Al-Qasmi, 2006). How and why this happens is uncertain. It could be because the working memory stores new information in the long term memory in such a way that many links are formed. It could simply be based on genetics - some people are born with a better brain architecture. It could even be a matter of choice: some people choose to links ideas more than others. Of course, it might be a combination of any two or all three.

Convergency is more difficult. It is possible to see convergency as the absence of divergency but, convergency is a positive learning characteristic in its own right. The convergent is able to bring things together to make a useful coherent whole, or a meaningful conclusion. In some way, the working memory is able to pull together information from many parts of the long term memory in order to reach this endpoint.

(c) ***Visual-spatial ability***: It has been shown that the working memory has two loops (one for visual-spatial, the other or symbolics) (Baddeley, 1986). It is possible that the more visual-spatial learner possesses a better developed working memory loop. Equally, it is possible that the way information is stored gives a preference for information stored in the visual-spatial way. In an interesting experiment some years ago, it was found that presenting questions in visual form helped some students, symbolic form helped others (but not as many) while presenting in both forms gave the best overall results (Johnstone, 1993) This could be explained by the use of both working memory loops or it could be explained by the idea that storing information in two forms gives the greater advantage in terms of creating more usable links.

In looking at these three cognitive characteristics, it is clear that they can be interpreted in many ways, involving all three parts of the human memory. Fundamentally, convergency-divergency seems to relate primarily to storage, field dependency is focused on the way the perception filter is controlled while visual-spatial ability could be explained by the working memory or storage preferences.

A number of other issues arise. To what extent, if at all, can these abilities be enhanced by teaching, training or experience? Do they develop with age? Finally, to what extent do they reflect personal choice: does a learner build on some innate characteristic because they find it offers a more pleasant way to learn? It seems possible, and perhaps likely, that the answers to all these questions will be positive.

However, the real issue for this study is to speculate on the way the information model can interpret these learning styles to suggest how they relate to exceptional ability. Is it possible that possession of one or more of these learning characteristics means that it is more likely that the learner will be described as gifted in academic matters? It is also possible that academic giftedness means possessing *many* of these characteristics (and no doubt others as well) in well above average measure. Is any one more important than the others? These questions will be explored later in this study.

# Chapter Five

# The Gifted Education in the State of Kuwait

*Gifted people are the national wealth and the duty of us all is to look after this national wealth with care and humility. (Sheikh Jaber Al-Sabah)*

(translated from Al-Sabah, 2000)

## 5.1 Introduction

The previous chapters highlighted the giftedness approaches, theories, definitions identifications, characteristics, and cognitive style in general but this chapter will deal with the Kuwait education system, and explore how education in Kuwait views giftedness and cognitive style.

From an historical perspective, education in Kuwait had been affected by various factors: the Arabian Islamic culture, the Arabic education curriculum, and world education systems. In the following chapter, there will be a brief historical review of education in Kuwait in general and especially in special education for gifted students in different stages, as well as the most important factors that have influenced its course.

## 5.2 Education in the Mosque (Masjed)

From a thousand years ago, the education in different countries was the province of religious orders who considered their duties to be the promotion of religious beliefs (Yeomans and Arnold, 2006). Education in Kuwait began with mosques (Masjed) that had been founded in the early 18th century (e.g, Haateem, 1980; Rashid, 1960). The teaching began as religious learning, the lessons being an explanation of Islamic rule, culture, and the holy Koran. It resembled scholastic practice in the present time in that the squares of the mosques were used as classrooms and the worshippers were the students. At that stage of learning in the mosques, there were a few men who had a basic knowledge of reading, writing and mathematics, which they had learned during their travel for commerce.

When teaching in the mosque (Masjed) met with success, the people in Kuwait wanted an increase in the learning. This persuaded some people who had greater knowledge to volunteer to teach people in their houses, as a result of which it was known a 'Al-Katatib'. The 'Kuttab' is the first to be mentioned in Kuwait history books in 1887.

Almolla Qasem was one of the first volunteers with his brother. Actually, the word *Almolla* was used to refer to a religious person who taught in the 'Al-Katatib' and meant 'teacher' (Al-Mohaini 1974). The teacher 'Almolla' in the 'Al-Katatib' was able to choose what to teach to students as there was no special method to the Al-Katatib or books for subjects. The plan of what to teach came from the teacher himself, according to his qualifications and his readiness. For instance, the learning process covered:

1. Memorization of Arabic alphabet and spelling
2. A reading and memorization of the Holy Koran
3. Teaching of reading and writing

(Al-Abdulqhafoor, 1983)

The teacher in the Al-Katatib used an assistant. This assistant Almolla chose from his especially discerning students a gifted student who was more able than his peers to assimilate the knowledge and the skills that Almolla taught. He became distinguished in leadership so that Almolla came to rely on him.

The Al-Katatib had been deployed through Kuwait for a year in 1887 when these kuttab graduated educated people. Some of them opened their own Kuttab in which to begin teaching; they had a special kuttab in each town in Kuwait. This encouraged rivalry between them in the learning process. Those who graduated from these Al-Katatib were celebrated, especially those who were able to give a complete recital of the holy Koran before their peers could. To demonstrate this, the student had to go around the houses of the town singing songs, in parts of which they thanked God who gave them the ability to learn, and the inhabitants would give him money or gifts, praise him and encourage his companions (Al-Rashed, 1995).

The way of teaching in the kuttab was different from the way of learning in the mosques; the teaching in the kuttab consisted of reading, writing, and mathematics within religious teaching.

From the Al-Katatib stage, teaching developed in Kuwait until, in 1912, the first regular school was opened. This meant people became accustomed to the idea of an establishment where a group of Kuwaiti traders felt it enhanced their importance to have an educated youth who could read, write, and calculate well. They collected money to sponsor funding for a school in 1911 and, in 1912, Al-Mubarakia school was opened. Initially, 300 students were registered at the school, and in 1921 a second school, Al-Ahmadia, was opened, the financial source and direction of the two schools coming entirely from the Kuwaiti people. Therefore, it was normal that the economic situation influenced the funding of these two schools; when the economy was strong, the schools were financially strong and vice versa (Al-Abdulqhafoor, 1983).

## 5.3 Formal Learning: the Council of Knowledge

Before this time, there was no public education for the first part of the century, and funding for education came mainly from Kuwait's wealthier citizens privately. In the third decade of the last century, the whole world suffered from economic crises; the crisis in Kuwait made most of the people who financed the schools bankrupt for five years from 1931 until 1936. The government took control of education in 1936, when the government enjoyed abundant national income to support education. The first council for cultural affairs was called Da-erato Al-maref - the council of knowledge - and consisted of the Al-Mubarakia school and Al-Ahmadia school (Haatm, 1980).

The year 1936 is regarded as a year of cultural, scientific, intellectual, and educative significance for the following reasons:

- The government imposed a 5% tax upon all imports, a part of this being specified for spending on the teaching.
- A law was published to create "a council for knowledge affairs" to establish study of a new manner of teaching and supervision; "a formal system" to transform the private sector into the organized governmental sector.
- The society pursued patriotism by raising the profile of education in the Arab countries, which encouraged Kuwait to increase the improvement in the level of teaching.
- The first educational Palestinian mission was invited to participate with their Kuwaiti colleagues in planning and teaching.
- Kuwaitis received scholarships to travel to study education and methods of teaching.

(Al-Rashed, 1995)

The knowledge council became the formal education organizer and began setting out schemes and methods of teaching in accordance with education law. They tried to discover the learning level of the students so as to arrange the teaching on a more logical basis. The teaching became more interesting and developed from merely transmitting knowledge.

The knowledge council established another school for boys named 'Al-Shargeia' in 1937/1938 and in the following year opened another school 'Al-Gepleia' The first school for the girls opened in 1937/1938; it was opened for girls instead of the traditional schools called 'Almotawah' special for the girls which was similar Al-Katatib for boys. those responsible for education perceived the necessity for a unified method of teaching in Kuwait, and added to the previously elementary grade syllabus subjects such as engineering, mathematics, geography, history, principles of health, sciences, drawing, handcraft and English language.

There was also a revision of the examinations system in schools so that examinations took place over two periods, the first examination being after half a year. After this examination, all schools celebrated a special day and gave prizes to the top three students in every class as gifted students. In addition, there was a second examination at the end of the year, in addition to monthly tests. Afterwards the students received the certificate at the end of the academic year and progressed to a higher grade. Some students were moved to the next grade during the year if they were considered sufficiently able and capable of high achievement. At this early stage, the idea of giftedness was developing and was seen as worthy of reward (Al-Abdulqhafoor, 1983).

In addition, it was noted in a report in 1939, as a part of an investigation for the British government, that, 'some of the most intelligent students were accepted by the four big schools: Al-Mubarakia, Ahmadia, Al-Shargeia, and Al-Gepleia.' (Sheahab, 1984)

Other changes had taken place in teaching when the Department of Education in Kuwait asked the Ministry of Education in Egypt to cooperate in organizing the curriculum and planning for study in Kuwait: it was for this purpose that the first Egyptian mission travelled to Kuwait in 1942. From 1942 to 1953, the Egyptian methods were applied: on the educational ladder, there were seven grades for the elementary stage, and five grades for the secondary. In the fifth grade, 'the last one,' subjects were divided into three groups: arts, science, and mathematics (Abdalmatti, 1995).

In the academic year 1954 to 1955, there was a re-examination of the teaching methods, the schemes, and the organization of the stages of education, and an outline was drawn of a global policy for the development of education. A detailed approach to these important issues was presented in the Qabbani and Aqrawi report, which was critical of the then current arrangements of both the teaching and the organization of the stages of education in Kuwait. The report confirmed the necessity of making education compulsory between the ages of six and fourteen. It also recommended adopting a strategy to combat illiteracy and to promote the diversification of education after the middle certificate to include a focus on teaching for industry and for commerce. The report recommended the integration of the elementary stage in four years, the middle stage in four years and a further four years for the secondary stage (Abdalmatti, 1995).

The new system attempted to meet the needs of the country's ambitious development plans, and to cope with social characteristics when the students started school attendance late, which led to there being a huge difference between students' ages. The economy still needed workers after the middle stage. Furthermore, the recommendation to divide the educational ladder in this manner led to an increasing demand by educationalists to find a stage of concentration to discover the capacities of the educated and to take advantage of educational opportunities and activities in the ascertainment of this aim. According to the recommendations of this report:

> *"The government provided programmes for students who had excelled at various education stages, rather than isolating them in a school for gifted students only, thereby running the risk of isolating them, both socially and academically"*
>
> (Al-Ahmed, 1990)

## 5.4 Ministry of Education

Education was not compulsory until 1962, in other words, after the Kuwaiti constitution was established. Clause (40) states, 'the education is free in all stages and compulsory in the first stage' Accordingly, the Parliament agreed on 27 March 1965 that compulsory education for all of the Kuwaiti students, both male and female, should begin with the elementary stage and continue until the end of the middle school level. This means that, beginning from age six, the obligatory regulations say the students should remain in full time education

In 1962, the government decided to reorganise the ministries. By 1979, the responsibility of the Ministry of Education to Kuwaiti society was as follows: the development of the Kuwaiti society and for the upbringing of generations within a framework of scientific integration, religion, ethics, philosophy, social awareness, in light of the principles of submission and the Arabic heritage, and the contemporary culture in accordance with the Kuwaiti environment, which aid development and progress (translated from Al-Ahmed, 1990).

The general education law number (4) in 11 February 1987 confirmed the responsibility of the Ministry of Education as being an important social organization and vital according to the following resolution:

> *Clause 3: the aim of teaching is to help the students to have opportunities for integral growth, spiritual, intellectual and bodily, to reach their maximum abilities. Within the principles of Islam, the Arabic heritage, the contemporary culture, the nature of the Kuwaiti society, its habits, its traditions, the growth of the citizen's soul, the allegiance for the homeland and the prince.* (Translated from Al-Ahmed, 1990:85)

Recently, Kuwait's education system has become larger than ever. There are currently close to 305,000 students enrolled in 668 schools according to the last report in 2005/2006. There are three basic levels of education in Kuwait: elementary (132,845 students), middle (100,114 students), and secondary (31,597 students). Each level involves four years of study, and schooling usually beginning at the age of six. Kindergarten is available for students from four to six years old, and the students can continue in higher education after completing their basic education.

Learning is compulsory for all children aged six to fourteen (elementary and middle levels), and all stages of state education are free. The teaching approach and curriculum have a formal emphasis. The classrooms are formally arranged with individual desks in rows facing the blackboard (in fact, most schools use a white board and pen). In terms of content, for each subject the same textbook is used throughout schools, and is followed by the teachers according to a timetable agreed by the directors. Because of an obligation to teach from the textbook, the school year tends to be planned in order to cover all chapters within the available time for all girls and boys (Al-Hajji, 2002).

Several studies have found that the main teaching method in Kuwait has tended to comprise lectures and question-response sessions (Al-Ahmad, 1986). The teacher presents information and the students reproduce it. Thus, the focus in Kuwaiti education is inclined to be on presenting knowledge rather than encouraging students to develop their own skills and to learn for themselves (Al-Hajji, 2002); however, there is a wide variety of technology and equipment.

With the increase in student numbers, the number of schools grew along with the number of teachers, administrative staff, and the basic educational services and assistance. The size of the Ministry of Education has also increased, so that the government decided to re-examine the administrative framework for the ministry, with the following aims:

- Increase the speed and ease with which policy can be implemented;
- Resolve conflict between specialities in the ministry departments;
- Reduce the routine pressure on the ministry as first supervisor on the work.

Before the beginning of the 1980s, the educational process was administered centrally by the Ministry of Education. At that time, Kuwait was divided into six educational areas where many of the things associated with the conduct of the educational process within the schools were organized. The structure of the system was changed to:

- Five years primary stage
- Four years middle stage
- Three years secondary stage

Statistics on enrolment in Kuwait's public schools are shown in

**Table 5.1 Government School Students Statistics by Governorate Districts, 2005-2006**

| 2005-2006 | School Students | | |
|---|---|---|---|
| ***District*** | ***Boys*** | ***Girls*** | ***Total*** |
| Al-Assema | 9376 | 8484 | 17860 |
| Hwallay | 7375 | 6966 | 14341 |
| Al-Faroaneia | 8379 | 9467 | 17846 |
| Al-Ahmady | 10110 | 10732 | 20842 |
| Al-Jahra | 7973 | 8292 | 16265 |
| Mubarak Al-Kabeir | 6017 | 6943 | 12960 |

## 5.5 Historical Resume of Care of Gifted Students

Many countries had started to care about gifted school students. Important events demonstrate this interest, such as sputnik and reports such as the Marland report in the United States of America (1972). The State of Kuwait showed clearly its interest in the gifted group with symposia about talented and handicapped people in 1973, when the State of Kuwait was under the supervision of the Arab organisation for Educational culture and science. Since then, efforts were made in the State of Kuwait to offer suitable care to the talented group (Al-Omar, 1975).

Between 1981 and 1989, the importance of the care of gifted students has been increasingly recognised. Provision has been organized to realise their potential, arranging and strengthening the programmes to help students' talents. Hence, the ministerial decision 'number 135' to sponsor the gifted was published in 1986 (Al Mashaan, *et.al*, 1998). So that a high council could begin to take care of the gifted, the characteristics of their potential were set out in different guidelines as follows:

- *"Identify academically gifted students;*

- *Apply experimentation of intelligence tests on these gifted students to identify the best ones;*
- *Prepare and deliver enrichment activities in the Arabic language, and mathematics, in two centres, one for boys and another one for girls".*

(Al Mashaan, *et.al*, 1998: 62)

Later, in the beginning of the academic year 1989/1990, an experiment was started with special centres to take care of the gifted student. Providing a service to these students in the evening to support them with a specified programme, with the intention that these centres would eventually give overall special care, but the circumstances of the war in 1990 stopped this programme until 1993 (Abu-Allam, *et.al*, 1983). Then the ministerial decision "number 187" was established to construct a council of special education, and a general secretariat for special education. These have specific responsibility for organising the care of special groups including children who are slow learners, autistic children, and gifted children. Further, the ministry began to set out the goals of the characteristics for each project.

The goals of the programme for care of the gifted are as follows:

- Working to find the necessary teaching for this kind of education in Kuwait or the in countries of the Arab Gulf;
- Using to the full the capacities of the mentally gifted;
- Preparing future leaderships in the different fields of science, art, and literacy;
- Developing the ability for creative thinking in the fields of science, language, and art;
- Increasing understanding of the social responsibility and the need to perform their assignments for the benefit of the homeland and their success in specialized area.
- Developing the personality of gifted students

(Al-Mashaan, *et al*, 1998)

## 5.6 Special Programme for Gifted Students

After the guidelines were published, the council for special education and the general secretariat for special education decided to identify gifted students by some suitable criteria. They first needed to decide how to define the gifted student who will be using the enrichment programme and the definition used states that a gifted student is one "*who has a mental ability to help him/her in the future to reach a high performance. Emphasis is given to academic ability, leadership skills and skills in the performing arts*" (Al

Mashaan, 2001: 64). Furthermore, they decided on the following characteristics the students must have to be accepted as eligible for special education:

- High level grades in examinations, placing the student within the top 5% from student's age group;
- A high level intelligence score (not less than 120) in one of the individual IQ test;
- A high ability level in creative thinking;
- A high ability in collective leadership and effective reactive behaviour

Additionally, as part of the progress in the field of care of gifted students, an enrichment centre was established in 1994/1995. The centre received a list of the names of gifted students that are in the top of 5% in each class in grade two of all the elementary schools. Then, these students took a general intelligence test, *the John Raven test*, as part of a survey designed to identify gifted students. Any students who passed this test then took the *Stanford Binet test*, which is designed to test individual intelligence. The students who did best received an invitation to attend the enrichment centre. However, they did not use any test for the last two criteria, leaving the selection to be based on academic test scores.

The strategy of this programme is to teach a special enrichment topic during the afternoons (after the school day) in the enrichment centre, prepared for gifted students from ages 9-14, and to initiate a special class in secondary schools for gifted students to learn high level thinking skills through seven subjects: Arabic, English, science, social studies, mathematics, computer studies, and creative skills. Strategy details are given in the next section.

### 5.6.1 The Enrichment Programmes

**Firstly: evening care enrichment centre**

The Ministry of Education determined in ministerial decision number (29084) on 24 October 1996 to prepare five committees with he following aims:

- To draw up the programmes and write the text books for five topics: Arabic language, English language, mathematics, sciences, social study
- To choose competent teachers and train them to teach the enrichment books in the programmes.
- To arrange teaching provision over two days instead of three days each week.
- To prepare and offer programs to develop the imagination, creativity, and artistic taste through training by special psychologists.

- To present training on the use of computers to increase the skills of utilization and the use of computers, to employ computers in the acquisition and development of the skills for mental problem solving.

Thus, the total number of students at the enrichment center in the academic year 2001/2002 was 344 students (148 boys, 196 girls): see Table 5.2.

**Table 5.2 Number of Student in the Enrichment Programme 2001/2002**

| 2001/2002 | *Boys* | *Girls* | *Total* |
|---|---|---|---|
| Grade 4 | 67 | 87 | 154 |
| Grade 5 | 26 | 49 | 75 |
| Grade 6 | 28 | 28 | 56 |
| Grade 7 | 16 | 15 | 31 |
| Grade 8 | 11 | 17 | 28 |
| **Total** | **148** | **196** | **344** |

The Ministry of Education developed a plan to implement provision for the gifted students during the school day, on the instructions of the Minister of Education. The plan was outlined for students and teachers. Then, intelligence tests were applied to identify the gifted students in grade three. However, at this stage, the plan was left and not implemented further. The former programme was reviewed and all the final reports indicated the existence of many difficulties affecting the achievement of the enrichment centre goals. This appeared to be leading to decreasing numbers of students at the centre year after year. Some of these problems are:

1. Absence of a permanent centre for gifted students,
2. A shortfall in the number of teachers,
3. No plans for social, culture and scientific activities,
4. Provide lack of prior coordination meetings between coaches and officials at the centre,
5. The centre was not equipped techniques and tools, such as laboratories and library,
6. Lack of seriousness and the desire and motivation on the part of some students in terms of school attendance,
7. The problem of the absence of students in the school examinations lasting leader.

From the annual report of the Secretariat of special education in the academic year 2002/2003, it was noted that the number of students was decreasing year after year. There was evidence that many students were not committed to regular attendance.

**Table 5.3 Number of Student in the Enrichment Programme 2002/2003**

| 2002/2003 | ***Boys*** | ***Girls*** | ***Total*** |
|---|---|---|---|
| Grade 4 | 40 | 42 | 82 |
| Grade 5 | 21 | 40 | 61 |
| Grade 6 | 22 | 36 | 58 |
| Grade 7 | 19 | 26 | 45 |
| Grade 8 | 16 | 14 | 30 |
| **Total** | **118** | **158** | **276** |

The following graphs shows the number of students through the most recent reports on the numbers of students in the enrichment centre.

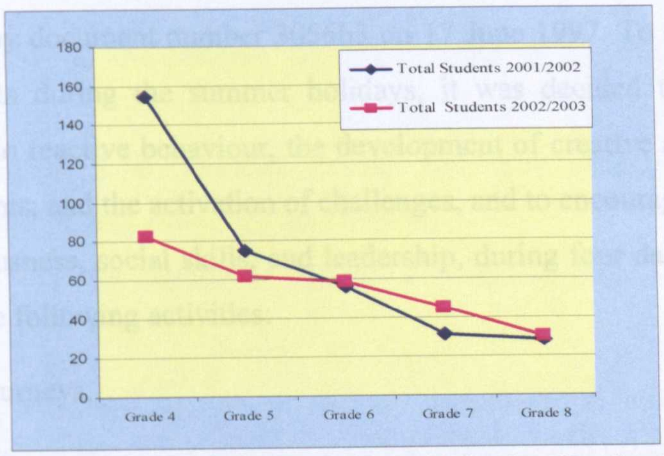



**Figure 5.1 Total Number in 2001/2002 Compared with Student Number in 2002/2003**

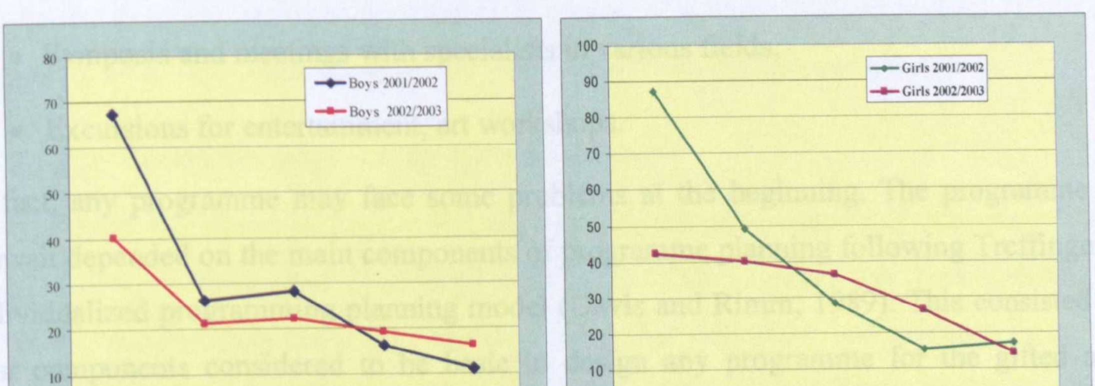



**Figure 5.2 The Number Students Boys and Girls in year 2001/2002 Compared 2021/2003**

In spite of this problem, the sense in an importance of given special care to the gifted student was remained constant, and continue attempts to improve the experience by the researchers through a lectures given for teachers and parents.

**Secondly: care of gifted students in the secondary school.**

According to document number 32544 published on 30 July 2000, a special class for those students would be set up in regular schools, It was decided to open a special class in two public schools for gifted students, one for boys, and another for girls since the academic year 2000/2001.

**Thirdly: care of the gifted students during the summer holidays.**

The general secretariat for special education wanted to continue the care during the summer holidays. It was decided to open a summer club for the gifted students under a decision introduced by document number 305663 on 17 June 1997. To continue the care of the gifted students during the summer holidays, it was decided to offer different programmes related to reactive behaviour, the development of creative skills, the care of students' special talents, and the activation of challenges, and to encourage a deepening of the personal consciousness, social skills, and leadership, during four days a week. These programmes offer the following activities:

- Educational journeys,
- Creative training programme,
- A science workshop,
- Symposia and meetings with specialists in various fields,
- Excursions for entertainment, art workshops.

In fact, any programme may face some problems at the beginning. The programme in Kuwait depended on the main components of programme planning following Treffinger's individualized programming planning model (Davis and Rimm, 1989). This consisted of four components considered to be basic to design any programme for the gifted and talented: firstly, programme philosophy and goals; secondly, definition and identification; thirdly instruction grouping (e.g acceleration, and enrichment); finally, evaluation and modification. The Kuwait enrichment programme faced many problems as a result of a lack of serious evaluation. However, one study showed students, teachers, and coordinators asking for some changes to the programme to avoid problems which had also been identified in the annual reports for the general secretariat for special education (Hindal, 2000).

### 5.6.2 National Committee for Creative Activity

The Ministry of Education desired to give more attention to the work with the gifted and talented, and so published decision number 21330 on 20 April 1996 to construct a national committee to take care of the creative activity. This committee involved representatives from the Ministry of Education, the general secretariat for special education, and the general secretariat of the Islamic affairs ministry (which deals with scientific, cultural, and intellectual development), Kuwait's university, and Kuwait's association for science progress, and the college of basic education. The aims of the committee are:

- Working to discover the creative and the talented in the different academic fields;
- Organizing the work in creative activity and talent through centres and corporations involved in caring for the talented;
- Seeking help from associations in society to finance projects characterised by inventiveness.

This committee has conducted a study survey to identify the creative students in all elementary stage schools. However, the results have not been published and none of the researchers in the field of giftedness have seen it, especially those who are working in the enrichment programme in the Secretariat of special education. The Secretariat of special education, with their concerns about the whole provision, has ignored this report.

## 5.7 The Future Strategy for the Gifted Student

In June 2003, the future strategy was completed for the development of education in the State of Kuwait from year 2005 until year 2025. This included the consolidation of measures, the methods used, and the directions that education had adopted since the 1960s to raise awareness of and care for gifted students in Kuwait. These strategies aim to produce an increase in the basic quality of education regarding academic levels, skills, and levels of knowledge and, on the domestic front, to enable students to realise their potential and make an effective contribution that will enable them to follow the requirements for the global development in society. This strategy depends on the development of the global plan, which has specific aims. The following abridged version highlights the important points:

- Undertake studies, scientific research, field surveys, and follow-up and comparison studies, to collect as much information as possible about the talented to help in the early identification of gifted students.
- The importance of a mechanism in the Ministry of Education to draw up, coordinate and continue the programmes, schemes, and connected field work by uncovering and caring for talented students.
- The formation of a committee to gather data about the students who show a high levels of achievement and show indications that they have an abundance of talent, to cooperate with the ministry of education in the mechanism, to choose the best method to support them.
- The confirmation on the importance of the construction of Enrichment programmes, consisting of the characteristics and circumstances of Kuwaiti students and care for the talented in collaboration with the advanced national experience in organizations of UNESCO and specialist centres.
- The cooperation with Kuwait University and college of basic education to take a decision about the best methods of preparing the teachers to teach the talented and gifted students; also, to help the teachers in finding out more information about the students more the aim of improving their care.
- Preparing training courses or vocational development programs to enlighten the teachers and enhance their ability in this field.
- Prepare leaflets and guide books for parents and teachers to guide them in the definition of the talented, and care of gifted students.
- To produce an annual show involving talented students to spread perception and interest among the general public

(Ministry of Education, 2003)

Although this new strategy has been developed, there has been no attempt to implement it so far. Thus, in terms of selection and educational provision, the past procedures have continued on despite the evidence that there are problems.

## 5.8 Summary

In summary, at the beginning it was recognized that education in the State of Kuwait pays attention to gifted students, and appreciates that they need to be treated in a different way from other students. In addition, it was shown how Almolla chose his assistant from the brighter students. This developed into a celebration of the three top students in the class, giving those testimonials and encouragement with gifts and sending them to finish their higher education in universities abroad. Further, in the beginning of the 1970s, the interest was clarified by research and studies related to the field of the care of gifted students. In addition, following this research, committees were established to complete studies in this field and clarify characteristics whereby gifted students could be identified, as well as opening an enrichment centre and classes for gifted students. In addition, the Ministry of Education has sent many employers to do postgraduate courses in the field of gifted education, to investigate different areas related to teaching methods, the identification process, and planning strategies and mechanisms, to give gifted students suitable care.

Of course, the concept of giftedness varies but the most important change is that the Ministry of Education is now prepared to concentrate on potentially gifted students rather than just on those who have shown good examination marks. However, there is still a tendency to see giftedness in fairly fixed terms. There has been an inadequate emphasis on the development of abilities and realizing the potential of students. This affects the whole basis of selection which needs to take into account many aspects of successful learning.

Therefore, the present study investigates the cognitive characteristics into the students in middle school with emphasis on high achievement (gifted), because there are a few studies in this field in the State of Kuwait.

# Chapter Six

## A First Look at Giftedness

### 6.1 Introduction

In the previous chapters two, three, four, and five, a review is provided on giftedness, cognitive characteristics, working memory and the education system in the State of Kuwait. Performance in examination and tests is almost always linked to working memory capacity, extent of field independency, extent of divergency (see Danili and Reid, 2005). It seems possible that performance may be linked to visual-spatial abilities. These are now explored, with the emphasis more on their relationship to giftedness in Kuwait.

The current study is divided into three experiments (see Figure 6.1).

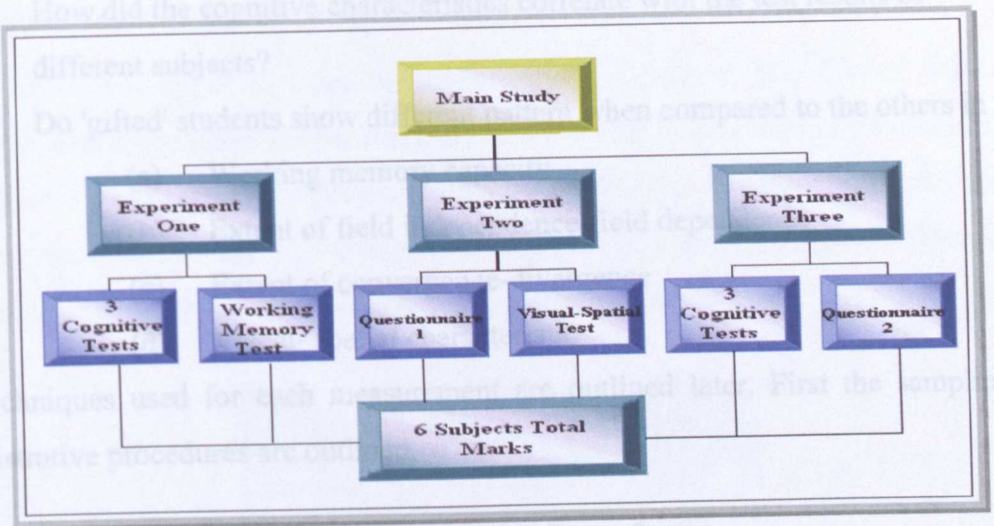



**Figure 6.1 The Study Outline**

The present chapter discusses the measuring instruments that have been used in the whole study and the sampling process as well as the statistical methods for first experiment. The findings of the working memory capacity test and the three cognitive tests are presented. The second experiment will be discussed in chapter seven and experiment three in chapter eight.

## 6.2 The Measurements Used in Experiment One

The aim of this part of the study was to explore some cognitive characteristics of students and relate these to performance and, specifically, to the supposed extent of giftedness as measured in the Kuwaiti educational system. Four characteristics were measured:

(a) Working memory capacity;
(b) Extent of field dependency;
(c) Extent of divergency-convergency;
(d) Visual-spatial

The first three involved paper and pencil tests while the fourth involved paper and pencil responses to a computer-based test. The marks in the six subjects studied at this stage were also gathered. Several questions were explored:

Q1 How did working memory correlate with test results in six subjects?

Q2 How did the cognitive characteristics correlate with the test results of different subjects?

Q3 Do 'gifted' students show different pattern when compared to the others in

(a) Working memory capacity
(b) Extent of field independence-field dependence
(c) Extent of convergence-divergence
(d) Visual- spatial characteristic

The techniques used for each measurement are outlined later. First the sampling and administrative procedures are outlined.

## 6.3 Sampling Method and Administration Procedures

This part of the study was conducted in Kuwait during the school year (April-May 2004). Thirteen public middle schools participated.

It was decided to work with the students of the third year in middle school (Grade 7, age approximately 13) because there has been very little research investigating cognitive characteristics at this age and stage. This stage lies between primary and secondary stages in the educational ladder in the State of Kuwait. On the other hand, this stage is the end of compulsory stage of education (Department of curricula and textbooks 90/91). The middle school stage is characterized by:

- Students are moving from the age at which the manifestations of childhood are gradually vanishing and the characteristics of adolescence begin to emerge.

- Students are still following a common curriculum and this is not specifically differentiated. Students have not chosen any areas of specialism.

Another very important reason to work with grade 7 students is that all students remain in the same school during grade 8 and 9 and that makes it easy to follow them in grades 8 and 9.

Ngoi and Vondracek (2004) describe ways of using school test marks as a basis by which 'gifted' students are identified: This can be done by considering those with top scores on a subject assessment tool; another approach is to look at assessments in many subjects over a longer period of time (over one academic year). Kuwait has a system of offering enrichment to those students deemed to be 'gifted', the selection being based, in large measure, on performance in six school subjects. The key aim is to explore the selection process, relate the outcomes to cognitive characteristics; and to examine the nature, purpose and, perhaps, ethical validity of the whole enrichment concept, this latter discussion being left until nearer the end of this thesis.

Following ethical approval from the University of Glasgow, the Kuwait Ministry of Education was approached for permission to have access to schools in order to administer the cognitive tests, and access student final term marks. The measurements were gathered a few weeks after the start of the second term in the academic year 2003/2004, drawing from students in three education areas. Table 6.1 shows the details.

**Table 6.1 Numbers of Students in Middle Schools**

| Areas | Boys | Girls |
|---|---|---|
| Al-Asema | 9251 | 8647 |
| Al-Frwanya | 8450 | 8997 |
| Al-Ahmady | 9488 | 10137 |
| **Total** | **27189** | **27781** |

The schools were not chosen at random, because it was important to select a sample which is typical of the Kuwaiti population at this age. Two criteria were used to select the schools:

- The schools came from the three most populated areas and represented 57% of the total number of students in the all middle stage schools in Kuwait. They represented a wide variety of social and home backgrounds and are typical of the whole middle school population.
- The schools were selected from the largest schools to minimise the impact of

specific teacher characteristics in the educational process – this sometimes happens in very small schools.

In the Kuwaiti education system, high achievement students 'gifted' at age 13 are selected in the following way.

- *Overall-gifted*: those who achieve over 91% in the total marks in the six subjects studied at this stage. They are offered enrichment in an enrichment centre.
- *Semi-gifted:* those who achieve from 85% to 91% in the total marks for the six subjects and who also achieve >90% in 2 or 3 of them.
- *Non-gifted*: those who achieve less than 85% in total marks.

The phrases *overall-gifted, semi-gifted* and *non-gifted* carry unfortunate meanings. They are used here as used in Kuwait (in Arabic) simply as labels with no pejorative overtones intended. The terms are, of course, never used with students or outside the school.

As chapter 2 and chapter 5 shows, academic giftedness is one of the underlying ideas which can be used to define the gifted student and Kuwaiti society follows this approach to identify the gifted student. Hence, this study uses Sousa (2003) to define a gifted student:

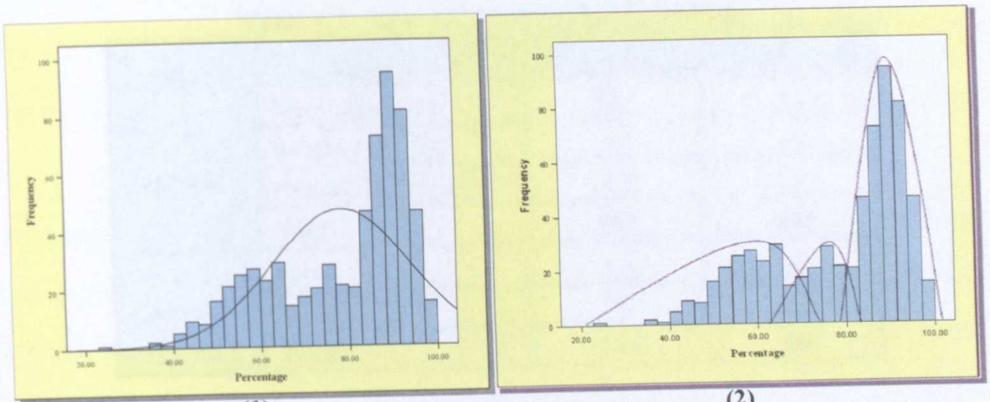
> *"One who demonstrates an exceptionally high level of performance in one or more areas of human endeavor."*
>
> (Sousa, 2003: 2)

This offers some consistency with the Kuwaiti approach: selecting those with high intellectual ability in all academic areas.

In most studies, simply selecting a cross section of the total student population would be ideal but, in this case, with the focus on giftedness, such a procedure would not have given sufficient numbers of 'gifted' students. Therefore, the following selection procedure was adopted in order to enhance the numbers of 'overall gifted' (denoted as 'G'), and semi-gifted (denoted as 'g'), the non-gifted being denoted as 'N'.

152 'overall-gifted' students were identified by means of academic marks. 165 'semi-gifted' students were identified by marks and nominations from teachers. In these selections, the procedures as used in Kuwait were followed. A further 324 were selected by taking two classes from each school (not including any students identified as gifted in any way) illustrates the kind of way the students' distribution from 13 schools was

selected according to their subject marks:




(1) (2)

**Figure 6.2 Distribution of the Study Sample**

Figure 6.2 (1) shows the distribution in general and figure 6.2 (2) shows the sample distribution, with three curves illustrating the likely distribution of the three subgroups (see Table 6.2).

**Table 6.2 Schools and Students Involved in the First Stage of the Study**

| Schools | Number of Students in each school | Students Classification | | |
|---|---|---|---|---|
| | | Non gifted | Semi-gifted | Overall Gifted |
| 1 | 55 | 28 | 18 | 9 |
| 2 | 64 | 30 | 16 | 18 |
| 3 | 55 | 27 | 16 | 12 |
| 4 | 28 | 21 | 7 | - |
| 5 | 70 | 22 | 18 | 30 |
| 6 | 39 | 26 | 9 | 4 |
| 7 | 47 | 32 | 12 | 3 |
| 8 | 48 | 20 | 18 | 10 |
| 9 | 54 | 28 | 11 | 15 |
| 10 | 48 | 16 | 16 | 16 |
| 11 | 28 | - | 6 | 21 |
| 12 | 49 | 34 | 10 | 5 |
| 13 | 56 | 40 | 8 | 8 |
| Total | **641** | **324** | **165** | **152** |

Table 6.3 gives the overall description of the sample.

**Table 6.3 Description of the Study Sample**

| *Valid* | *Category* | *Frequency* | % |
|---|---|---|---|
| *Academic* | Non-gifted (N) | 324 | 51 |
| | Semi-gifted (g) | 165 | 26 |
| | Overall Gifted (G) | 152 | 24 |
| | **Total** | **641** | **100** |
| *Gender* | Girls | 311 | 49 |
| | Boys | 330 | 52 |
| | Total | **641** | **100** |

## 6.4 Validation and Reliability of the Instruments

When any measurement is made, it is important to know how accurate, dependable or reliable the measurement is. It is even more important to know if the measurement is actually measuring what is intended.

The first is usually described as test reliability while the second raises the question of test validity. There are no perfect measurements but it is important to make some kind of check to see to what extent there is confidence in any measurement. This can be shown: if a person's height is to be measured, it is essential to know that the measuring tape (if that is what is to be used) is accurate and that the height of a person is likely to be a constant. Ideally, the measurement is made several times and the result obtained as an average. The world of educational measurement is not as simple although the same principles apply.

Reliability is now considered: if an educational measurement was made on two separate (but equivalent) occasions, the results obtained should be similar. There are other forms of reliability (see Reid, 2003) but this is, perhaps, the most critical. A formal definition might be the correlation between the scores on a test made by the same subjects on two different occasions. This may involve using two different forms of the test as, with repetition of the same form, the subject is likely to remember and repeat the answers he gets on the first time of testing. However, this raises several questions: are the two forms exactly equivalent; are the two occasions are the same: perhaps some event or learning will affect test results in some way.

Reid (2003: 52) has noted that reliability is not too serious an issue if certain sensible steps are taken: tests being of reasonable length, of appropriate difficulty, avoiding verbal ambiguity and applied under appropriate test conditions. Later, Reid (2006), looking specifically at attitude measurement, has addressed the issues of the statistical measurement of reliability and has raised major concerns about some practices where reliability (in the test-retest sense) is confused with internal consistency. He points out that internal consistency is very frequently *not* desirable in tests used in an educational setting.

Validity is more difficult and of greater importance. Reid (2003: 52) has pointed out that "An invalid test may be reliably useless!" In other words, by applying sensible test procedures, a test may reliably give information which is not the same as intended. For example, a mathematics test is unlikely to assess verbal skills. The only certain way to be sure of validity is to find some external separate measure and see if the test gives similar outcomes. However, this is often not at all easy. Nonetheless, steps can be taken to examine validity.

One of the simplest ways forward is for the researcher to know the population to be tested very well and, therefore, knowing their language, thoughts, skills and approaches, devise the test appropriately. Experienced teachers are often very good at this when it comes to testing in their specialist subject areas. This leads to a second approach. The researcher devising the test needs to talk to those who know the population and also know the subject matter under test. They can often offer insightful comments which may improve test considerably. The third approach is to talk to those who are being tested or have been tested. For example, by talking to a sample of school students who are typical of the population to be tested *before* the test is constructed, insights can be gained which will aid test construction. Equally, interviewing samples *afterwards* may throw light on test validity. Indeed, observing the behaviour of the school students may offer useful insights as well.

The main point is that it is not easy to put a simple number on test validity. Some tests are much more obviously valid than others. For example, if the aim is to test school students in relation to their ability to remember historical dates, then a test where they have to recall historical dates is likely to have some validity, provided that the kinds of questions, the format of presentation and the level of difficulty reflect what they have been taught. On the other hand, devising a test of convergency is much more difficult. There is much less certainty that any such test will be valid.

## 6.5 Statistical Analyses

Statistics can be used to describe what has been measured or they can be used to help to draw conclusions. The techniques used here for the latter are described briefly.

### Standardization

Marks in six subjects were considered (Islamic Studies, Arabic language, English language, Mathematics, Science, and Social Studies). Each was considered on its own. However, to get a total mark, the marks in the six subjects have to be standardized before being added. In standardization, the means and standard deviations of the six sets of marks were all brought to a common mean (60% was chosen) and common standard deviation (10 was chosen). This meant that a mark in each subject carried the same weight and it offers a spread of marks which was convenient.

### Correlation

This is the approach used to explore whether two variables are related in any way. Thus for example, if the height and weight of a sample of students is measured, then it would be expected to find that those who were taller tended also be heavier. This could be shown by calculating a correlation coefficient. A value of +1 would indicate perfect match of the two measures while a value of -1 would indicate that the taller were least heavy. A value of zero would indicate that that the two measures were completely unrelated. The probability of a value arising by chance can also be obtained. In studies in the social sciences, probability values of $p < 0.05$, $p < 0.01$ and $p < 0.001$ are usually used, these reflecting the mathematical nature of the normal distribution. This was followed in this study and SPSS was used for statistical analysis.

The Pearson correlation coefficient (denoted by the letter r) is the most common one and it is used when the data comes from measurements and from a scale: the data are integer. The Pearson correlation coefficient measures the linear association between two scale variables but assumes that the data show some approximation to normality and the variables follow an approximately normal distribution. The data obtained from test marks as well as from the four tests of cognitive characteristics would be expected to be approximately normally distributed and are integer in nature.

It has to be remembered that correlation shows a relationship between measurements. It does not, on its own, indicate causality. This has to be assessed by other observations.

**Factor analysis**

Factor analysis is used to look at a range of measurements and to explore to see whether there is a small set of reasons which underpin the way the students have responded. An imaginary example illustrates this. Suppose school students answer ten questions. It is found that their responses correlate with each other. The questions are whether these correlations can be explained by a small number of underlying factors. Usually the correlations have above 0.3 for this to arise. The method does not say what the factors are. That is a matter of judgement for the researcher.

The approach adopted in this study was to use Principal Components Analysis, with Varimax rotation, using SPSS. Rotation is used simply to ensure that the questions relate to the factors as tightly as possible. There is disagreement about the amount of variance (variability of responses) which has to be explained by the small number of factors. Here, it was set at a cautious 70% as a minimum.

**Analysis of Variance**

It is often important to explore whether the performance of one group is statistically different from the performance of another or could have happened by chance. This is done using a t-test. If there are more than two groups, the t-test approach is expanded into ANOVA (Analysis of Variance).

## 6.6 Examination Marks

Unfortunately, standardization is not carried out in Kuwait before adding up marks in determining who is 'gifted'. However, it was carried out here.

**Table 6.4 The Unstandardised Examination Marks: Descriptive Statistics**

| | *Social Studies* | *Islamic Studies* | *Mathematics* | *Science* | *English* | *Arabic* |
|---|---|---|---|---|---|---|
| ***Maximum*** | 100 | 100 | 100 | 100 | 100 | 98 |
| ***Minimum*** | 28 | 21 | 22 | 26 | 8 | 28 |
| ***Mean*** | 82.4 | 82.4 | 74.9 | 80.2 | 79.5 | 73.3 |
| ***Standard deviation*** | 17.2 | 15.3 | 18.3 | 15.6 | 18.5 | 15.3 |

The marks were correlated with each other to see to what extent high performance in any one subject corresponded to high performance in the others (Table 6.5).

**Table 6.5 Inter-subject Correlations**

| | *Islamic Studies* | *Mathematic* | *Science* | *English* | *Arabic* |
|---|---|---|---|---|---|
| ***Social Studies*** | 0.86 | 0.83 | 0.87 | 0.82 | 0.84 |
| ***Islamic Studies*** | | 0.83 | 0.85 | 0.81 | 0.80 |
| ***Mathematic*** | | | 0.88 | 0.84 | 0.85 |
| ***Science*** | | | | 0.86 | 0.88 |
| ***English*** | | | | | 0.87 |

The results shown in table 6.5 are somewhat surprising. Performance in all the subjects correlates with all the other subjects to a *very* high degree. This suggests that the examinations in the six subjects might be simply testing the same thing. This can be checked by carrying out a Factor Analysis on the six sets of data to see if there is more than one factor. This was done using Principal Components Analysis. It was found that one component accounted for slightly more than 87% of the variance which is quite remarkably high. The six subjects loaded on to this factor (table 6.6). [A loading is the correlation of the marks in each subject with the factor (component) found.]

**Table 6.6 Loadings of Six Subjects**

| Subject | Loading |
|---|---|
| Social Studies | 0.93 |
| Islamic Studies | 0.92 |
| Mathematics | 0.93 |
| Science | 0.96 |
| English | 0.93 |
| Arabic | 0.94 |

This indicates that all six subject assessments were measuring one factor (or component). In looking at the assessments used, 80% of the questions are multiple-choice questions. The use of these has been extensively criticised on the basis of numerous studies (see Johnstone and Ambusaidi, 2000). Indeed, most of the questions tend simply to measure recall of information. It is, therefore, likely that recall skills is the single factor found.

It is possible that recall skills might involve the student efficiency in the remembering process, the efficiency of recall from long term memory and the skills associated with producing answers in the forms required by the examination paper. In this case, multiple choices dominated and it is possible that skills of handling multiple choice questions are part of the process of recall.

The outcomes from this first analysis raise some interesting questions. If 'giftedness' is being assessed primarily on the basis of an overall examination mark and the marks in all the separate subjects are essentially based on aspects of recall skills, then it is clear that those perceived as 'gifted' are those who are best at recall skills. Therefore, 'giftedness' in Kuwait is being defined in terms of recall. Of course, recall might be the essential underpinning of many higher order cognitive skills relating to successful academic performance. However, evidence would have to be found to support this.

## 6.7 Working memory

Working memory was measured using the Figural Intersection Test (FIT). There were three reasons for this:

(a) The test has been widely used and its outcomes related to the better known Digit Span Backwards Test. Results from its widespread use show that the test is both reliable and valid (see El-Banna, 1987).
(b) It is a written test and is, therefore, easy to administer.
(c) It is based on shapes. This means that it is probably fairly independent of culture and education environment.

According to El-Banna (1987: 49), the measurement of working memory (holding-thinking space) must employ a method which meets the following requirements:

1. *"The task used must require some transformation of the input data and operations to ensure that it measures both holding and thinking processes;*
2. *The task must be unfamiliar to the student to ensure that the individual differences in holding-thinking space are not due to strategies or operations used by students rather than to their holding-thinking space alone;*
3. *In order to reduce measurement errors, it is useful to use more than one task with different stimuli to ensure that whatever the stimuli are, the size for holding these stimuli and working through it is the same."*

The Figure Intersection Test was first developed by Pascual-Leone (1970). The test comprised 36 items, each item involving from 2 to 8 shapes There are two sets of simple geometric shapes, one on the right and other on the left. The left contains the same shapes as on the right but over-lapping (see figure 6.3).

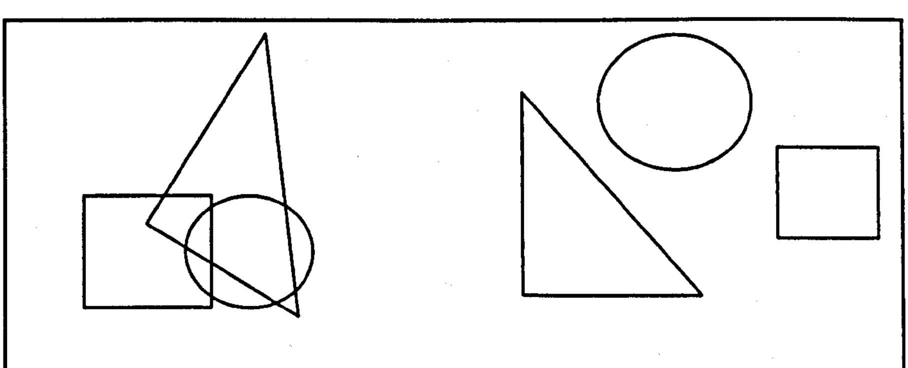


**Figure 6.3 Example 1 of the Figure Interaction Test**

There exists a common area which is inside all of the shapes. The student must find and shade in the common area of overlap. The time is limited to 25 seconds per item, on average. In one or two items case (see figure 6.4), an extra shape has been added, (this irrelevant item appear in the compound form of figures but not in the discrete form), to see if the student is able to select only the relevant shapes.

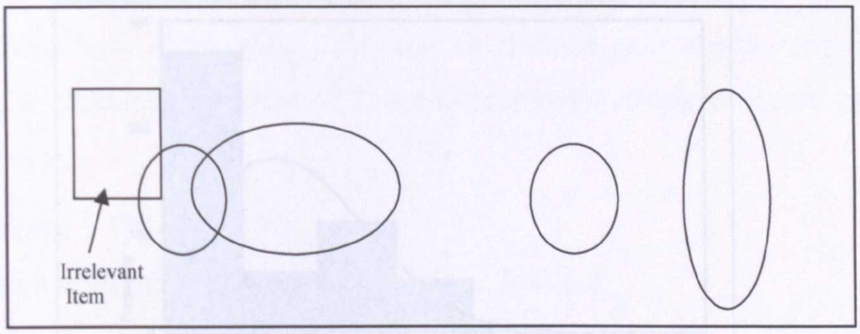



**Figure 6.4 Example 2 of the Figure Interaction Test.**

The entire test specification is shown in table 6.7. The questions are not presented in order of the number of shapes but the original test was randomized and this was followed exactly here.

**Table 6.7 Items of Figure Intersection Test (FIT)**

| Number of shapes | Frequencies | Items with same figure | |
|---|---|---|---|
| | | Same number of shapes | Items with extra shape |
| 2 | 5 | 9,14,16,28,29 | none |
| 3 | 5 | 2,3,7,21,31 | 31 |
| 4 | 6 | 11,12,18,23,26,36 | 12, 36 |
| 5 | 5 | 1,4,17,30,33 | 17 |
| 6 | 5 | 5,6,15,20,35 | 6 |
| 7 | 5 | 8,13,24,25,32 | 25 |
| 8 | 5 | 10,19,22,27,34 | 22 |

### 6.7.1 Correction Method

Ideally, the test is marked by looking at the highest number of shapes where a candidate has them all correct. However, the data obtained are often not as neat as this. For example, a student may have all the items with 2, 3, 4 and 5 shapes correct and then have *some* of the items correct where there are 6 shapes. Even worse, some candidates have many items incorrect at one level and then most correct at the next highest level. This sort of pattern is, perhaps, caused by a temporary loss of concentration. It is possible to ignore errors when most items are correct at the next level.

The test was marked in this way. This follows the approach adopted by El-Banna (1987) and Bahar (1999) with much older students. Unfortunately, it was found that a large number of study sample (142 of the total 641) responded in such a way that it as difficult to know exactly what their working memory capacity was. Furthermore, some individuals seemed to be placed in a level that might be less than the real level. Overall, it gave a mean of 2.9 with standard deviation of 1.2 (see figure 6.5). This was an unexpectedly low mean for age 13 where a predicted mean might be nearer 5.5.

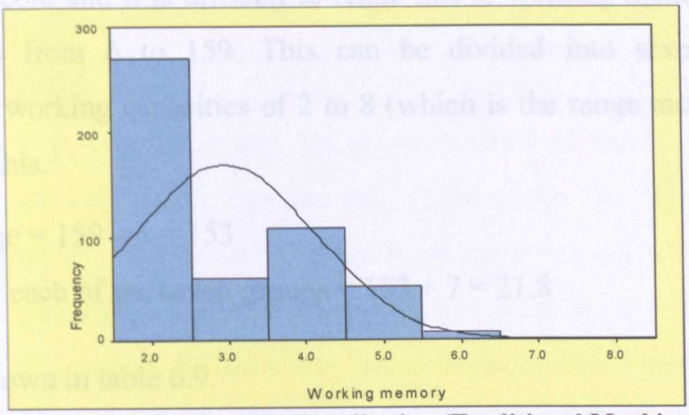



**Figure 6.5 The Sample Distribution (Traditional Marking)**

It is possible to modify the approach slightly. It is more accurate to award a working memory capacity if the student is successful with a clear majority of questions at any level. Thus, at level 5, for example, there are four questions with five shapes and one question with five shapes plus an extra shape. If a student is correct with four of the 5 shapes (or 3 of them as long as one of them is the question with the extra shape the student is awarded working memory of five. The test was marked in this way as well, the results give the following histogram (figure 6.6).

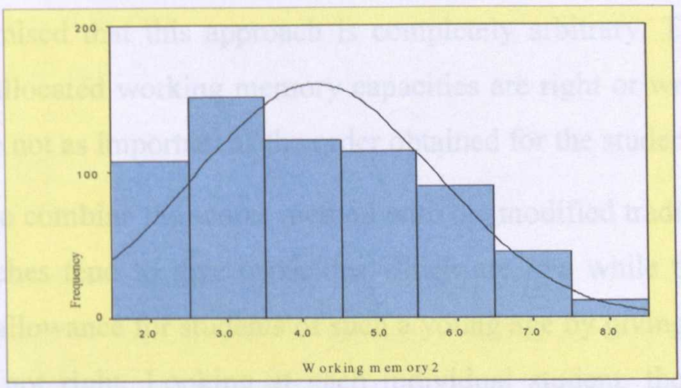



**Figure 6.6 The Sample Distribution (Modified Marking)**

This approach gives a mean of 3.9 (Table 6.8), looking more promising.

**Table 6.8 Descriptive Statistics (Modified Marking)**

| *Sample* | *Minimum* | *Maximum* | *Mean* | *Standard Deviation* |
|---|---|---|---|---|
| 641 | 2 | 8 | 3.9 | 1.6 |

A completely different approach was then considered. It is possible to give credit for every question answered correctly. This is done by giving 2 marks if the question has two geometrical shapes with overlap, 3 marks if the question has three geometrical shapes with overlap, and so on. Where there is an extra shape an extra half mark was allocated. The total score was used as a measure of working memory capacity. The problem is that this gives a test score and it is difficult to relate this to working memory capacities. The mark range runs from 6 to 159. This can be divided into seven ranges of 21.8, corresponding to working capacities of 2 to 8 (which is the range measured by the test). Table 6.9 shows this.

Total range = 159 – 6 = 153

Range for each of the seven groups = 153 ÷ 7 = 21.8

The scores are shown in table 6.9.

**Table 6.9 Capacity of Working Memory**

| WM | Frequency | % | Range |
|---|---|---|---|
| 2 | 137 | 21.4 | 6-21.8 |
| 3 | 149 | 23.2 | 21.9-43.6 |
| 4 | 128 | 20.0 | 43.7-65.5 |
| 5 | 104 | 16.2 | 65.6-87.2 |
| 6 | 84 | 13.1 | 87.3-109 |
| 7 | 30 | 4.7 | 109.1-130.9 |
| 8 | 9 | 1.4 | 131-153 |
| **Total** | **641** | **100** | |

It has to be recognised that this approach is completely arbitrary. There is no way of knowing that the allocated working memory capacities are right or wrong. However, the absolute values are not as important as the order obtained for the student group.

It is also possible to combine the scores method with the modified traditional method. The traditional approaches tend to give capacities which are low while the new method of scoring makes an allowance for students of such a young age by giving them credit for all the answers they got right. Looking at each individual student, the working memory capacities from the traditional approach are raised when the marking method gives a much higher result.

The fact that there are so many ways to approach the scoring of the test and that the actual capacities can vary somewhat between results is a matter of concern. Nonetheless, it is the order of capacities which is important not the absolute value.

### 6.7.2 Results

Table 6.10 shows the correlations obtained by the different approaches.

**Table 6.10 Working Memory Capacity and Performance**

| Working Memory | *Social Studies* | *Islamic Studies* | *Maths* | *Science* | *English* | *Arabic* | *Total Mark* |
|---|---|---|---|---|---|---|---|
| *Traditional Marking* | 0.19 | 0.16 | 0.20 | 0.21 | 0.19 | 0.19 | 0.21 |
| *Scores* | 0.19 | 0.18 | 0.22 | 0.24 | 0.19 | 0.20 | 0.22 |
| *Combined* | 0.21 | 0.17 | 0.22 | 0.23 | 0.19 | 0.19 | 0.22 |
| *Probabilities* | $p < 0.001$ | $p < 0.001$ | $p < 0.001$ | $p < 0.001$ | $p < 0.001$ | $p < 0.001$ | $p < 0.001$ |

Looking at table 6.10, it is clear that the actual method of marking makes very little difference. There are very minor changes only. This shows that the actual order of the students with regard to their measured working memory capacity does not vary much with the marking method used. The key result is to note that the correlation of working memory capacity with overall performance (based in standardised marks) is 0.22.

The mathematics and science marks show slightly higher correlations and the arts subjects slightly lower. By carrying out a Factor Analysis on the six sets of data and working memory total scores using Principal Components Analysis with Varimax Rotation, two factors were found (see table 6.11 for the factor loadings).

**Table 6.11 Factor Loadings: Working Memory and Six Subjects**

| N = 641 | Components 1 | Components 2 |
|---|---|---|
| Working Memory Capacity | 0.11 | 0.99 |
| Social Studies | 0.93 | 0.00 |
| Islamic Studies | 0.92 | 0.00 |
| Mathematics | 0.92 | 0.12 |
| Science | 0.95 | 0.13 |
| English | 0.92 | 0.00 |
| Arabic | 0.93 | 0.10 |

It is evident from Table 6.11 that the six subjects are loaded on to one factor, which is almost certainly recall. Working memory capacity hardly loads on to this factor at all. Recall is one of the most important processes associated with long-term memory. The capacity of working memory is not the same as recall of information. Working memory capacity was measured by the figural intersection test and this involves holding and manipulating various geometrical shapes in the working memory. This is a very different process when compared to the recall of information from long term memory (Higbee, 1977). Although the working memory capacity can influence test performance (depending on the test used). Working memory is a part of how the brain works where information is processed and understanding is gained (see Johnstone, 1997).

Table 6.11 shows very clearly that working memory capacity is very different from subject performance. Subject performance loads highly onto component (factor) 1 with almost no loading on to component (factor) 2. Working Memory capacity shows this in reverse.

### 6.7.3 Working Memory and Giftedness

It is possible to divide the whole sample up into three distinct groups: those with above average (or high) working memory capacity (HWM), those with average (medium) working memory capacity (MWM) and those with below average (low) working memory capacity (LWM). Using the scoring method, table 6.12 shows the descriptive statistics.

**Table 6.12 Descriptive Statistics for the Working Memory Test**

| *Sample* | *Girls* | *Boys* | *Minimum* | *Maximum* | *Mean* | *Standard Deviation* |
|---|---|---|---|---|---|---|
| 641 | 311 | 330 | 6 | 159 | 59 | 34 |

If the marks form an exactly normal distribution, then three approximately equal groups will be formed in the following way:

- HWM: those who scored above the mean their sample population are classified as high visual-spatial learners (i.e. HWM> mean + ½StD).
- MWM: those who may be located between the above two categories (mean ± ½StD)
- LWM: those who scored score less than ½StD below the mean (i.e. LWM < mean -½StD)

This cut-off divides the whole cohort into three almost equal groups and table 6.13 shows the actual group sizes obtained.

**Table 6.13 Number of Students in Each Category.**

| WM Category | Number of Students | % |
|---|---|---|
| *High working memory* | 202 | 32 |
| *Medium working memory* | 189 | 30 |
| *Low working memory* | 250 | 39 |
| **Total** | 641 | 100 |

One of the questions at the start related to whether being 'gifted' was affected by the capacity of the working memory. Of course, this question is only answerable if there is some agreed definition of 'giftedness'. In Kuwait, potentially 'gifted' students are selected initially on grounds of examination performance. Examination performance is significantly (at a low level) correlated with working memory capacity. Therefore, it follows that working memory capacity is related to being 'gifted' in Kuwait.

The sample used did not represent a typical cross-section of Kuwait students at this age. It contained a higher proportion of 'overall gifted' (G) and 'semi gifted' (g). It is possible to illustrate the relationship between working memory capacity and 'giftedness' as defined in Kuwait (see table 6.14).

**Table 6.14 Working Memory Capacity and Giftedness**

| Academic | N = 641 | Working Memory | | | Total |
|---|---|---|---|---|---|
| | | L | M | H | |
| Non-gifted (N) | % | 23 | 15 | 12 | 51 |
| Semi-gifted (g) | % | 8 | 8 | 10 | 26 |
| Overall gifted (G) | % | 8 | 7 | 10 | 24 |
| **Total** | **%** | **39** | **29** | **32** | **100** |

This does show how, with those classified as 'non-gifted', there is high proportion of low working memory capacity students. Nonetheless, reflecting the quite low overall correlation value (0.22), there are quite high proportions of students whose working memory capacities are not strongly linked to their overall examination performance. If the suggestion that the examinations are simply testing recall skills, then it is clear that, while working memory capacity correlates highly significantly with test performance, the low correlation values (averaging 0.22) suggest that it is not a very important correlate of such skills. This is consistent with other studies which have shown that it is the handing of information and thinking processes that make working memory capacity important for academic success (see Johnstone, 1997; Johnstone *et al*., 1998; Johnstone, 2000; Reid and Yang, 2000; Danili and Reid, 2004). These studies show much higher correlation values where the tests involved required thinking and processing skills in solving problems.

Comparisons of the mean scores between each academic levels One-Way Analysis of Variance (ANOVA) procedure were used to test the null hypothesis that the means are equal. This given a probability value [$F(2, 683) = 9.8$, $p<0.001$]. Despite reaching statistical significance the actual difference in mean scores between the groups was high. The effect size, calculated using eta squared, was 0.03 which is mean a small effect (see

Pallant, 2005). post-hoc comparisons using the Tukey HSD test indicated that the mean score for group N (M=53.0, SD=31.9)was significantly different from group G (M=65.7 SD= 36.5) and Group g (M=63.9, SD= 34.2). This confirms the results from the correlation: students classified as gifted tend to have a higher working memory.

## 6.8 Field Dependency

Witkin *et al* (1971) developed a Hidden Figures Test (HFT) to measure the extent of field dependency. This test was used with very minor adjustments by El-Banna (1987) and found to work well. Later, the same test was used in many studies (e.g. Bahar, 1999; Al-Naeme, 1989; Danili, 2005). The test is a timed written test, making its use straightforward. The time allowed is 20 minutes (5 minutes for instruction and 15 minutes for completing the test). The test booklet comprises 20 complex figures. There are 2 figures used as examples before the student starts to show how the procedure works (figure 6.7) The student has to find a simple shape which is embedded in a complex matrix of shapes. The simple shape is given to the student and they are asked to trace the shape hidden in the matrix, the shape being of the same size, the same proportions, facing in the same direction, with only one shape within each pattern. The Hidden Figure Test (HFT) was translated in Arabic to use with Arabic students.

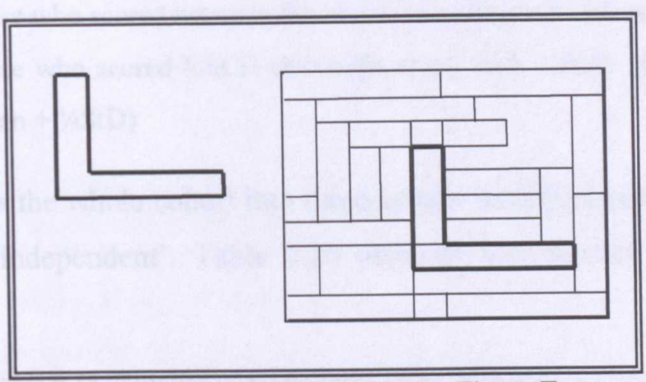


**Figure 6.7 Example of Hidden Figure Test**

The Hidden Figure Test (HFT) was scored by giving one point for each correct answer. The total score is found by simple addition, the maximum score being 20. The descriptive statistics for the test are shown in table 6.15.

**Table 6.15 Descriptive Statistics for the Hidden Figure Test**

| *Sample* | *Girls* | *Boys* | *Minimum* | *Maximum* | *Mean* | *Standard Deviation* |
|---|---|---|---|---|---|---|
| 604 | 289 | 315 | 0 | 9 | 2.0 | 1.6 |

The hidden figure test results show that the students found this test too difficult. The results must, therefore be treated with some caution in that the discrimination of the test will be low, given the low spread of scores.

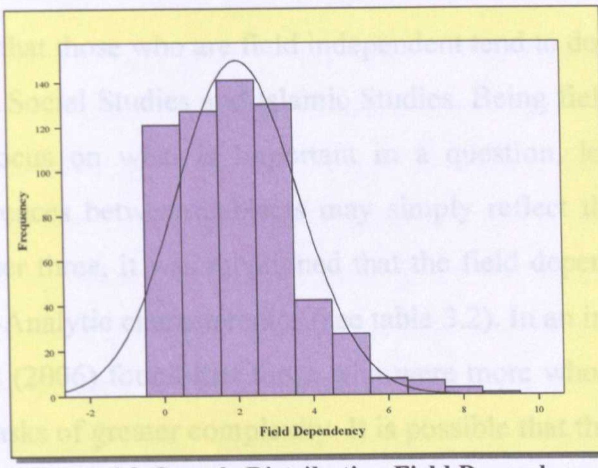



**Figure 6.8 Sample Distribution Field Dependency**

The sample can be divided into three categories: Field-Dependent (FD), Field-Intermediate (FINT), and Field-Independent (FIND). Following Bahar (1999), this was done in the following way.

- FD: those who scored less than ¼standard deviation below the mean their sample population (i.e.FD < mean - ¼StD)
- FINT: those who scored between the above two categories (mean ± ¼St.D)
- FIND: those who scored ¼St.D above the mean their sample population (i.e. FIND > mean + ¼StD)

This cut-off divides the whole cohort into three groups with high proportions classified as 'dependent' and 'independent'. Table 6.16 presents the number of students in each category.

**Table 6.16 Number of Students in Field Dependency Category**

| FD/IND Category | Number of students | % |
|---|---|---|
| ***Field Dependent*** | 247 | 41 |
| ***Field Intermediate*** | 141 | 23 |
| ***Field Independent*** | 216 | 36 |
| **Total** | 604 | 100 |

It was expected that the extent of field dependency would correlate with examination scores, at least in some subjects, in that it has frequently been found that those who are more field independent perform better in academic assessments (see Danili and Reid, 2004). The results, using Pearson correlation, are shown in table 6.17.

**Table 6.17 Correlations of Field-Dependency/Independency Test with Subject Performance**

| | *Social Studies* | *Islamic Studies* | *Mathematics* | *Science* | *English* | *Arabic* | *Total Mark* |
|---|---|---|---|---|---|---|---|
| ***Field Dependency*** | 0.12<br>$p < 0.05$ | 0.08<br>$p < 0.05$ | 0.21<br>$p < 0.001$ | 0.19<br>$p < 0.001$ | 0.18<br>$p < 0.001$ | 0.20<br>$p < 0.001$ | 0.18<br>$p < 0.001$ |

The table 6.17 shows that those who are field independent tend to do better in all subjects. The effect is least for Social Studies and Islamic Studies. Being field independent means that a student can focus on what is important in a question, leaving aside the less important. The differences between subjects may simply reflect the types of questions being asked. In chapter three, it was mentioned that the field dependency characteristics are similar Wholistic-Analytic characteristics (see table 3.2). In an interesting experiment, Peterson and Deary's (2006) found that those who were more wholistic-analytic in style were able to handle tasks of greater complexity. It is possible that those who could handle tasks of greater complexity were also field independent and the ability to handle such tasks relied in part on their ability to select what was important for the task, leaving aside the less important.

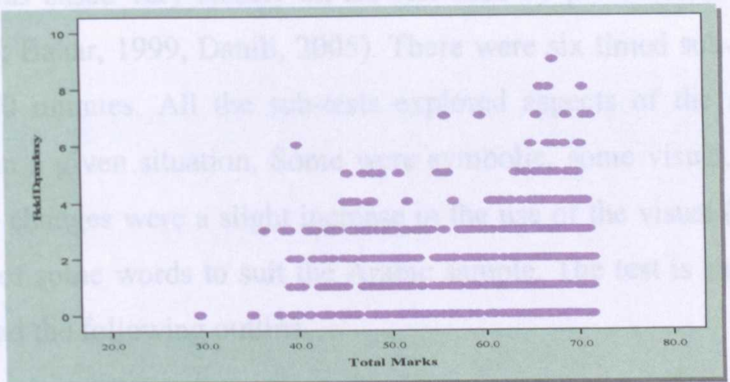



**Figure 6.9 Correlation between Field Dependency and Total Standardised Marks**

As with working memory, if higher marks determine whether a student is seen as 'gifted' then being field independent will also be more associated with giftedness. This can be illustrated by looking at the proportions that field dependent (low scores) field intermediate (middle scores) and field independent (high scores) as in table 6.18.

**Table 6.18 Field Dependency and Giftedness**

| Academic | N = 604 | Field Dependency | | | Total |
|---|---|---|---|---|---|
| | | FD | FINT | FIND | |
| Non-gifted (N) | % | 23 | 11 | 15 | 49 |
| Semi-gifted (g) | % | 10 | 6 | 10 | 26 |
| Overall gifted (G) | % | 8 | 6 | 11 | 25 |
| **Total** | % | 41 | 23 | 36 | 100 |

It can be seen from table 6.16 that the proportion of field independent students is higher with the 'gifted' groups, illustrating what the significant correlation coefficient indicates. Comparisons of the mean scores between each academic levels One-Way Analysis of Variance (ANOVA) procedure were used to test he null hypothesis that the means are equal. This given a probability value [$F (2, 602) = 9.4$, $p<0.001$]. Despite reaching statistical significance the actual difference in mean scores between the groups was high. The effect size, calculated using eta squared, was 0.03 which is mean a small effect. Post-hoc comparisons using the Tukey HSD test indicated that the mean score for group N (M=1.7, SD=1.4)was significantly different from group G (M=2.4, SD= 1.8). Group g (M= 2.1, SD= 1.6) did not differ significantly from either Group N or G

Thus, from the above analysis it can be concluded that there is significant difference in overall-gifted (G) students' field dependent-independent style and non-gifted (N) students.

## 6.9 Convergent /Divergent Test

The test used was based very closely on the test used by previous researchers (e.g. Al-Molhodai, 1996; Bahar, 1999, Danili, 2005). There were six timed sub-tests, with a total time limit of 20 minutes. All the sub-tests explored aspects of the student ability to generate ideas in a given situation. Some were symbolic, some visual, some geometric. The only minor changes were a slight increase in the use of the visual (in sub test 1) and the adjustment of some words to suit the Arabic sample. The test is shown in full in the appendix and had the following outline.

*Test 1*: The researcher decided to add a new pictorial test, its aim being to give the students an opportunity to produce ideas related to circles in 4 minutes.

*Test 2*: The students are asked to write as many sentences as possible including four given specific words in each sentence. These given words should be used in any constructive sentence in the same form. Three minutes is the time limit to complete two questions.

*Test 3*: This test is the second pictorial test and, in this test, the students are required to draw up to five different pictures explain the idea for each four words given, and the time limit they are given six minutes.

*Test 4*: In this test the students are required to give as many different things as possible within in the time limit of two minutes. To see how many things the students could think of that are alike in some way. They were asked to write all the things that are red, or that are red more often than any other shape. An example was given at the beginning.

*Test 5*: This tests the students ability to think of as many words they can that begin with one letter and end with another: this test includes two questions. They must answer in two minutes.

*Test 6*: This test is to examine how many ideas the student can think of about a given topic. Three minutes is the limit time for this test and the student must write all the idea they can about this topic, no since how much it is long or important.

In order to measure students' performance, one mark was given for every single correct response (Hudson, 1966). Both tests are given in full in (appendix A). A Cronbach's Alpha gave a value of 0.76 which is satisfactory. This statistic is a measure of internal consistency, suggesting that the six tests were all consistent in their measurement.

The descriptive statistics for the test are shown in table 6.19 showing that this well established test worked well with the students here, giving a good spread of marks.

**Table 6.19 Descriptive Statistics (Convergent Divergent Style)**

| *Sample* | *Girls* | *Boys* | *Minimum* | *Maximum* | *Mean* | *Standard Deviation* |
|---|---|---|---|---|---|---|
| 592 | 274 | 318 | 5 | 77 | 33.6 | 11.4 |

The distribution of marks is shown in figure 6.10.

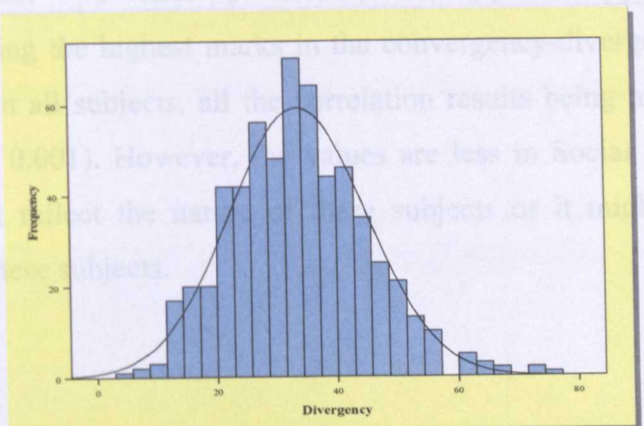



**Figure 6.10 Sample Distribution for Divergency Test**

Hudson (1966) divided his sample of school students according to their performance in open-ended and IQ tests into 'divergers' (top 30%), who were predominantly better in the open-ended tests, and the 'convergers' (bottom 30%), who were substantially superior at the IQ tests. There was also what can be classified as 'all-rounders' (40%), who were more or less equally good at both kinds of test. Bahar, (1999) used the mean score ±¼SD as a cut-off to divide his sample. The same procedure was adopted here (see table 6.20):

- Convergers (Con): will be those who scored less than a quarter standard deviation below the mean their sample population (i.e.Con <mean - ¼StD)
- All-rounders (AR): will be students whose scores were between the above two categories (i.e mean ± ¼StD)
- Divergers (Div): will be those scoring more than a quarter standard deviation above the mean their sample population (i.e. Div > mean +¼StD)

**Table 6.20 Number of Students in Convergence/Divergence Category**

| Category | Number of students | % |
|---|---|---|
| ***Convergent*** | 226 | 38 |
| ***All-rounder*** | 140 | 24 |
| ***Divergent*** | 226 | 38 |
| ***Total*** | 592 | 100 |

The measured convergent/divergent scores were correlated with student academic performance, using Pearson correlation. The value obtained was $r = 0.56$ ($p < 0.001$).

The correlations with the separate subjects is shown in Table 6.21.

**Table 6.21 Correlations of Convergency-Divergency Test with Subject Performance**

| | *Social Studies* | *Islamic* | *Math* | *Science* | *English* | *Arabic* | *Total Mark* |
|---|---|---|---|---|---|---|---|
| Divergency | 0.45<br>$p < 0.001$ | 0.46<br>$p < 0.001$ | 0.51<br>$p < 0.001$ | 0.54<br>$p < 0.001$ | 0.57<br>$p < 0.001$ | 0.57<br>$p < 0.001$ | 0.56<br>$p < 0.001$ |

Those who are scoring the highest marks in the convergency-divergency test tend to be those who do best in all subjects, all the correlation results being highly significant (at much less than $p < 0.001$). However, the values are less in Social Studies and Islamic Studies. This might reflect the nature of these subjects or it might reflect the actual questions asked in these subjects.

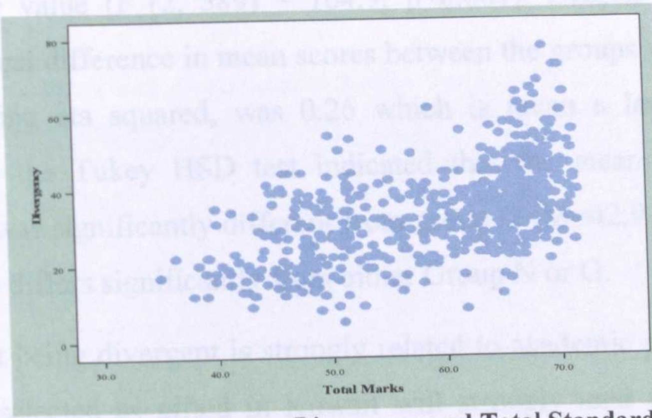



**Figure 6.11 Correlation between Divergency and Total Standardise Marks**

At first sight, it might seem strange that such very high correlations are obtained showing that being divergent is a very considerable advantage in examination success although it has to be noted that high values were also obtained by Danili and Reid (2005). They were able to show that one factor was the actual style of test question. Nonetheless, if the examinations here are simply testing recall skills, then it appears strange that being divergent has any advantage. The work of Al-Qasmi (2006) throws some light on this. In the light of her results (where she was looking at problem solving in university biology), she deduced that being divergent offers many 'pathways' between what she called 'nodes of knowledge' as held in long term memory. The person with more pathways had a better chance of finding an answer when compared to the person whose number of pathways was more limited. If divergency means the opportunity (for some reason) to be able to use more pathways linking ideas, then it is likely that such a person is more likely to be able to recall information in an examination situation.

The differences between the three groups (overall gifted, semi-gifted and non-gifted) are illustrated in table 6.22.

**Table 6.22 Convergency/Divergency and Giftedness**

| Academic | N = 592 | Divergency | | | Total |
|---|---|---|---|---|---|
| | | Con | AR | Div | |
| Non-gifted (N) | % | 31 | 11 | 12 | 53 |
| Semi-gifted (g) | % | 6 | 9 | 11 | 26 |
| Overall gifted (G) | % | 2 | 4 | 15 | 21 |
| **Total** | % | 38 | 24 | 38 | 100 |

It is very clear that those who are 'gifted' tend very strongly to be divergent. Comparisons of the mean scores between each academic levels One-Way Analysis of Variance (ANOVA) procedure were used to test he null hypothesis that the means are equal. This given a probability value [F (2, 589) = 104.9, p<0.001]. Despite reaching statistical significance the actual difference in mean scores between the groups was high. The effect size, calculated using eta squared, was 0.26 which is mean a large effect. post-hoc comparisons using the Tukey HSD test indicated that the mean score for group N (M=28.5, SD=9.7)was significantly different from group G (M=42.9 SD= 10.6). Group g (M=36.5, SD= 9.4) differs significantly from either Group N or G.

It is very clear that being divergent is strongly related to academic performance and this means that those selected as gifted in Kuwait will strongly tend to be those who are divergent.

## 6.10 Visual-Spatial Test Description

Although visual-spatial ability is often discussed, no specific test was found to measure it (Silverman, 1989, 2004). It was necessary to develop a test for the purpose. Looking at the literature (e.g. Johnson, 1996; Silverman, 1989, 2004; Golon, 2004; Hudson, 1960), the following skills were identified as part of visual-spatial Cognitive characteristics:

**Table 6.23 Skills related to Visual-spatial Ability**

| Skill to be Measured |
|---|
| • Discrimination between different forms and shapes<br>• Focus in the counting of shapes, in different sizes and position<br>• Distinguish between figures and their backgrounds and inverse images<br>• Estimation of distances and velocities<br>• Accurate perception of shapes and number of shapes<br>• Speed tracking information visually |

The test was designed to reflect ability in these skills. Several early versions (with 57 items) were tried out with experienced teachers and researchers and numerous modifications were incorporated until the final test, comprising 33 items with some of these items containing sub-items with the maximum score being 46, was developed. The test was computer based allowing for movement, colour and simple forms of animation. The specification of the test is shown in table 6.24. The test had a specification which reflected the skills found in the literature which were thought to be associated with visual-spatial ability.

**Table 6.24 Visual-spatial Ability Test Specification**

| Q | Items | Description | Skill Measured |
|---|---|---|---|
| 1 | 5 | Find the different shape | Discrimination between different forms and shapes |
| 2 | 5 | Counting of the of object | Focus in the counting of shapes, in different sizes and position |
| 3 | 4 | Shape of and the facing form | Distinguish between figures and their |
| | 2 | Points to fix a hidden form between | |
| 4 | 4 | Distances between the shapes | Estimation of distances and velocities |
| 5 | 4 | Assembling of shapes is geometrical | Accurate perception of shapes and number of shapes |
| 6 | 5 | True picture from a piece of folded paper | Speed tracking information visually |
| | 4 | Product from move of object | |

The visual–spatial test was designed specifically for this study and is shown in full in the attached CD. This test used a computer and data projector. The students were shown a series of visual representations, often for a very short fixed length of time and then asked a question which they recorded on paper. This procedure has many advantages: it allows the use of pictures and animation; it allows the use of colour; it gives a tight control of timing as every class would meet exactly the same test at exactly the same speed, it being projected for the whole class at one time.

The problem with any new test is to establish its validity. This was approached from several standpoints. The extensive trialling with other adults and repeated refinements introduced as a result of comment helped. However, the whole test was pre-tested carefully, using the 48 items left after the initial editing.

Before using the visual-spatial test, it was pre-tested in different schools chosen randomly within the school high populated in the Al-Ahmadey education area. Care was taken to check how the students would see the test. They were told that the test was for a research purposes and nothing to do with the school, that the results would not be shared with anyone, that the results would not affect any school tests. It was explained to them that they were being asked to check a test which might bring benefits to others in schools. The aim was to gain as accurate a picture as possible about the possible use of the test. About 90 students were involved. The researcher was careful to test the student without teacher involvement.

In this stage, there were thirty students in each classroom who completed the test. It was found there were some technical errors and the test took longer than expected with the larger numbers. From this observation, it was decided to omit some items. The students were asked to write their comments about the test and there were many informal discussions with them. While many commented on the level of difficulty and the speed of the test, it appeared that the test was acceptable. Later refinements reduced the number of items and allowed a little more time.

The final stage involved examining the data for the 48 items using principal component analysis but the scree plot revealed no useful discontinuity and it was not possible to explain 70% of the variance with the small number of factors, The test was designed to measure a wide range of skills and the factor analysis is consistent with this.

After all the modifications were completed, the test was then used with the sample of 560. The distribution of marks is shown in figure 6.12 and the descriptive statistics is shown in (table 6.25).

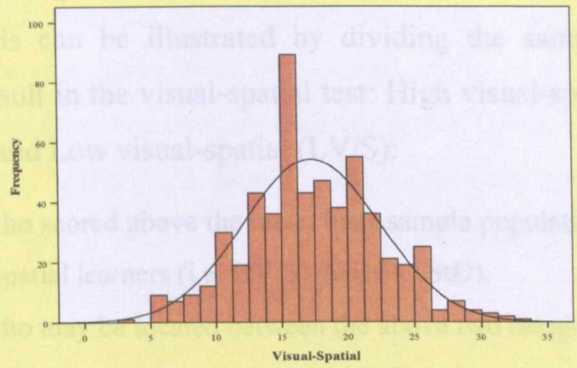



**Figure 6.12 Sample Distribution for the Visual-spatial test**

Table 6.25 shows that a good spread of marks was obtained.

**Table 6.25 Descriptive Statistics for Visual-spatial Test**

| *Sample* | *Girls* | *Boys* | *Minimum* | *Maximum* | *Mean* | *Standard Deviation* |
|---|---|---|---|---|---|---|
| 560 | 281 | 279 | 3 | 33 | 17.3 | 5.2 |

The measured visual-spatial scores were correlated with academic performance in all six subjects and the total mark, using Pearson correlation table 6.23.

**Table 6.26 Correlations of Visual-Spatial Ability with Subject Marks**

| | *Social Studies* | *Islamic* | *Math* | *Science* | *English* | *Arabic* | *Total Mark* |
|---|---|---|---|---|---|---|---|
| Visual-Spatial Test | 0.28 | 0.23 | 0.31 | 0.33 | 0.33 | 0.34 | 0.33 |
| | p<0.001 | p<0.001 | p<0.001 | p<0.001 | p<0.001 | p<0.001 | p<0.001 |

It is clear that the results of the visual-spatial test correlate very significantly with performance in all subjects. Silverman (2004) has found that many highly gifted visual-spatial learners were successful at many tasks given in many ways although there were some visual-spatial learners who seemed to depend almost entirely on this way of learning. The first group could choose to learn visually spatially as a preferred learning style; the latter group had to use this learning style.

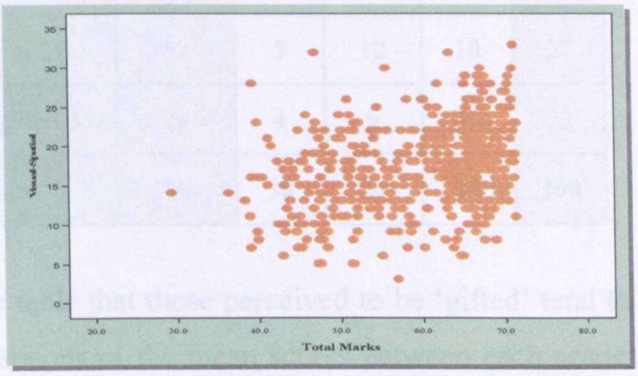



**Figure 6.13 Correlation between Visual-Spatial and Total Standardise Marks**

Again, as 'giftedness' is determined largely by performance in school subjects, it means that those who are seen as 'gifted' in Kuwait will tend to be those who are more visually-spatially equipped. This can be illustrated by dividing the sample into three groups according to the test result in the visual-spatial test: High visual-spatial (HV/S), Medium visual-spatial (MV/S), and Low visual-spatial (LV/S):

- HV/S: those who scored above the mean their sample population are classified as high visual-spatial learners (i.e. HV/S> mean+½StD),
- MV/S: those who may be located between the above two categories (mean ±½StD)
- LV/S: those who scored score less than ½StD below the mean (i.e. LV/S <mean-½StD)

Again, half of a standard deviation was used simply because this allowed the formation of three very approximately equal groupings (see table 6.27).

**Table 6.27 Number of Students in Visual-Spatial Category**

| Visual-Spatial Category | Number of Students | % |
|---|---|---|
| High visual-spatial (HV/S) | 177 | 32 |
| Medium visual-spatial ( MV/S) | 217 | 39 |
| Low visual-spatial (LV/S) | 166 | 30 |
| **Total** | 560 | 100 |

Table 6.28 shows how the giftedness relates to visual spatial ability.

**Table 6.28 Visual-spatial Test with Giftedness**

| Academic | N = 560 | Visual-spatial Ability | | | Total |
|---|---|---|---|---|---|
| | | LV/S | MV/S | HV/S | |
| Non-gifted (N) | % | 20 | 18 | 11 | 50 |
| Semi-gifted (g) | % | 5 | 12 | 10 | 27 |
| Overall gifted (G) | % | 4 | 9 | 10 | 23 |
| **Total** | % | 38 | 24 | 38 | 100 |

Again, it is clear from the table that those perceived to be 'gifted' tend to be better in the visual-spatial test. Comparisons of the mean scores between each academic levels One-Way Analysis of Variance (ANOVA) procedure were used to test the null hypothesis that the means are equal. This given a probability value [$F (2, 557) = 25$, $p<0.001$]. Despite reaching statistical significance the actual difference in mean scores between the groups was high. The effect size, calculated using eta squared, was 0.11 which is mean a Medium effect (see Pallant, 2005). Post-hoc comparisons using the Tukey HSD test indicated that the mean score for group N ($M=15.8$, $SD=5.1$)was significantly different from group G ($M=19.3$, $SD= 5.1$). Group g ($M=18.2$, $SD= 4.5$) differs significantly from Group N. This result confirms the conclusions from the correlation.

## 6.11 Inter-Correlations

The results from the four cognitive characteristics test can be correlated with each other (table 6.29):

**Table 6.29 Inter-Correlations**

| | Working Memory Capacity | Field Dependency | Convergency-divergency |
|---|---|---|---|
| **Field Dependency** | 0.30 | | |
| | <0.001 | | |
| **Convergency-divergency** | 0.22 | 0.27 | |
| | <0.001 | <0.001 | |
| **Visual-Spatial Ability** | 0.21 | 0.30 | 0.39 |
| | <0.001 | <0.001 | <0.001 |

It is possible to interpret these correlations in terms of information processing.

Field dependency relates to the ability to selection information efficiently for a task. It is well established that field dependency correlates with working memory capacity measures, the field independent characteristic being seen as one aspect of the efficiency by which the working memory operates (Johnstone and Al-Naeme, 1991). This is achieved by the perception filter working efficiently and this is controlled by the way the long term memory operates.

Being divergent means being able to use (or generate) links between ideas. It has been established that divergency correlates with performance (Danili and Reid, 2005) and, particularly, problem solving ability (Al-Qasmi, 2006). In the latter study, it was suggested that this was dependent on the presence of usable, accessible links between ideas in long term memory.

Being visual-spatially able means a strong tendency to see things in terms of pictures, diagrams or spatial relationships; and these must be being stored in long term memory. All three characteristics relate to long term memory and the way it works. This might relate to the presence of the significant correlations although the exact explanation awaits further research.

## 6.12 Some Conclusions

Using a very large sample of grade 7 students (aged about 13), performance in six subjects has been considered in relation to measures of working memory capacity, extent of field independency, extent of divergency, and a new test of visual-spatial. The sample was selected in such a way that it contained a good proportion of these regarded as 'gifted' under the procedure used in Kuwait. The validity of the measures of working memory, field dependency and convergency-divergency are well established while the validity of the new test for visual-spatial abilities was checked by consulting many others and conducting extensive pre-testing.

The examination marks for the six subjects are extremely highly correlated with each other and a factor analysis shows that only are factor accounts for almost all the variance in these results, with every subject loading onto that factor by at least 0.9. Given the nature of the test material and the fact that it was testing recall, it is almost certain that this one factor is 'recall skills'. As 'giftedness' in Kuwait depends largely on examination results, it means that those selected as 'gifted' in Kuwait are those who have shown very high abilities in the process of recall. This process needs to be explored in more detail and this follows later.

All the four cognitive measurements also correlate with examination performance, in all subjects. The correlations obtained with the overall mark (obtained from standardised subject marks) are shown in table 6. 30

**Table 6.30 Summary of Correlations with Total Marks**

| Test | Correlation |
|---|---|
| Working Memory Capacity | 0.22 |
| Field Dependency | 0.18 |
| Convergency-Divergency | 0.56 |
| Visual-spatial | 0.33 |

The correlations show very clearly that those selected as 'gifted' will tend to be those who are highly divergent and strongly visual-spatial as well as those tending to have higher working memory capacities and being more field independent. It has to be noted that these correlations are obtained with the examination results from examinations used in Kuwait. Different examination formats and different examination aims might produce very different results.

A possible next stage is consider other ways by which these characteristics might be explored and this is the theme of the next chapter.

# Chapter Seven

# Experiment Two

# Methodology and Results

## 7.1 Introduction

In Kuwait, the key method for selecting those who are described as 'gifted' (in order to carry out further testing and then offer enrichment where appropriate) is by means of their performance in examinations in six subjects. In the last chapter, it was found that these six subjects were assessing the same skill – probably related to recall. It was also found that those who possessed higher working memory capacities, who were more field independent and were more divergent, and those who were more visually-spatially equipped, these all tended to do better in all the subject examinations. Those who were thought to be 'gifted' tended to show well above average in all these attributes.

This chapter describes the next stage in the investigations. Firstly, a sample drawn from the previous sample (now grade 8) was given a revised version of the visual-spatial test and a short questionnaire. The aim was to incorporate improvements in the visual-spatial test in the light of its first use. This involved the modification of only two items to make them more accessible to students. However, more importantly, there was an opportunity to explore if the students' self-awareness relating to the attributes measured previously related to the actual measurement of the attributes.

The previous experiment had shown quite high correlations between visual-spatial ability (as measured by the test which had been developed) and performance. This needed further exploration as the validity of the test was uncertain. Of greater interest was the idea of how the students saw themselves: were they aware in any way of the approaches they adopted when learning? Was this just their natural way of working which gave them some advantage?

Secondly, a fresh sample was obtained from the new intake into grade 7. These were also given the new visual-spatial test and the questionnaire.

## 7.2 Measuring instrument

The following measuring instruments were employed to gather information from these students:

- Three cognitive tests:
    1. Field Dependence-Field Independent test (previous score): grade 8 only
    2. Convergence-Divergence test (previous score): grade 8 only
    3. Visual-spatial test (revised test)
- Questionnaire (seeking to explore self awareness related to cognitive attributes)
- Six subject marks

## 7.3 Sampling Method and Administration Procedures

This study was conducted in Kuwait during the school year, first semester (October to December, 2004), with fifteen middle schools participating. The total number of students was 423, the students being divided in two groups as follow:

- Selected students from previous stage (N = 124)
- Random new sample students (N = 299)

The 124 students were selected in a very specific way. 139 students were drawn from those who participated in the previous experiment and had shown high working memory capacity and high scores in field independency, divergency, visual-spatial. Of these, 124 were able to participate.

It was expected that this group would contain a high proportion of those who had been classified in Kuwait as 'gifted'. The constitution of the group was as follows:

They were drawn from the 14 schools as shown in Table 7.1

**Table 7.1 Description of the Students Sample in Each School**

| *Derived from previous sample* | **School** | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **10** | **11** | **12** | **13** | **Total** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Grade 8** | 6 | 21 | 11 | 7 | 27 | 9 | 2 | 4 | 19 | 4 | 9 | 5 | **124** |

| *New Sample* | **School** | **1** | **5** | **7** | **8** | **9** | **10** | **12** | **13** | **14** | **15** | **Total** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Grade 7** | 28 | 20 | 34 | 31 | 28 | 24 | 31 | 31 | 44 | 28 | **299** |

Because of time constraints in gaining access to the schools, it was not possible to apply all the tests to all the students. Thus, the samples drop considerably when making some of the comparisons.

## 7.4 Statistical Methods Adopted

The statistical approaches adopted here are similar to those used in the previous chapter. The examination marks as well as the scores in the tests for visual-spatial ability, divergency, and field dependency are all integer data, following approximately normal distributions. The questionnaire data is ordinal on a five point scale for each question. The nature of the data determines the correlation methods employed. Pearson correlation is used for the former while Kendall's tau-b is required when there is ordinal data with a high possibility of 'ties'. The questionnaire uses a question format which will involve many 'ties' (respondents with different views who nonetheless tick the same box) and the Kendall's tau-b correlation formula is more appropriate. Each question in the questionnaire tested a different perspective. For this reason each question in the questionnaire was analysed on its own (see Reid, 2003).

There is another possible approach with the questionnaire. It is possible to look at all the questions which relate to visual-spatial ability. Each was designed to reflect one specific aspect of this characteristic. However, it is possible to look at the total number of responses which are 'strongly agree' and 'agree' to these questions (all polarised the same way) for each student and this will offer some kind of insight into the overall strength of the characteristic as perceived by each student. What was done was to add up all the 'ticks' for 'strongly agree' and 'agree', subtracting the number for 'ticks' for 'strongly disagree' and 'disagree'. This gives a kind of score for each part of the questionnaire and this score can be related to the actual score in the visual-spatial test. The same procedure can be used to consider field dependency and divergency. This leads to scores which may negative or positive, depending on where the majority of ticks are placed.

The experiment here aimed to see whether the students were self aware on three cognitive characteristics and to see how their responses related to the test on these cognitive characteristics. In particular, how do the gifted students see themselves?

## 7.5 The Questionnaire Description

The questionnaire was entitled *'What is your cognitive style*?' in order that it might seem unthreatening to the students. The aim of the questionnaire was to explore how the students saw themselves and to relate this to how they performed in various tests (field dependency, convergency-divergency, visual-spatial). Both groups of students were involved in this questionnaire. The questionnaire offered the opportunity for self-disclosure relating to the three cognitive characteristics.

Most of the questions adopted a Likert format (Likert, 1932). In this, the students are offered various statements and are asked to express their agreement or otherwise by ticking one of five boxes: 'strongly agree', 'agree', 'neutral', 'disagree', 'strongly disagree'.

| **SA** – Strongly Agree **A** – Agree **N** – Neutral **D** – Disagree **SD** – Strongly Disagree |
|---|

The questions were arranged in three groups:

*Visual-spatial characteristics*: 13 questions were used, 12 of them in words and one expressed visually. The final question was marked (one mark for the correct answer).

*Field independent/dependent characteristics*: 13 questions were used, the first 6 items of them reflecting field dependent characteristics and second 6 items field independent characteristics. The final question was an open-ended question desired to identify the characteristics. For this question, two marks were awarded for a complete correct (say his/her name) and one mark for correct but incomplete answer.

*Convergent/divergent characteristics*: 15 questions were used, the first 7 items reflecting convergent characteristics and the 7 items left reflecting divergent characteristics. The final question is a divergent question and is given one mark for an acceptable answer

Likert questionnaires are used extensively in surveys of attitudes. They are known to be highly reliable in terms of test-retest reliability provided that samples are high and the responders do not think there is some kind of hidden agenda (see Reid, 2006). However, there is always uncertainty whether students of a relatively young age (in this case, 13) will respond reflecting what their *actual* experience is or reflecting what they would *like* their experience to be. This is the 'reality-aspiration' problem and is discussed in Danili (2004). In the light of this, results have to be interpreted with great caution. However, the purpose of the questionnaire relates to its possible relationship to cognitive tests and to performance. As with all attitude questionnaires, absolute measurement is impossible. Trends and relationships, however, can be explored (See Reid 2006).

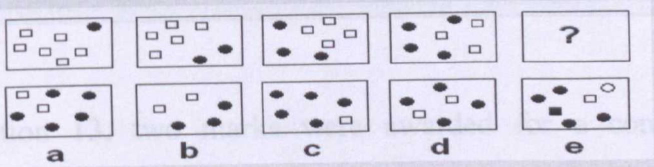
The validity of the questionnaire used here was checked by asking a small group of experienced researchers and teachers to try it out. It was modified in the light of their comments. Although every step was taken to ensure validity, the results must be interpreted with caution in that there is never any absolute guarantee that validity has been achieved. Indeed, it can probably never be achieved fully. The questionnaire is shown in full in the appendix (in its English versions) while each group of questions is shown here as the data are discussed.

### 7.5.1 Overall Questionnaire Results

The questionnaire was designed to explore as many aspects as possible of the three cognitive characteristics. The intention was to consider each question on its own and see how it related to the test measurements in the three learner characteristics. The data obtained for the 13 questions relating to visual-spatial abilities are summarized in Table 7.2. For clarity, data are presented as percentages.

**Table 7.2 Visual-Spatial Characteristics**

| | N =299 | SA | A | N | D | SD |
|---|---|---|---|---|---|---|
| 1 | In school I prefer subjects like art, technical drawing, and geometry. | 18 | 21 | 34 | 13 | 13 |
| 2 | I like using a camera or video camera to capture the world around me. | 30 | 19 | 25 | 9 | 16 |
| 3 | I navigate well and use maps with ease. Rarely I get lost. | 12 | 16 | 24 | 24 | 23 |
| 4 | I have a good sense of direction. I usually know which way North is. | 14 | 17 | 30 | 18 | 21 |
| 5 | I can easily visualise objects, buildings, situations etc from plans or descriptions. | 16 | 21 | 29 | 16 | 17 |
| 6 | I find myself drawing or doodling on a notepad when thinking. | 27 | 17 | 20 | 15 | 19 |
| 7 | I use diagrams and scribbles to communicate ideas and concepts. | 32 | 25 | 22 | 12 | 7 |
| 8 | I love using colour pen when I am studying. | 40 | 22 | 18 | 8 | 11 |
| 9 | I like pulling things apart, and I usually put things back together. | 20 | 18 | 30 | 14 | 17 |
| 10 | I like visual arts, painting, and sculpture. | 32 | 20 | 22 | 9 | 16 |
| 11 | I like jigsaws and mazes. | 47 | 25 | 16 | 5 | 7 |
| 12 | I have a good sense of colour. | 30 | 25 | 26 | 9 | 9 |
| 13 | Find a possible answer for the last box (from a-b-c-d-e). | The correct answer is ( a) 41 | | | | |



Looking at question 13, the answer is (a). From left to right, black circles go up by one and white boxes go down by one, from picture to picture. Therefore, the fifth box must have five black circles and 2 white squares: choice (a).

To check if some underlying factor or factors underpinned the responses to the set of 12 questions, a factor analysis was run on the raw data. This was conducted using Principal Components Analysis with Varimax rotation using SPSS. The results showed that 7 factors were needed to account for over 70% of the variance and the Scree-Plot did not suggest that the 12 questions related to a small number of factors. Data are in appendix D. The 12 questions were designed to explore 12 *different* aspects of the visual-spatial characteristic and the factor analysis results are consistent with this. Since the nature of question 13 is different from the rest of the questions, it was not included in the factor analysis.

The responses for the questions relating to extent of field dependency and independency are summarized in Table 7.3. The first six questions relate to field dependency characteristics while the next six relate to field independency characteristics.

**Table 7.3** ***Field independent/Dependent Characteristics***

| | N = 299 | SA | A | N | D | SD |
|---|---|---|---|---|---|---|
| 1 | I have no problem concentrating amid noise and confusion. | 15 | 10 | 16 | 15 | 45 |
| 2 | I enjoy analysing grammar structures. | 24 | 17 | 24 | 14 | 21 |
| 3 | I feel I must understand every word of what I read or hear. | 50 | 24 | 19 | 4 | 4 |
| 4 | I think that every word said in class has a value in the learning process | 39 | 24 | 24 | 7 | 6 |
| 5 | I prefer working alone to working with other people. | 15 | 9 | 21 | 19 | 34 |
| 6 | Receiving feedback from other people really doesn't affect my learning at all. | 21 | 19 | 26 | 13 | 18 |
| 7 | I need a quiet environment in order to concentrate well. | 48 | 22 | 13 | 9 | 7 |
| 8 | I find grammar analysis tedious and boring. | 15 | 15 | 24 | 20 | 28 |
| 9 | I don't mind reading or listening without understanding every single word as long as I "catch" the main idea. | 14 | 12 | 26 | 19 | 27 |
| 10 | I think communication is the key to effective language learning. | 31 | 26 | 23 | 9 | 9 |
| 11 | I really enjoy working with other people in pairs or groups. | 51 | 21 | 19 | 3 | 5 |
| 12 | I find feedback useful as a means of understanding my problem areas. | 32 | 26 | 22 | 7 | 12 |
| 13 | *If you are a taxi driver, going to airport with Norman and Rex, from the airport going to a hotel with Mark and his wife Margaret and his daughter Emma., what is the taxi driver's name?*........................................ | Part answer | | | | Full answer |
| | | 37 | | | | 16 |

For question 13, two marks were awarded for a completely correct answer (the respondent's name) and one mark for correct but incomplete answer (for example, when they say 'me').

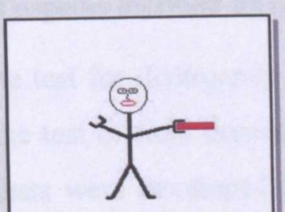
A similar procedure using factor analysis was used to check if some underlying factor or factors underpinned the responses in the set of 12 questions. Again, the results showed that 7 factors were needed to account for over 70% of the variance and the Scree Plot did not suggest that the 12 questions related to a small number of factors.

The 12 questions were designed to explore 12 different aspects of the field dependency characteristic and the factor analysis results are consistent with this.

Because the nature of question 13 was different from the rest of the questions, it was not included in factor analysis. The percentage of students' responses to this question shows 37% with a partial answer and a further 16% with an answer seen as partial.

The responses for the questions relating to extent of convergency and divergency are summarized in Table 7.4. The first seven questions relate to convergency characteristics while the next seven relate to divergency characteristics

**Table 7.4 Convergent/Divergent Characteristics**

| | N = 299 | SA | A | N | D | SD |
|---|---|---|---|---|---|---|
| 1 | I am good at the practical application of ideas. | 23 | 21 | 34 | 7.4 | 14 |
| 2 | I am specialise in physical science and classics. | 11 | 13 | 20 | 23 | 32 |
| 3 | I prefer formal materials. | 39 | 24 | 22 | 9 | 6 |
| 4 | I prefer a logical argument. | 17 | 23 | 36 | 13 | 10 |
| 5 | I have ability to focus on hypothetical-deductive reasoning on specific problems. | 16 | 17 | 36 | 20 | 11 |
| 6 | I am better in abstract experimentation. | 18 | 25 | 31 | 12 | 11 |
| 7 | I hold conventional attitudes. | 33 | 24 | 21 | 10 | 10 |
| 8 | I like unambiguity. | 19 | 20 | 34 | 12 | 12 |
| 9 | I am good at generating ideas and seeing things from different perspectives. | 27 | 20 | 27 | 11 | 12 |
| 10 | I experiment in the arts. | 18 | 22 | 29 | 15 | 12 |
| 11 | I am better with concrete experience. | 23 | 24 | 28 | 13 | 9 |
| 12 | I hold unconventional attitudes. | 16 | 20 | 35 | 13 | 15 |
| 13 | I am strong in imaginative ability. | 26 | 24 | 26 | 12 | 12 |
| 14 | I like to give many solutions for one problem. | 43 | 23 | 22 | 6 | 5 |
| 15 | In this sketch a person hold a piece of wood, what do you think will happen if he let go of the piece of wood?  | 1mark 85 | | 2 marks 2 | | 3 marks 0.3 |

Question 15 shows person holding a piece of wood in frame without any background or context. Most students simply saw gravity causing the wood to fall. Others (very few) had the flexibility to give more than one answer: on the earth, under the water, in space. The question was marked out of 3, but very few offered complete answers but 85% were awarded 1 mark.

The factor analysis procedure was used to check if some underlying factor or factors underpinned the responses to the set of 14 questions. The results showed that 9 factors were needed to account for over 70% of the variance and the Scree-Plot did not suggest that the 14 questions related to a small number of factors. Due to the different nature for question 15, this question was not included in factor analysis. The 14 questions were designed to explore 14 different aspects of divergent characteristic and the factor analysis results are consistent with this.

It has to be noted that, in all three parts of the questionnaire, the Arabic version was designed to be accessible to the students. The English version tries to capture the meaning as exactly as possible without taking up more space but exact translation is impossible.

### 7.5.2 The Problem of Validity

The three parts of the questionnaire were all developed using criteria for each cognitive characteristic derived from the literature (see section 3.3). Each question was trying to explore a different aspect. Despite this, in some of the questions, the face validity is not very apparent. Nonetheless, it was decided to use these questions in that they seemed to reflect important aspects of the various cognitive characteristics.

This is a problem with many cognitive characteristics like convergency-divergency and visual-spatial ability. Each of these characteristics is made up of many features. Researchers have tried to list these but many of the lists tend to be long. They do not reflect a simple, easily defined characteristics but a group of related characteristics. The factor analysis data are consistent with this picture. Nonetheless, it does make the measurement of such characteristic difficult. Both the test approach and the questionnaire seek to reflect the range of aspects outlined by others in the past.

The problem is least in the test for divergency in that it is possible to define divergency fairly clearly. Similarly, the test of field dependency is fairly unambiguous. Perhaps that explains why these two tests were developed long ago and are so widely used. Visual-spatial skills are less clear cut and the use of questionnaires to assess all these areas is problematic. This study, therefore, tries to see if this approach is possible.

This offers the overall picture. The next sections explore how all of this might relate to giftedness as seen in Kuwait.

## 7.6 The Year 8 Sample

As above the total number of students involved was 423: 299 students the total sample in grade 7 completed the questionnaire and all the other measurements while 124 students from grade 8 were involved (selected from the first experiment). The grade 8 group will be considered first.

124 students (grade 8) were selected from experiment one. All those selected had high scores in the working memory capacity test, the field dependency test, the convergent-divergent test and the visual-spatial test. As all these characteristics correlated positively with examination scores in all subjects, the selected group must contain far more than an average proportion of gifted students as identified by the Kuwaiti system. This can be seen in Table 7.5

**Table 7.5 The Selected Group from Experiment One (Grade 8)**

| Groups | Academic | Frequency | % |
|---|---|---|---|
| ***Grade 8*** | Non- gifted (N) | 43 | 35 |
| | Semi-gifted (g) | 35 | 28 |
| | Overall Gifted (G) | 46 | 37 |
| | **Total** | **124** | **100** |

Here, 63% of those selected are either 'gifted' or 'semi gifted'. With the total population, the percentage might be expected to be about 15% (see table 7.13).

### 7.6.1 Overall Data

In this section, the performance of the grade 8 students in the new visual-spatial test (named: visual-spatial test 2) is summarized and the inter-correlations between the various tests and questionnaires outlined.

Table 7.6 shows that the sample students in grade 8 (the selected group) had two scores for the visual-spatial test; firstly a previous score from the first experiment (visual-spatial test 1) and a new score came from visual-spatial test 2.

**Table 7.6 Student Descriptive Data: Visual-Spatial Tests 1 and 2**

| *Sample* | *Girls* | *Boys* | *Test* | *Minimum* | *Maximum* | *Mean* | *Standard Deviation* |
|---|---|---|---|---|---|---|---|
| **Grade 8 N=124** | 73 | 51 | ***Visual-Spatial 1*** | 5 | 33 | 20.7 | 5.8 |
| | | | ***Visual-spatial 2*** | 10 | 38 | 24.9 | 5.6 |

The next diagrams shows the distribution of student performance for visual-spatial test 1 and visual-spatial test 2.

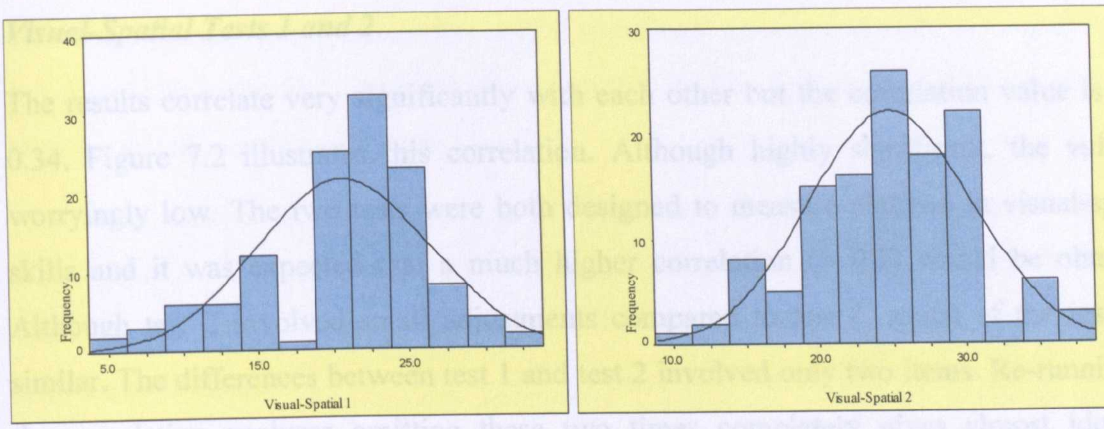



**Figure 7.1 Distribution of Sample Visual-Spatial Test 1 and 2**

Where the two tests (test 1 and test 2) are correlated, Pearson correlation is used. When the performance in a questionnaire is involved, as shown by the Pearson correlation is used (Table 7.7). Significant correlations are shown in yellow for clarity.

**Table 7.7 Test and Questionnaire Correlations Grade 8**

| Correlations | Field Dependency | Divergency | Visual-Spatial 1 | Visual-Spatial 2 |
|---|---|---|---|---|
| **Visual-spatial 2** | 0.25 | 0.13 | 0.34 | |
| ***Probabilities*** | 0.009 | ns | <0.001 | |
| **Visual-spatial Questionnaire** | 0.13 | 0.36 | 0.10 | 0.20 |
| ***Probabilities*** | ns | < 0.001 | ns | 0.030 |
| **Field Dependency Questionnaire** | -0.02 | -0.02 | -0.02 | 0.10 |
| ***Probabilities*** | ns | ns | ns | ns |
| **Divergency Questionnaire** | 0.16 | 0.17 | 0.22 | 0.19 |
| ***Probabilities*** | ns | ns | 0.015 | 0.035 |
| **Total standardised marks** | 0.12 | 0.38 | 0.20 | 0.18 |
| ***Probabilities*** | ns | <0.001 | 0.028 | 0.046 |

The table shows surprising correlations in that some which might be expected to be high are low and vice versa. The results are discussed in turn, with reference to the scatterplots.

### *Visual-Spatial Tests 1 and 2*

The results correlate very significantly with each other but the correlation value is only 0.34. Figure 7.2 illustrates this correlation. Although highly significant, the value is worryingly low. The two tests were both designed to measure abilities in visual-spatial skills and it was expected that a much higher correlation (> 0.7) would be obtained. Although test 2 involved small adjustments compared to test 1, much of the test was similar. The differences between test 1 and test 2 involved only two items. Re-running all the correlation analyses omitting these two times completely gives almost identical correlation values in every case. Therefore, the changes in these two items have not lowered correlation values. This raises questions about test reliability and, possibly, test validity. These will be discussed later.

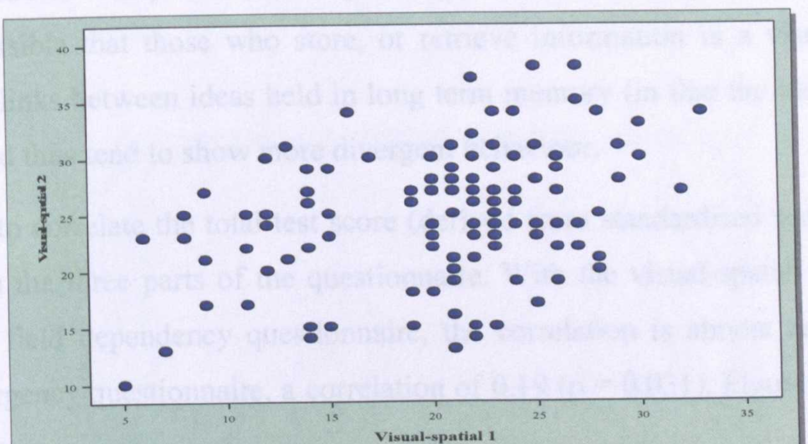
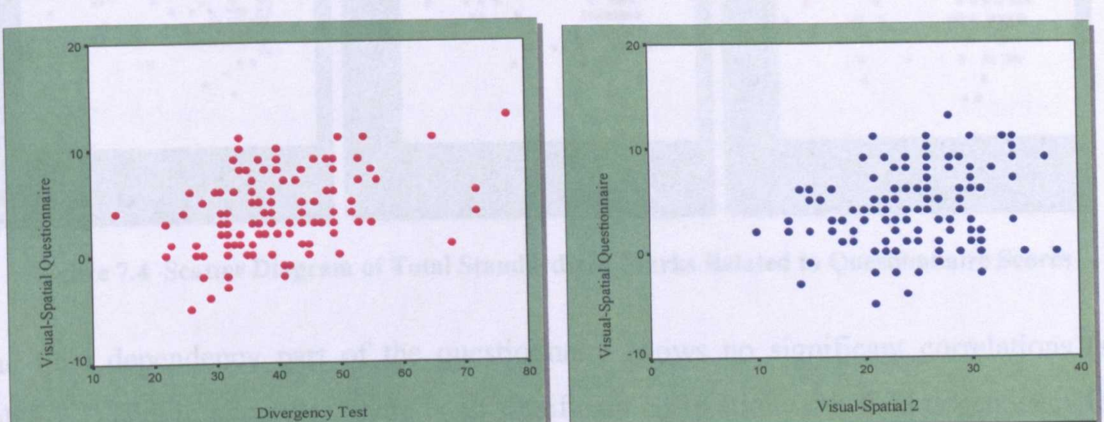



**Figure 7.2 Scatter Diagram of Visual-Spatial Test 2 Related to Visual-spatial Test 1**

### *The Visual-Spatial Questionnaire*

Figure 7.3 shows the scatter plots for the two correlations which are significant. There is a strong positive linear association illustrate from the diagram.




**(1) Divergency** **(2) Visual-spatial test 2**

**Figure 7.3 Visual-Spatial Questionnaire with Divergency Test and Visual-spatial Test 2**

The visual-spatial questionnaire has a low significant correlation with the visual-spatial test 2 and the scatterplot illustrates this (Figure 7.3 [2]). This raises questions about the both the questionnaire and the test.

The visual-spatial questionnaire has a moderate significant correlation with the convergency-divergency test and the scatterplot illustrates this (Figure 7.3 [1]). The graph illustrates the correspondence of the value between the divergent test and the visual-spatial questionnaire.

The results from the divergency-convergency part of the questionnaire correlate significantly with the results of visual-spatial test 1 and also with visual-spatial test 2 (see table 7.7). This finding was unexpected. It means that those who are more divergent (if the questionnaire is valid) tend also to gain higher marks in either of the visual-spatial tests. It is possible that those who store, or retrieve information in a visual form will possess more links between ideas held in long term memory (in that the ideas are linked pictorially) and thus tend to show more divergent behaviour.

It is possible to correlate the total test score (derived from standardised scores in the six subjects) with the three parts of the questionnaire. With the visual-spatial questionnaire and with the field dependency questionnaire, the correlation is almost zero. However, with the divergency questionnaire, a correlation of 0.19 ($p = 0.031$). Figure 7.4 illustrates the scatterplots.

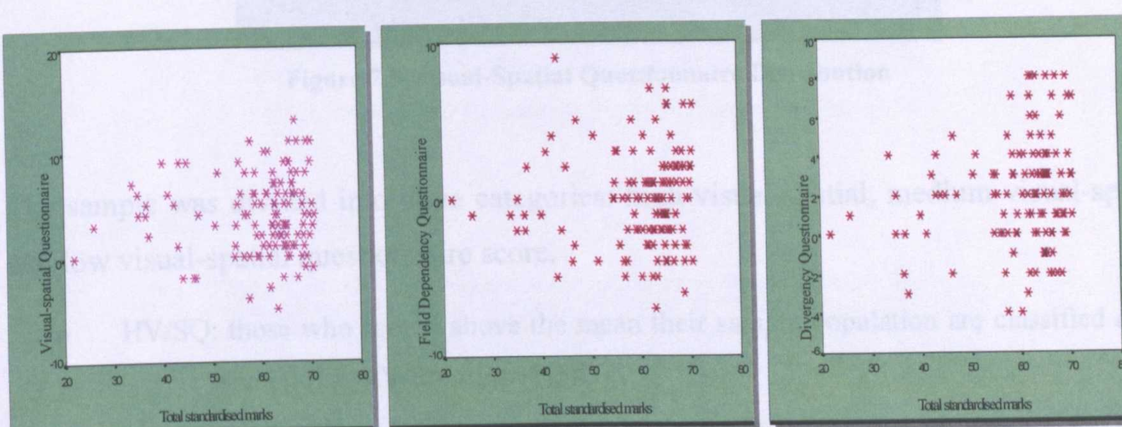



**Figure 7.4 Scatter Diagram of Total Standardized Marks Related to Questionnaire Scores**

The field dependency part of the questionnaire shows no significant correlations (see Table 7.7) and, in particular, there is no significant correlation with field dependency test. Either the field dependency part of the questionnaire is not valid or the students are unable to see themselves correctly with regard to this attribute.

Given the rather puzzling correlation data from year 8, it is now necessary to explore the questionnaires more. Looking at the questionnaire in terms of scores for each of the three sections, Table 7.8 gives the descriptive data.

**Table 7.8 Descriptive Statistics for Questionnaire Scores**

| Sample | Girls | Boys | Test | Minimum | Maximum | Mean | Standard Deviation |
|---|---|---|---|---|---|---|---|
| Grade 8 N=124 | 73 | 51 | Visual-spatial Questionnaire | -5 | 13 | 4.0 | 3.6 |
| | | | Field Dependency Questionnaire | -7 | 9 | -0.7 | 3.0 |
| | | | Divergency Questionnaire | -4 | 8 | 2.1 | 2.7 |

Each of the three parts is now considered, with special reference to the differences between those who are gifted and those who are not. The scores from the visual-spatial parts of the questionnaire are shown in Figure 7.5 where an almost normal distribution is obtained.

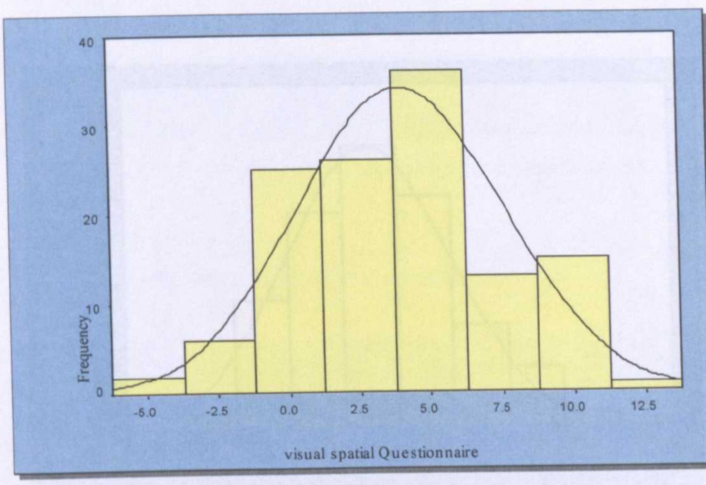



**Figure 7.5 Visual-Spatial Questionnaire Distribution**

The sample was divided into three categories: high visual-spatial, medium visual-spatial and low visual-spatial questionnaire score.

- HV/SQ: those who scored above the mean their sample population are classified as high visual-spatial (i.e. HV/S> mean+½StD),
- MV/SQ: those who may be located between the above two categories (mean ±½StD)
- LV/SQ: those who scored score less than ½StD below the mean (i.e. LV/S <mean-½StD)

Half a standard deviation was used simply because this allowed the formation of three very approximately equal groupings.

**Table 7.9 Visual-Spatial Questionnaire Scores and Giftedness**

| | | visual-spatial questionnaire score | | | Total |
|---|---|---|---|---|---|
| | | L | M | H | |
| *Non-gifted (N)* | % | 20 | 16 | 17 | 35 |
| *Semi-gifted (g)* | % | 15 | 15 | 14 | 28 |
| *Overall gifted (G)* | % | 21 | 14 | 22 | 37 |
| *Total* | % | 45 | 29 | 35 | 100 |

Table 7.9 illustrates that there is no relationship between giftedness (based on test scores) and scores derived form the visual-spatial questionnaire (the correlation was r = 0.05)

The same procedure was adopted for the field dependency part of the questionnaire, Figure 7.6 showing the distribution and Table 7.10 showing how the scores in the divergency-convergency questionnaire relate to giftedness.

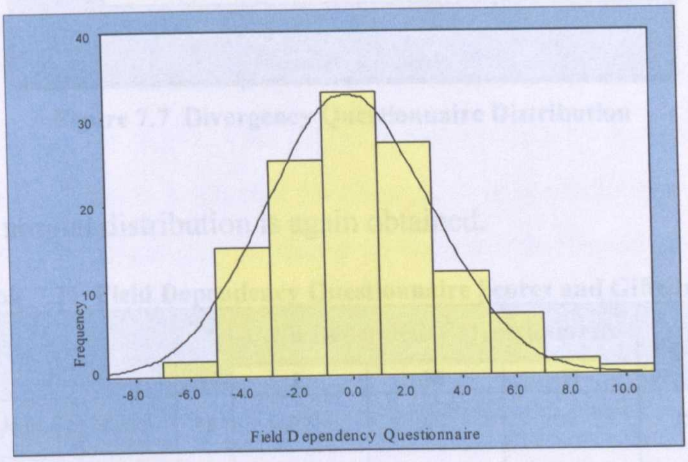



**Figure 7.6 Field Dependency Questionnaire Distribution**

Again, the distribution is normal.

**Table 7.10 Field-dependency Questionnaire Sscores and Giftedness**

| | % | Field Dependency Questionnaire | | | Total |
|---|---|---|---|---|---|
| | | L | M | H | |
| *Non-gifted (N)* | % | 19 | 21 | 14 | 35 |
| *Semi-gifted (g)* | % | 16 | 21 | 6 | 28 |
| *Overall gifted (G)* | % | 17 | 17 | 22 | 37 |
| *Total* | % | 34 | 39 | 27 | 100 |

Table 7.10 illustrates that there is no relationship between giftedness (based on test scores) and scores derived form the field dependency questionnaire (the correlation was r = 0.03).

Finally, the same procedure was adopted for the divergency-convergency part of the questionnaire, Figure 7.7 showing the distribution and Table 7.11 showing how the scores in the divergency-convergency questionnaire relate to giftedness.

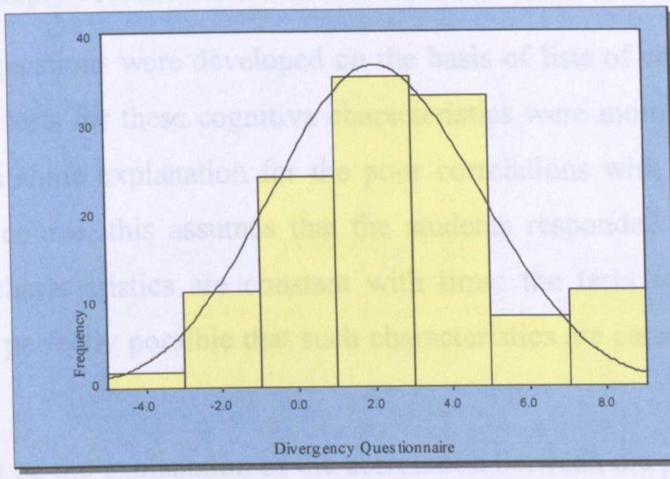



**Figure 7.7 Divergency Questionnaire Distribution**

An approximately normal distribution is again obtained.

**Table 7.11 Field Dependency Questionnaire Scores and Giftedness**

| | % | Field Dependency Questionnaire | | | *Total* |
|---|---|---|---|---|---|
| | | L | M | H | |
| *Non-gifted (N)* | % | 27 | 17 | 9 | 35 |
| *Semi-gifted (g)* | % | 14 | 15 | 15 | 28 |
| *Overall gifted (G)* | % | 22 | 19 | 16 | 37 |
| *Total* | % | 41 | 33 | 26 | 100 |

The correlation between the divergency part of the questionnaire and test scores was 0.19 and Table 7.11 shows a pattern consistent with this. 'Non-gifted' tend to show poor scores in the questionnaire while the others tend to show the reverse tendency. The effect is small, reflecting the low correlation.

### 7.6.2 Some Tentative Conclusions

Looking at the results for grade 8, it has to be noted that the sample was made up of those who had performed well in the cognitive characteristics tests when in grade 7. As expected, the sample contains mainly those considered 'gifted' in the Kuwaiti system. Inevitably, this will mean that there will not be a good spread of marks in either school examinations or in cognitive tests. Most will score highly. This will tend to lower correlation values simply because there is little discrimination.

The questionnaire questions were developed on the basis of lists of characteristics in the literature while the tests for these cognitive characteristics were more narrowly focused. Perhaps, this offers some explanation for the poor correlations with the tests for these characteristics. Of course, this assumes that the students responded accurately. It also assumes that the characteristics are constant with time: the tests were conducted the previous year. It is perfectly possible that such characteristics are capable of change with time.

This last point may be the explanation of the correlation between the performances in the two visual-spatial tests ($r = 0.34$). This value is not altered by ignoring the two items where changes had been made from test 1 to test 2. It is possible that both the tests are valid but the students have actually changed in their skills related to the visual-spatial characteristic. This might be developmental or it might be due to increased experience, perhaps in some course at school. There is another possible explanation for this result. It was observed that, with a small minority of the students, they seemed to be showing an unwillingness to undertake visual-spatial test 2, having completed visual-spatial test 1 the year before.

This analysis has looked at the questionnaire data overall, by simply relating the number of positive responses to the test data. In the next stages, each year group is considered separately.

## 7.7 Grade 7 Sample

The second group in this experiment involved 244 students in grade 7 from 10 schools. Table 7.12 shows the tests undertaken and Table 7.13 shows the make-up of the group, as determined by the Kuwaiti procedure in selecting gifted students.

### 7.7.1 Overall Data

**Table 7.12 Description of the Test Undertaken**

| Sub-group | | Numbers |
|---|---|---|
| Total group: | total sample | 299 |
| Sub group 1: | have a marks and questionnaire | 244 |
| Sub-group 2: | have marks, questionnaire *and* visual-spatial test 2 | 184 |

**Table 7.13 Description of the Sample**

| Groups | Variables | Frequency | % |
|---|---|---|---|
| Grade 7 | Non-gifted (N) | 208 | 85 |
| | Semi-gifted (g) | 19 | 8 |
| | Overall Gifted (G) | 17 | 7 |
| | ***Totals*** | ***244*** | ***100*** |

The group undertook visual-spatial test 2 and the same self-awareness questionnaire used with grade 8. Table 7.14 shows the descriptive data for 184 students who sat the visual-spatial test 2 while Figure 7.8 shows the scores distribution, both illustrating that the test spread the scores adequately and was at an appropriate difficulty level.

**Table 7.14 Student Descriptive Data: Visual-Spatial Test 2**

| Sample | Girls | Boys | Minimum | Maximum | Mean | Standard Deviation |
|---|---|---|---|---|---|---|
| Grade 7 N=184 | 71 | 113 | 4 | 33 | 16 | 6 |

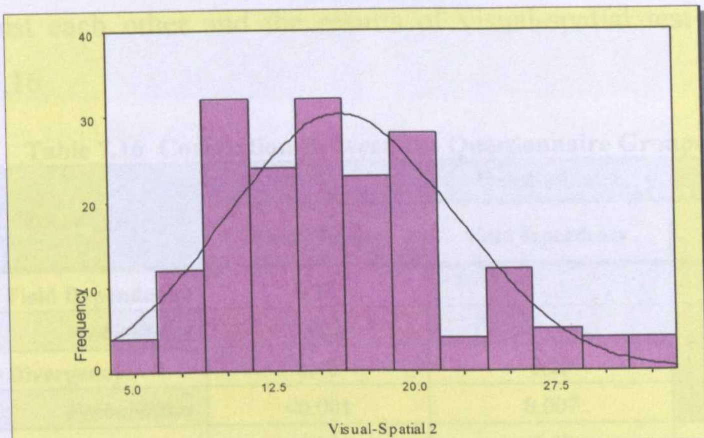



**Figure 7.8 Grade 7 Student Performance in Visual-Spatial Test 2**

### 7.7.2 Correlations

The Pearson coefficient correlation between the questionnaire sub-groups, standardized marks for six subjects and visual-spatial test 2 were calculated (see Table 7.15).

**Table 7.15 Test and Questionnaire Correlations Grade 7**

| N=184 | *Social Studies* | *Islamic* | *Mathematics* | *Science* | *English* | *Arabic* | Total | Visual-spatial 2 |
|---|---|---|---|---|---|---|---|---|
| Questionnaire Visual-Spatial | 0.04 | 0.11 | 0.13 | 0.14 | 0.15 | 0.11 | 0.12 | 0.13 |
| *Probabilities* | ns | ns | ns | ns | ns | ns | ns | ns |
| Questionnaire field dependency | 0.31 | 0.23 | 0.36 | 0.28 | 0.34 | 0.33 | 0.34 | 0.09 |
| *Probabilities* | <0.001 | 0.001 | <0.001 | <0.001 | <0.001 | <0.000 | <0.001 | ns |
| Questionnaire Divergency | 0.24 | 0.19 | 0.27 | 0.22 | 0.29 | 0.19 | 0.26 | 0.11 |
| *Probabilities* | 0.001 | 0.011 | <0.001 | 0.002 | <0.001 | 0.010 | <0.001 | ns |
| Visual-spatial Test 2 | 0.20 | 0.23 | 0.38 | 0.33 | 0.32 | 0.32 | 0.33 | |
| *Probabilities* | 0.006 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | |

Table 7.15 shows there are highly significant correlations with all subject marks and total marks with two sub-groups of questions from the questionnaire: field dependency and divergency. There is no significant correlation between any of the subjects and the visual-spatial questionnaire score. What is even more important is that there is no significant correlation between the scores in the visual-spatial questionnaire and the scores from visual-spatial test 2 broadly consistent with the year 8 observations.

However, the presence of the significant correlations with the other two parts of the questionnaire (field dependency and divergency) and the examination marks suggest that the absence of many significant correlations previously with Grade 8 was caused by the lack of variability in the characteristics: field dependency and divergency.

Each of the three sections of the visual-spatial test 2 can be correlated (using Pearson correlation) against each other and the results of visual-spatial test 2. The results are shown in Table 7.16

**Table 7.16 Correlation Between the Questionnaire Groups**

| Correlations | Questionnaire | | |
|---|---|---|---|
| | Visual-Spatial | Field dependency | Divergency |
| Questionnaire Field Dependency | 0.22 | | |
| *Probabilities* | 0.002 | | |
| Questionnaire Divergency | 0.40 | 0.20 | |
| *Probabilities* | <0.001 | 0.007 | |
| Visual-spatial Test 2 | 0.13 | 0.09 | 0.10 |
| *Probabilities* | ns | ns | ns |

The significant correlations are shaded in yellow. The separate parts of the questionnaire correlate significantly with each other but none of them shows a significant correlation with the visual-spatial test 2.

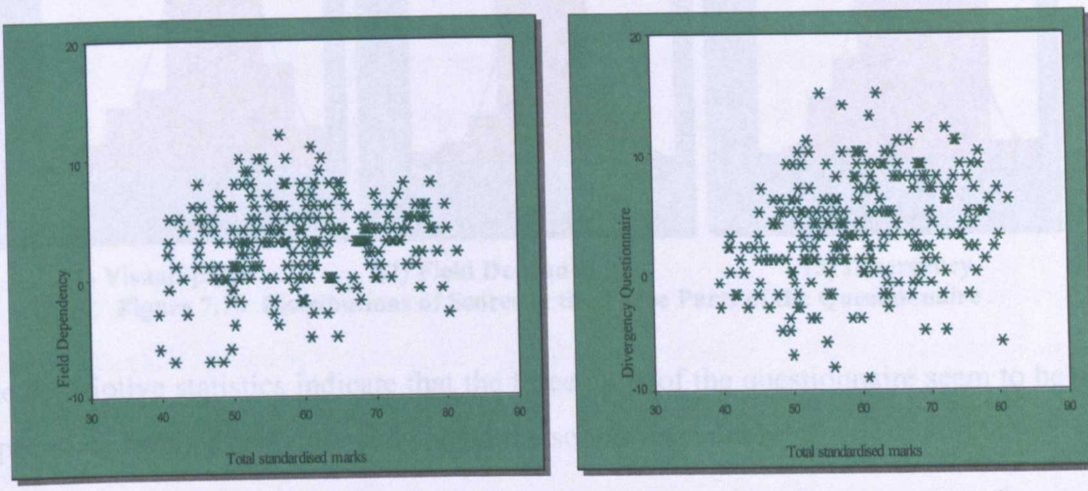
However, this might suggest that the visual-spatial test 2 has problems with regard to validity. While this might be caused by the reality-aspiration issue noted before, this is unlikely in that the same explanation would make significant correlations for field dependency and divergency unlikely. Perhaps it is simply not valid to try to measure visual-spatial ability with a written questionnaire.

Scores in the three parts of the questionnaire can be correlated with the total standardised mark and this is shown in Table 7.17.

**Table 7.17 Questionnaire Scores and Total Standardised Mark**

| | Correlations | Visual-spatial Questionnaire | Field Dependency Questionnaire | Divergency Questionnaire |
|---|---|---|---|---|
| Grade 7 | Total standardized Marks | .06 | .15 | .25 |
| N = 244 | *Probabilities* | ns | .021 | <0.001 |

There is a low but significant correlation between the field dependency questionnaire and standardized marks and also the divergency-convergency questionnaire with standardized marks. See (Figure 7.9 (1,2)) for the scatterplots.




**(1) Field Dependency Questionaire (2) Divergency Questionnaire**
**Figure 7.9 The Correlations with Total Marts**

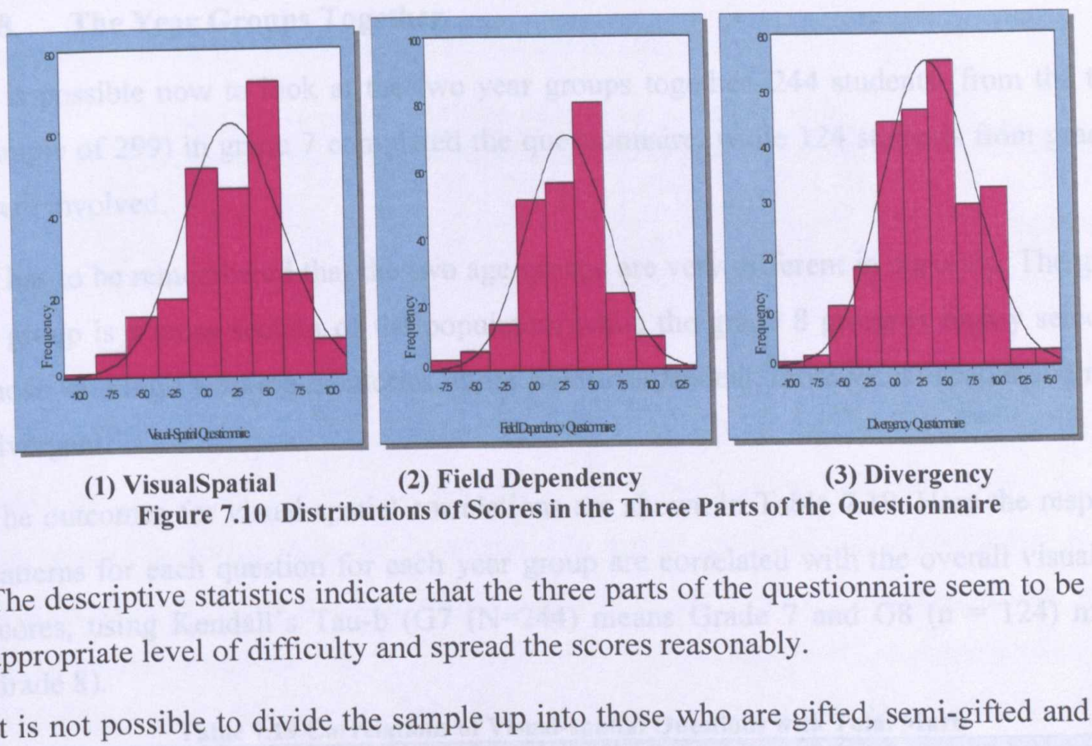
It is difficult to see why these correlations arise when there is no significant correlation for the Visual-Spatial part of the questionnaire.

Table 7.18 shows the descriptive statistics for questionnaire scores while Figure 7.10 shows the histograms of scores obtained.

**Table 7.18 Descriptive Statistics for Questionnaire Scores**

| *Sample* | *Test* | *Minimum* | *Maximum* | *Mean* | *Standard Deviation* |
|---|---|---|---|---|---|
| Grade 7 N=244 | Visual-spatial Questionnaire | -10 | 10 | 2.3 | 2.0 |
| | Field Dependency Questionnaire | -7 | 12 | 3.1 | 3.5 |
| | Divergency Questionnaire | -9 | 15 | 3.6 | 4.4 |

The scoring method was based on the number of positive response 'ticks' for a characteristic less the number of negative response 'ticks'. In the case of field dependency and divergency, positive responses to field dependent characteristics and convergent characteristics were used instead of negative ticks to field independency and divergency, respectively. Thus scores reflect visual-spatial characteristic, field independent characteristic and divergent characteristic. A negative score indicates lack of visual-spatial characteristic, field dependent characteristics and convergent characteristics.



**(1) VisualSpatial** **(2) Field Dependency** **(3) Divergency**

**Figure 7.10 Distributions of Scores in the Three Parts of the Questionnaire**

The descriptive statistics indicate that the three parts of the questionnaire seem to be at an appropriate level of difficulty and spread the scores reasonably.

It is not possible to divide the sample up into those who are gifted, semi-gifted and non-gifted in that the last group contains 85% of the sample and the other two groups are too small to see any patterns.

### 7.7.3 Some Tentative Conclusions

The grade 7 group is completely mixed, a random sample of the population at this age. Therefore, as there is a greater mix of ability and skills in the cognitive characteristics, correlation values might be expected to be a little higher when compared to grade 8. Where comparison is possible, this is true.

As with grade 8, the visual-spatial questions in the questionnaire do not correlate significantly with the results from the visual-spatial test (test 2). This seems to confirm that it is simply not possible to measure visual-spatial abilities using a questionnaire. Indeed, although the field dependency questions do correlate significantly with overall marks (r = 0.15) and the divergency-convergency questions do correlate significantly with overall marks (r = 0.25), there is still the uncertainty that the questionnaires are not really measuring the characteristic intended or are measuring something different from the tests of characteristics.

## 7.8 The Year Groups Together

It is possible now to look at the two year groups together. 244 students (from the total sample of 299) in grade 7 completed the questionnaire, while 124 students from grade 8 were involved.

It has to be remembered that the two age groups are very different in make up. The grade 7 group is a cross section of the population while the grade 8 group is highly selected: those with high working memories, more field independent, more visual-spatial and more divergent.

The outcomes for visual-spatial correlations are shown in Table 7.19. Here the response patterns for each question for each year group are correlated with the overall visual test scores, using Kendall's Tau-b (G7 (N=244) means Grade 7 and G8 (n = 124) means Grade 8).

**Table 7.19 Correlations of Visual-spatial Questions with Total Mark**

| Correlations | VS1 | VS2 | VS3 | VS4 | VS5 | VS6 | VS7 | VS8 | VS9 | VS10 | VS11 | VS12 | VS13 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **G8: Total marks** | -.07 | -.05 | .06 | .01 | .18 | -.14 | .10 | .05 | -.03 | -.09 | -.04 | .09 | -.05 |
| ***Probabilities*** | ns | ns | ns | ns | .011 | .040 | ns | ns | ns | ns | ns | ns | ns |
| **G7: Total mark** | -.07 | .11 | -.00 | -.08 | .06 | -.07 | .12 | .01 | .01 | -.07 | .10 | .01 | .09 |
| ***Probabilities*** | ns | ns | ns | ns | ns | ns | ns | ns | ns | ns | ns | ns | ns |

The first thing is that, for both groups, there are few significant correlations and when significant, the correlation values are low (shown in yellow). Indeed, the correlations are negative!! Either the students are not self aware with regard to visual-spatial abilities or there are validity problems with the questions and/or the visual-spatial test.

The table can be re-drawn (Table 7.20), with the boxes coloured as green with the questions where the actual correlation values differ by more than 0.1 (significance arises around 0.14): it is possible that these questions *may* be showing different patterns. The others are likely to showing the same pattern despite the very different constitutions of the two groups. The justification for the use of 0.1 is discussed further in appendix D

**Table 7.20 Correlations of Visual-spatial Questions with Total Mark**

| Correlations | VS1 | VS2 | VS3 | VS4 | VS5 | VS6 | VS7 | VS8 | VS9 | VS10 | VS11 | VS12 | VS13 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **G8: Total marks** | -.07 | -.05 | .06 | .01 | .18 | -.14 | .10 | .05 | -.03 | -.09 | -.04 | .09 | -.05 |
| ***Probabilities*** | ns | ns | ns | ns | .011 | .040 | ns | ns | ns | ns | ns | ns | ns |
| **G7: Total mark** | -.07 | .11 | -.00 | -.08 | .06 | -.07 | .12 | .01 | .01 | -.07 | .10 | .01 | .09 |
| ***Probabilities*** | ns | ns | ns | ns | ns | .ns | ns | ns | ns | ns | ns | ns | ns |

In only four questions do the correlations appear to be rather different (difference defined as differing by more than 0.1) and, even here, the differences are small.

The outcomes for field dependency are shown in Table 7.21

**Table 7.21 Correlations of Field Dependency Questions with Total Mark**

| Correlations | FD1 | FD2 | FD3 | FD4 | FD5 | FD6 | FI1 | FI2 | FI3 | FI4 | FI5 | FI6 | Q |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **G8: Total marks** | -.03 | .09 | .11 | .07 | .001 | -.06 | .04 | -.02 | -.09 | .06 | -.01 | .01 | .06 |
| ***Probabilities*** | ns | ns | .ns | ns | ns | ns | ns | ns | ns | ns | ns | ns | ns |
| **G7: Total marks** | -.06 | -.05 | .08 | .09 | -.05 | -.03 | .10 | .05 | -.14 | .06 | .04 | .14 | .24 |
| ***Probabilities*** | ns | ns | ns | ns | ns | ns | ns | ns | .004 | ns | ns | .004 | <0.001 |

As with the data for visual-spatial characteristics, the first thing is that, for both groups, there are few significant correlations and when significant, the correlation values are again low. Either the students are not self aware with regard to field dependency or there are validity problems with the questions. The test of extent of field dependency is well established and known to work with a high degree of validity. Thus, the validity of the questionnaire questions has to be considered. It is highly likely that the students are responding with a mixture of reality (they seen themselves as they are), aspiration (this is how they would like to be seen) and this is making the response patterns somewhat confused in terms of offering an accurate picture about themselves.

Although the pattern of significance appears different, the actual correlation values, however, are not as different as might appear. As before, the table is coloured as green with the questions where the actual correlation values differ by more than 0.1.

**Table 7.22 Correlations of Field Dependency Questions with Total Mark**

| Correlations | FD1 | FD2 | FD3 | FD4 | FD5 | FD6 | FI1 | FI2 | FI3 | FI4 | FI5 | FI6 | Q |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **G8: Total marks** | -.03 | .09 | .11 | .07 | .00 | -.06 | .04 | -.02 | -.09 | .06 | -.01 | .01 | .06 |
| ***Probabilities*** | ns | ns | ns | ns | ns | ns | ns | ns | ns | ns | ns | ns | ns |
| **G7: Total marks** | -.06 | -.05 | .08 | .09 | -.05 | -.03 | .10 | .05 | -.14 | .06 | .04 | .14 | .24 |
| ***Probabilities*** | ns | ns | ns | ns | ns | ns | ns | ns | .004 | ns | ns | .004 | <0.001 |

Again, the two year groups are behaving similarly in all but three questions.

The outcomes from the questionnaire questions relating to convergency-divergency are shown in Table 7.23

**Table 7.23 Correlations of Conv-Div Questions Total Mark**

| Divergency | C1 | C2 | C3 | C4 | C5 | C6 | C7 | D1 | D2 | D3 | D4 | D5 | D6 | DI7 | Q15 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **G8:Total marks** | -.10 | .04 | .10 | -.01 | .10 | -.07 | -.10 | .05 | -.08 | .27 | -.02 | -.01 | .13 | .07 | .02 |
| ***Probabilities*** | ns | ns | ns | ns | ns | ns | ns | ns | ns | <.001 | ns | ns | ns | ns | ns |
| **G7:Total marks** | .08 | -.06 | .13 | .02 | .13 | .02 | -.09 | .06 | .08 | .11 | .13 | .01 | .15 | .19 | .22 |
| ***Probabilities*** | ns | ns | .009 | ns | .008 | ns | ns | ns | ns | ns | .005 | ns | .001 | <.001 | <.001 |

There are 7 significant correlations out of a possible 30. Most of them relate to questions focusing on divergent characteristics and again correlation values are low. The test of convergency-divergency is well established. Thus, the validity of the questionnaire questions has to be considered. Again, it is highly likely that the students are responding with a mixture of reality (they see themselves as they are), aspiration (this is how they would like to be seen). Simmons *et al* (1975) found similar factors in their study on self-image. This is making the response patterns somewhat confused in terms of offering an accurate picture about themselves.

Although the pattern of significance appears different, the actual correlation values, however, are not as different as might appear. The table is coloured as green with the questions where the actual correlation values differ by more than 0.1. In this case, six questions out of 15 show possible differences.

**Table 7.24 Correlations of Conv-Div Questions Total Mark**

| Divergency | C1 | C2 | C3 | C4 | C5 | C6 | C7 | D1 | D2 | D3 | D4 | D5 | D6 | D7 | Q15 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **G8:Total marks** | -.10 | .04 | .10 | -.01 | .10 | -.07 | -.10 | .05 | -.08 | .27 | -.02 | -.01 | .13 | .07 | .02 |
| ***Probabilities*** | ns | ns | ns | ns | ns | ns | ns | ns | ns | <.001 | ns | ns | ns | ns | ns |
| **G7:Total marks** | .08 | -.06 | .13 | .02 | .13 | .02 | -.09 | .06 | .08 | .11 | .13 | .01 | .15 | .19 | .22 |
| ***Probabilities*** | ns | ns | .009 | ns | .008 | ns | ns | ns | ns | ns | .005 | ns | .001 | <.001 | <.001 |

Looking at tables 7.20, 7.22 and 7.24, it appears that the two groups (grade 7 and grade 8) are behaving very similarly, despite the very different make up of the groups

The results here suggest a number of possibilities:

- The questionnaires are, in varying degree, invalid as measures of cognitive characteristics;
- This particular group of students (selected from those with high scores in field dependency, visual-spatial ability and divergency) are not self-aware with regard to these characteristics;
- The students are responding in terms of what they would like to be as well as what they are.

Overall, this study suggests that it not possible to be sure the questionnaire is helpful to measure these cognitive characteristics. The question of validity is considered further later.

The way the questionnaire scores relate to the total marks (derived form standardised scores) is shown in Table 7.25.

**Table 7.25 Questionnaire Scores and Total Standardised Marks**

| | Correlations | Visual-spatial Questionnaire | Field Dependency Questionnaire | Divergency Questionnaire |
|---|---|---|---|---|
| Grade 7<br>N = 244 | Total standardized Marks | 0.06 | 0.15 | 0.25 |
| | *Probabilities* | ns | 0.021 | <0.001 |
| Grade 8<br>N = 124 | Total standardized Marks | 0.05 | 0.03 | 0.19 |
| | *Probabilities* | ns | ns | 0.031 |

Grade 8 was highly selected and is made up of those who showed high scores in the various cognitive characteristics measured when they were in Grade 7. The Grade 7 group is a random selection of the population. Therefore, higher correlations might be expected for Grade 7 simply because there is a wider variation on all these characteristics.

## 7.9 Test Validity

In considering the results from this series of experiments, everything depends on the validity of the tests being used. The field dependency test was based on the work of Witkin *et al* (1962) and the test validity is fairly well assured from their studies. The visual-spatial test was derived from a previous test which, itself, was new. While every attempt was made to check its validity by seeking the views of those with knowledge and experience, its validity cannot be certain. However, its face validity looks encouraging.

However, the two versions of the visual-spatial test do not correlate highly with each other. This could be caused by poor reliability (although with the good samples, this is unlikely). When the students were re-measured in grade 8, the researcher did notice some resistance to undertaking the test again from a minority of students. This might have affected the data obtained. There is also the intriguing possibility that the students have changed over the period of time from grade 7 and grade 8 with respect to visual-spatial characteristics.

This is perhaps less likely to have happened with divergency-convergency or field dependency. There is no certainty that these characteristics are constant with time but, perhaps, they do not appear to be so open to learning.

However, the test for convergency-divergency raises some important issues. It was based tightly on the test for convergency-divergency used by Bahar (1999) who used a well established test. This suggests good validity. However, every item was, in reality, a test of *divergent* ability. Thus, a low score in the overall test was seen as an *absence of divergent* capability and this was *assumed* to indicate convergency. This assumption needs challenged.

While a low score on a working memory test indicates a low working memory and a low score on a field dependency test indicates field *dependence*, a low score on this test of convergency-divergency only indicates a low ability in what is known as divergency. That does not necessarily imply that the person is convergent. It is perfectly possible that convergency is *not* the opposite of divergency. Thus, an individual may be convergent, divergent, both or neither. Indeed, further thought about the nature of each of divergentand convergent behaviour might suggest that the two characteristics are, indeed, separate. This leads to the need to develop a test for convergency, a subject taken up in the next chapter.

One of aims of this experiment was to test out a questionnaire approach in assigning learner characteristics. The results are not encouraging. Perhaps it is not possible to measure such characteristics reliably and validly by using a self-report approach. Perhaps students of this age were seeing themselves as they *wished to be seen* rather than as they actually were. In addition, while the student perceptions as shown in the questionnaire do not seem to hold strong relationships with the actual test results (except perhaps for divergency), it can be deduced that the students are not self-aware in relation to characteristics like field dependency, divergency and visual-spatial. However, this will only be true if the questionnaire is valid as well as the tests being valid.

The next experiment seeks to find another way to approach questionnaires as well as exploring the idea of convergency further.

# Chapter Eight

# Experiment Three

# Methodology and Results

## 8.1 Introduction

'Gifted' students are selected in Kuwait largely on the basis of subject examinations, the results of which were found in chapter six to relate to one factor, probably recall skills. It has also been found that 'gifted' students tended to have higher than average working memory capacities and tended to be field-independent, divergent and visual-spatial. Using a questionnaire which tried to explore their self-perceptions of field dependency, extent of divergency and visual-spatial characteristics, these students do not appear to be aware of their strengths and weakness in these three aspects of cognitive characteristics.

In the last chapter, the nature of the test of convergency-divergency was discussed. The need to separate divergency from convergency was suggested and this made it necessary to develop a test for convergency, such a test not being found to exist in a search of the literature.

In the last chapter, a self-report measure of three cognitive characteristics (visual-spatial, field dependency, divergency-convergency) was used. It was found that the responses for the students did not correlate very well with well established measures nor did the responses relate clearly to giftedness. It is clear the either students of this age cannot self-report accurately with regard to these learner characteristics or the questionnaire items were invalid. Given the amount of examination by experienced researchers, it is not likely that the validity of the tests was the key problem. The aim here was to develop a new test which was based on behaviour preferences rather than self report.

## 8.2 The Measurements Made

In light of the findings described in chapter 7, four main areas are explored in this chapter:

(1) The development and use of a measuring instrument, aiming to measure convergency;

(2) Analysis of any relationship between the outcomes of the new convergency test and the test data from the divergent-convergency test and the visual-spatial test;

(3) Analysis of any relationship between the outcomes of the new convergency test and the six subjects marks.

(4) Development of a new cognitive characteristic self-report instrument and the analysis of the data obtained.

For this work, a new test was developed in an attempt to measure convergency. The convergency-divergency test essentially measures extent of divergency and then assumes that a low score indicates convergency. The aim here is to develop a test which specifically targets those skills which are described as convergent. Students also took the same test of divergency so that relationships could be explored between the two tests.

Two versions of the visual-spatial test had been used previously and both used moving graphics. A new test was developed which was paper-based, to see if this was a possible useful way forward. The range of tests used is summarized in Table 8.1.

**Table 8.1 Convergency Test Description and Purpose**

| Test | Description | Purpose |
|---|---|---|
| Divergent test | Same test as before | To see if this test relates to the new test of convergency |
| Convergent test | New test designed to specifications derived form the literature | To see if convergency is a separate skill and whether it links in any way to giftedness |
| Visual-spatial test | New paper-based test | To see how it relates to performance and convergency, divergency |
| Self report | New survey | To refine and develop possible approaches to self-report in relation to wider cognitive characteristics |
| Examination marks | Six subjects, total derived from standardised marks as before | To see how cognitive characteristics tests relate to examination performance (which is partly determining extent of giftedness) |

Each of the tests is now described in detail and the way the experiment was conducted is described along with an outline of the samples used. This part of the study was conducted in Kuwait during the school year (October to December 2005/2006). In this stage, fourteen new public middle schools participated along with the thirteen schools which had participated in part I, stage two. The details will be described later.

## 8.3 The Convergency Test

Hudson (1966) laid the foundations for the idea of convergency and divergency in educational settings. His test examined the extent of convergency by seeing it as an absence of divergency as measured in his test. However, the list of abilities for each characteristic suggests that they are not neat opposites but rather simply two sets of skills (see chapter 3). Sternberg and Grigerenko (1995) noted that there is no specific measure for convergency available. Indeed, Cornish (1989) suggested the need to measure of convergency-divergency using separate convergent and divergent tasks. The self-report questionnaire described in the last chapter was a first attempt to explore this but the outcomes were not encouraging.

The first task is to attempt to define as precisely as possible what is meant by convergency and divergency. Table 8.2 is based on the work of Bahar (1999) who brought together the work of many others.

**Table 8.2 Characteristics of being Convergent and Divergent**

| Converger Characteristics | Divergers Characteristics |
|---|---|
| • Higher performance in intelligence tests<br>• Good at the practical application of ideas<br>• Specialised in physical science and classics<br>• Prefer formal materials and logical arguments<br>• Ability to focus hypothetical-deductive reasoning on specific problems<br>• Better in abstract conceptualisation<br>• Hold conventional attitudes<br>• Like unambiguity<br>• Emotionally inhibited | • Higher performance in open-ended tests<br>• Good at generating ideas and seeing things from different perspectives<br>• Specialised in the arts<br>• Better in concrete experience<br>• Interested in people<br>• Hold unconventional attitudes<br>• Strong in imaginative ability<br>• More likely to be witty |

Table 8.2 offers a long list of characteristics. Of course, an individual may not show all the characteristics of being divergent and yet, overall, can be though of as being divergent.

Looking at the table, it is clear that some of the behaviour characteristics will be very difficult to assess in a written test. Indeed, in the divergent list of characteristics, the accepted test (which was used in this study already) relates to three aspects:

- Higher performance in open-ended tests
- Good at generating ideas and seeing things from different perspectives
- Strong in imaginative ability

Essentially, the test allowed the respondents to generate possibilities in numerous different settings and modes. It is highly open-ended and offered opportunities for creativity and imagination.

With the convergent characteristics, three areas could be the basis of a new test:

- Higher performance in intelligence tests
- Prefer formal materials and logical arguments
- Ability to focus hypothetical-deductive reasoning on specific problems

These points might be translated into a test where the respondents were tested in their abilities to get to one answer, to be successful in closed questions where focussing on one idea was important and where they could demonstrate deductive reasoning in closed situations.

This was then translated into a set of test specifications and these were subjected to scrutiny by several other researchers. From this, the test specifications were developed and these are shown in Table 8.3.

It is recognised that, in developing a new test, the difficulty could be to match items to specifications and, indeed, the test went through numerous versions, being scrutinised by many other researchers before it reached its final form. Even at that stage, there is no certainty of validity in that there is no other test for convergency in the literature, it being assumed that a lack of divergency meant that a person was convergent. The actual test did not depend on any specific content but was designed to reflect a variety of situations which would be familiar to the students. The test structure was designed to make it as similar in format and timing to the established test for divergency as was possible.

### 8.3.1 The Convergent Test Description

The convergency test was designed along similar lines to the divergency test. Five short tests were developed, each with a specified time limit. Table 8.3 shows the structure of the test, which lasted 20 minutes exactly.

**Table 8.3 The Convergent Test Specification and Design**

| Specification of Convergency Test | | | | |
|---|---|---|---|---|
| ***Section*** | ***Item*** | ***Description*** | ***Aim*** | ***Time*** |
| 1 | 1 | Given a number of countries and their capitals students are asked to classify them according to two ways | Find the relationship | 5 |
| | 2 | Gives letter in a random order, the student is required to form words. | Put in right order and understanding sequencing using words | |
| | 3 | Three sets of figures in each group there is a number missing. First is required to write the missing number, then write that the relationship between the figures, which led to take this figure specifically in the empty space | Understand sequencing using numbers. Seeing patterns and drawing a conclusion | |
| 2 | 1 | The student is required to read and then summarize the paragraph in three main ideas are in the paragraph then put it in the form of cognitive map | Picking out key ideas and leaving aside the lees important | 5 |
| 3 | 4 | Gives students four sets of pictures of each group containing four forms required of a student to put on different format and give the reason | Finding the relationship; pattern seeking | 3 |
| 4 | 2 | Four graphs, ask the student to identify two aspects of the differences | Ability to identify common features presented in graphical form | 2 |
| 5 | 2 | Describe an itinerary of the person from starting point on to the end shown on a map. The students are require to draw the route on the map in the beginning Then write describing this as a way to indicate that to somebody who wants to go the same route. | Able to extract form a matrix of information the key essential features and place them in a coherent logical order. | 5 |

Each of the five sub-tests was designed to test the convergent skills that have been identified in the literature (see chapter 3). After the test had been designed, it was subjected to intense scrutiny by a number of experienced researchers with knowledge of the field and modifications were incorporated. It was then used with a small sample of students (in Arabic and of the right age) and adjusted in the light of their comments before being re-used with another larger group of students, with further refinements. In this way, it was hoped that test validity might be enhanced and that ambiguities would be removed. The pre-testing is described in more detail below.

### 8.3.2 Pilot Studies for the New Test

The test contained 5 short tests, giving 19 items in all. The total time allowed was 20 minutes to answer, with 5 minutes for initial explanations. The test was translated into Arabic and tried out with a small group of 15 Arabic students living in Glasgow of the same age group to be used in Kuwait. After running the test and subsequent discussion with the students, minor changes in wording and timing were incorporated. From this, it was decided to omit one item [Q1-3c]) which many of students failed to complete (See the appendix D).

This revised test was then piloted with 128 students in schools chosen randomly in Kuwait. The purpose of this pre-test was to see if the timing of the test was appropriate, and whether there were any serious problems with language and clarity. The test was designed to test as many different aspects of convergency as was possible. The student responses to the 18 items were then explored using Factor Analysis (Principal Components Analysis, with Varimax rotation, using SPSS) to see if there was any underlying structure. Of course, none had been planned. The Scree plot showed little evidence of any clear cut break off point while it took seven factors to account for 70% of the variance. This suggests no underlying structure. The pre-test brought about no changes as the students coped well.

The final version of the test is shown on the following pages in full, together with an explanation of how the items were marked. The Arabic version is shown in full in appendix B.

### 8.3.3 The Final Test Used

*Test One*

Your Name ..........................................................
Your School ..........................................................
Your class ........................

1- Look at the table alongside:

| | | | | |
|---|---|---|---|---|
| Morocco | Iran | Oman | Qatar | Lebanon |
| Rabat | Karachi | Beirut | Masqat | Doha |
| Egypt | Pakistan | France | United Kingdom | Spain |
| Cairo | Teheran | Madrid | Paris | London |

There are many patterns in the table which could link the names in the table together
Find two patterns and write them down.

Pattern 1...........................................................................................

Pattern 2...........................................................................................

2- Put the letters in the right order to give a correct word.

- E O N T ..................................................
- R E N I D F ..................................................
- E A C P E ..................................................

3- Here are several sets of numbers.
Add the next number in each sequence for each, and then explain why you chose the number.

- 2 .... 4 .... 8 .... □

Explain:...........................................................................................

- 1 .... 3 .... 6 .... 10 .... 15 .... □

Explain:...........................................................................................

One mark was given for each correct answer, giving a maximum of seven marks.

The students are given five minutes and then, together, they move on to test two.

*Test Two*

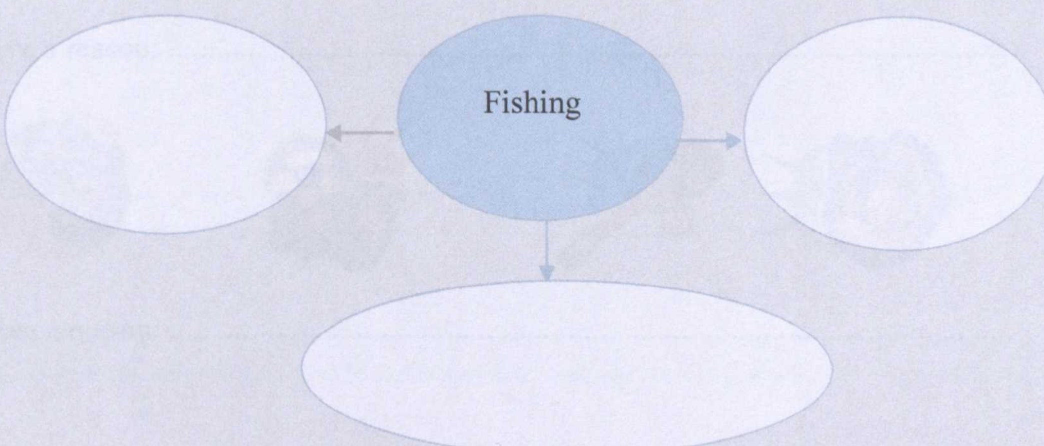
Here is a short piece of writing, Pick out the three main ideas.

Read the topic and classify the three main ideas use the diagram.

<u>I like to eat a fish</u>

The fisherman, the pearl diver and the merchant mariner have all had a great influence on the Kuwaiti identity. Kuwait can trace its traditions back to one or the other. With the abundance of fish along Kuwait's coastline, In fact, before the discovery of oil, Kuwait's fishing industry was the main source of both food and income. Historically, fishing was concentrated within five miles of the shore since small vessels were unable to go into the deeper waters. Although the traditional fishing equipment was simple, relying on the use of stake traps and wire traps, most of it is still used by fishermen today with a little modernization. Today traditional methods still yield an impressive harvest of fish.

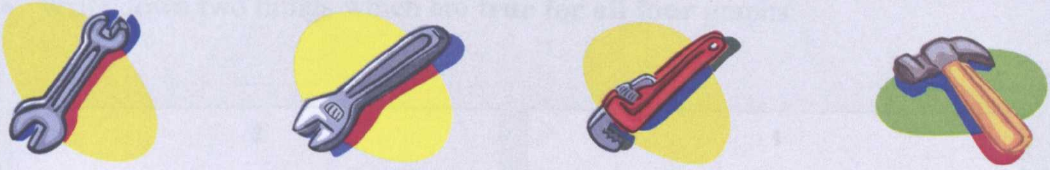
Annually Kuwait catches over 8,000 tons of fish (including 2,200 tons of shrimp). Kuwait has long been conscious of preserving its second natural resource. The Agriculture and Fisheries Department at the Kuwait Institute for Scientific Research (KISR) has one of the most comprehensive programs in the Middle Ease for the artificial breeding of fish, specifically *Zubaidy* and *Hamour*. In May 1997, KISR embarked on a five year experiment that would require transporting fertilized eggs from the sea to be hatched and raised among KISR's facilities and eventually released back into the sea.




This test is given 5 minutes and the student is given one mark for every correct idea with a maximum of 3 marks.

*Test Three*

- Picked out the different object, and then give a reason to select it.



Give a reason: ..........................................................................................................

Give a reason: ..........................................................................................................

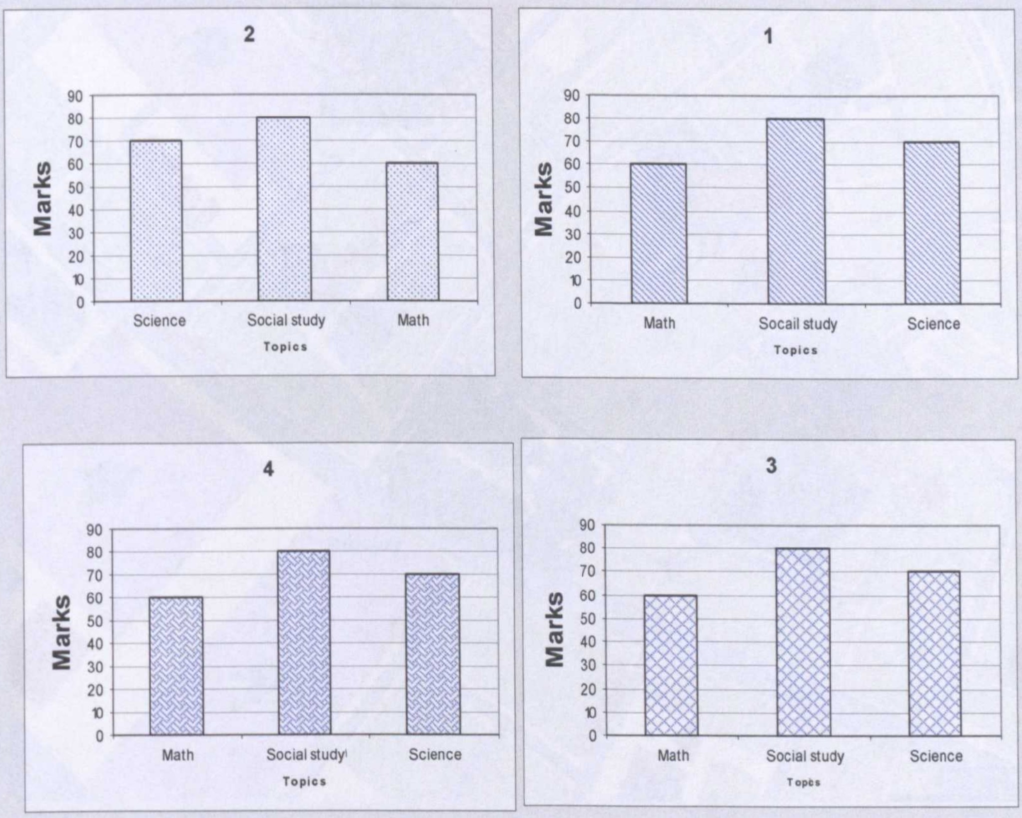
Give a reason: ..........................................................................................................

Give a reason: ..........................................................................................................

Eight marks given for test three: one mark for each choice and one mark for each correct acceptable reason. This test needs three minutes to complete.

*Test Four*

- Here are four graphs showing how students performed in examinations.
- All have the same axes, labelled in the same way.
- Look at the four graphs carefully.
- Write down two things which are **true for all four** graphs.




1-……………………………………………………………………………………

2-……………………………………………………………………………………

There are two marks allocated, one for each correct answer (there are, in fact, more than two things)

*Test Five*

Read the test instruction first:

There is a man stands near the school (on the map start point). Help him to go to a nursery then to the supermarket (the end point) by drawing the way on the map.

1- Use a pen or pencil and mark the route clearly on the map


2- Write your description for the way you drew on the map.

Your description

……………………………………………………………………………………………

……………………………………………………………………………………………

……………………………………………………………………………………………

The student was given a coloured map as shown above. Five minutes were allowed for this part and a maximum of four marks were awarded

## 8.4 The Experimental Organisation

In this part of the study the results were obtained from three groups:

**Table 8.4 Samples Used**

| Grade | Group Description | Schools | Size | Boys | Girls |
|---|---|---|---|---|---|
| Grade 7 | Random | 14 | 754 | 320 | 434 |
| Grade 8 | From previous grade 7 in experiment 2 . | 9 | 153 | 58 | 95 |
| Grade 9 | Gifted and semi-gifted who had completed tests from previous grade 8 experiment 1 | 13 | 198 | 107 | 91 |
| Totals | | | 1304 | 485 | 620 |

The way they were selected from school is shown in tables 8.5 and 8.6

**Table 8.5 Grade 7 Students**

| School | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Number | 57 | 59 | 51 | 49 | 31 | 54 | 60 | 50 | 49 | 56 | 48 | 57 | 57 | 76 | 754 |

**Table 8.6 Students Selected from Grades 8 and 9**

| Groups | Schools | 1 | 2 | 3 | 4 | 6 | 7 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Grade 8* | Number | 20 | * | 5 | * | * | * | 18 | 23 | 17 | 20 | 13 | 20 | 17 | 153 |
| *Grade 9* | Number | 18 | 11 | 24 | 27 | 22 | 12 | 14 | 6 | 20 | 16 | 28 | * | * | 198 |

All (Grade 7 only) the students took the questionnaire and the new test of convergency.

## 8.5 Cognitive Characteristics Questionnaire

The questionnaire involved 21 questions in Likert format and 12 questions in semantic differential format. The first 15 questions (in Likert format) explored aspects of what might be thought of as gifted characteristics. The next 6 questions (also in Likert format) considered aspects related to visual-spatial behaviour ability. The next 6 questions (in semantic differential format) looked at field dependency while the final 6 (also in semantic differential format) explored convergency/divergency.

Osgood (1957) developed the semantic differential technique and the method is used to measure people's reactions to stimulus words and concepts in terms of ratings on bipolar scales defined with contrasting concept or a phrase at each end. 'The advantage of the Osgood method (*semantic differential format*) are ease of construction, the speed at which it can be answered, and the fact hat both ends of the scale are defined. However, there are limitations to its usefulness without it becoming too wordy, both methods are recommended and six and five point scales are appropriate.' (Reid, 2003).

In its usual use, the points on the scale are not defined but it was found that the students in Kuwait found this idea confusing. As a result an attempt was made to explain to them verbally how they used the scale and what a tick in a particular box might mean. Before starting, the researcher checked with the students to be sure they understood the answer method and gave them enough time for any enquiry related to the method.

## 8.6 Data Obtained

Overall, the questionnaire was designed to explore as many aspects as possible of the four behaviour characteristics related to giftedness: visual-spatial, field dependency, and divergency related to convergency. The data obtained from the first 21 questions are shown in tables 8.5 and 8.6 for Grades 7 and 8 (both random selections from their populations). The data are shown as percentages for clarity.

**Table 8.7 Giftedness Characteristics Data**

| N | N= 754 | SA | A | N | D | SD |
|---|---|---|---|---|---|---|
| 1 | I can maintain attention for a long time | 22 | 39 | 26 | 7 | 2 |
| 2 | I have a good memory | 15 | 30 | 35 | 13 | 3 |
| 3 | I find mathematics exercises easy | 18 | 27 | 33 | 12 | 6 |
| 4 | I concentrate well until I finish a task | 46 | 28 | 13 | 6 | 3 |
| 5 | I have a wide interest in many topics, whether included in the curriculum or not | 25 | 30 | 21 | 12 | 7 |
| 6 | I like using different new vocabulary | 23 | 27 | 25 | 13 | 8 |
| 7 | I am very sensitive about many problems around the world | 23 | 24 | 19 | 14 | 16 |
| 8 | I can produce new ideas easily | 32 | 32 | 23 | 5 | 4 |
| 9 | It is very important for me doing my homework really well | 55 | 25 | 11 | 3 | 3 |
| 10 | I prefer friends who are older than myself | 10 | 20 | 26 | 19 | 21 |
| 11 | I am good at jigsaw puzzles | 32 | 29 | 20 | 8 | 7 |
| 12 | I have my own way to solve problems | 26 | 36 | 24 | 6 | 5 |
| 13 | I find it easy to imagine a story | 37 | 26 | 20 | 8 | 6 |
| 14 | I have an excellent sense of humour | 45 | 27 | 12 | 6 | 6 |
| 15 | I like to find out how things work | 24 | 20 | 24 | 14 | 15 |

**Table 8.8 Visual-spatial Characteristics**

| N | N= 754 | SA | A | N | D | SD |
|---|---|---|---|---|---|---|
| 16 | When I thinking about any topic I often can see an image in my mind for the topic. | 37 | 27 | 20 | 6 | 5 |
| 17 | I am better to learn in a whole, rather than taking things step by step. | 27 | 31 | 25 | 8 | 5 |
| 18 | I can remember things in general but I often forget the details | 20 | 26 | 30 | 11 | 9 |
| 19 | If I want to remember any word, I need to write it down | 45 | 23 | 12 | 8 | 7 |
| 20 | I find I can put parts together without reading the instructions | 17 | 18 | 30 | 18 | 14 |
| 21 | I prefer see a map for a place rather than describing it orally | 28 | 24 | 22 | 9 | 15 |

The actual pattern of results in the data obtained here is not important. The issue for this study is to relate the students responses to performance and other measurements.

The next group of 12 questions related to field dependency (1-6) and convergency/divergency (7-12). The data obtained are shown in table 8.9.

**Table 8.9 Field dependency and Convergency/Divergency Characteristics**

| | | | | | | |
|---|---|---|---|---|---|---|
| With a task, I prefer to be given a structure and plan | 28 | 12 | 15 | 10 | 29 | With a task, I prefer to develop my own structure and plan |
| I need to know explicitly the goals and objectives for an assignment | 36 | 18 | 21 | 8 | 13 | I can assume what to do from the task assigned. |
| I understand topics best when presented in a social context | 38 | 17 | 17 | 11 | 12 | I prefer information, charts and graphs that stress factual details |
| I prefer to learn in a situation where guidance and examples are provided | 42 | 17 | 13 | 7 | 17 | I prefer to learn on my own without help from others |
| I respond poorly to negative feedback | 27 | 18 | 24 | 11 | 17 | I react positively to feedback, even if negative |
| I find it is difficult to find the important point from the many details in the topic. | 18 | 15 | 22 | 15 | 26 | I am able to define the important point easily from any topic no matter how much detail is there |
| I tend to read stories where the end point is the goal of the story | 57 | 12 | 10 | 5 | 10 | I tend to read stories where there is no clear end point |
| I prefer themes related to the sciences and mathematics | 35 | 12 | 18 | 6 | 25 | I prefer themes that involve drawing, furnishings, music, and design |
| I prefer seeing the main idea which binds several ideas together | 19 | 10 | 25 | 16 | 26 | I prefer thinking about many ideas even when the links are not too clear |
| I like to summarise what I learn | 27 | 10 | 12 | 10 | 35 | I prefer to describe and give details in my studies |
| I enjoyed playing game like chess. | 32 | 11 | 19 | 6 | 27 | I enjoyed playing games with many parts and ideas |
| I like the topics which contain realities and clear information. | 30 | 10 | 18 | 10 | 27 | I like topics of the scientific imagination |

## 8.7 Analysis: Year 7

First of all, the results from the various tests of learner characteristics were correlated with the test performance in each of the six school subjects and in their total score in all six subjects (based on standardized scores) using Pearson correlation.

754 students (grade7) were selected randomly from 14 schools in year 2005/2006. They were selected by taking two classes from each school. Grade 7 was divided randomly into two groups: one group took the visual-spatial test and other group took the divergent test. It was not possible for all the students to take all tests because of time of access to them. See Table 8.10.

**Table 8.10 The Number of the Students in Grade 7 Involved in Each Test**

| Schools | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Convergency test | 50 | 57 | 45 | 45 | 31 | 51 | 55 | 48 | 48 | 48 | 46 | 47 | 53 | 34 | **658** |
| Questionnaire | 47 | 43 | 37 | 38 | 29 | 40 | 52 | 44 | 42 | 51 | 46 | 42 | 45 | 67 | **623** |
| Visual-Spatial Test3 | 27 | 28 | 22 | 5 | * | 26 | 30 | 50 | 25 | * | 1 | 32 | 28 | 38 | **312** |
| Divergency test | 24 | 28 | 19 | 37 | 31 | 24 | 25 | * | 23 | 47 | 46 | 21 | 27 | 71 | **423** |
| Total Marks | 57 | 59 | 51 | 49 | 31 | 54 | 60 | 50 | 49 | 56 | 48 | 57 | 57 | 76 | **754** |

Because of absences, not every student in the sample completed every test.

Figure 8.1 shows histograms of the distributions of the four tests.

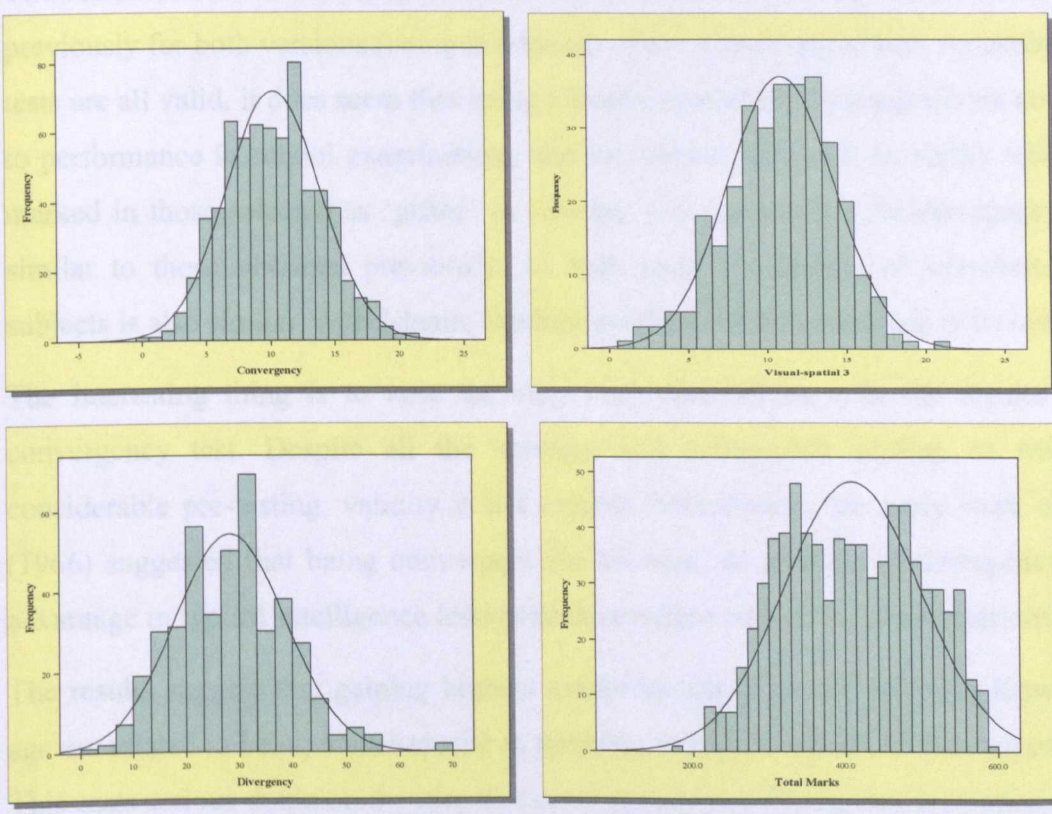



**Figure 8.1 Distributions in the Four Tests**

Table 8.11 shows the descriptive statistics of four tests.

**Table 8.11 Descriptive Statistics**

| Sample | Test | Minimum | Maximum | Mean | Standard Deviation |
|---|---|---|---|---|---|
| N= 658 | Convergency test | 0 | 21 | 10 | 3.7 |
| N= 312 | Visual-Spatial Test3 | 1 | 21 | 11 | 3.4 |
| N= 423 | Divergency test | 3 | 70 | 28 | 10.4 |
| N= 754 | Total Marks | 183.5 | 587.5 | 409 | 89 |

The three tests gave a good spread of marks.

Table 8.12 shows the correlation between the six subject and the three tests. There is significant Pearson correlation between the six subjects individually with convergent test, visual-spatial 3 and divergency test at p <0.001 in every correlation. However, the convergent test shows the highest correlation.

**Table 8.12 First group: Grade 7**

| N = 754 | Social Studies | Islamic Studies | Mathematics | Science | English | Arabic | TOTAL |
|---|---|---|---|---|---|---|---|
| *Convergency test* | 0.40 | 0.42 | 0.43 | 0.50 | 0.50 | 0.53 | 0.51 |
| *Visual-spatial 3* | 0.25 | 0.22 | 0.29 | 0.27 | 0.30 | 0.34 | 0.32 |
| *Divergency test* | 0.30 | 0.29 | 0.35 | 0.41 | 0.39 | 0.46 | 0.41 |

The correlation of the new (paper-based) visual-spatial test is very similar to that obtained previously for both versions (computer-based) of the visual-spatial test. Assuming that the tests are all valid, it does seem that being visually-spatial able is a significant contribution to performance in school examinations and this means that such an ability will be more marked in those selected as 'gifted' in Kuwait. The correlations for divergency are also similar to those obtained previously. In both tests, the pattern of correlations across subjects is also similar, with Islamic Studies and Social Studies tending to be lowest.

The interesting thing is to note the very high correlations with the results from the convergency test. Despite all the scrutiny and subsequent editing, as well as the considerable pre-testing, validity is not certain. Nonetheless, the early work of Hudson (1966) suggested that being convergent (in his case, an absence of divergency) was an advantage in typical intelligence tests (which correlate with school examinations).

The results suggest that gaining highest marks in school examinations in Kuwait at this age are related to being visual-spatial in thinking, being divergent ***AND*** being convergent. This casts serious doubt on the idea that convergency and divergency are opposites.

The correlations can be illustrated by scattergrams.

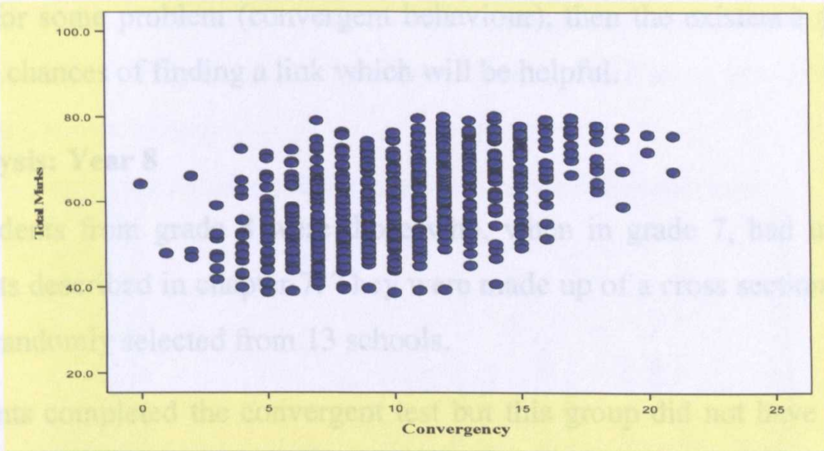
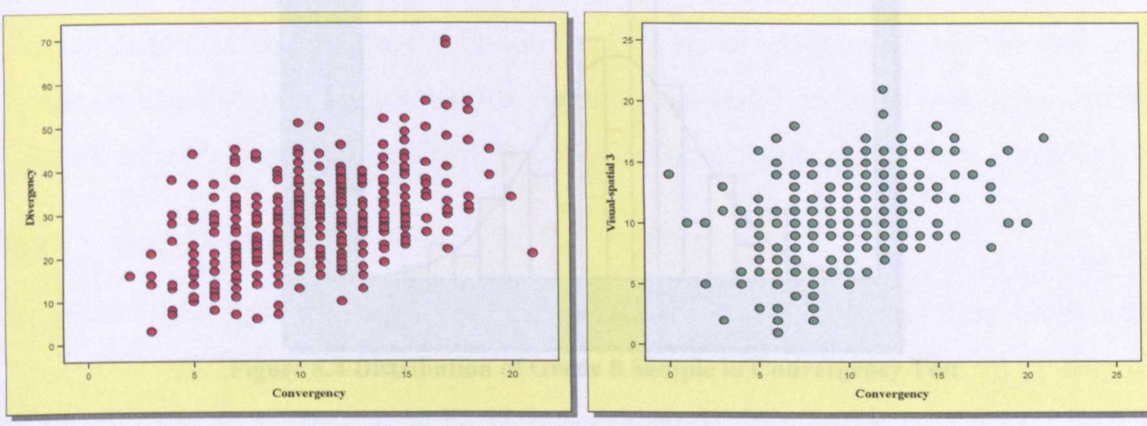



**Figure 8.2 Scatter Diagram of Convergency Test Related to Total Standardise Marks in Grade 7**

Furthermore, there are significant correlations between the divergency test and the convergency test at p <0.001 (r =0.52). This correlation is illustrated in Figure 8.3[1]. The existence of such a strong correlation shows that those who are divergent tend also to be convergent (assuming test validity) and undermines strongly the idea that convergency and divergency are alternative and opposite ways of thinking.




(1) (2)

**Figure 8.3 Correlation between Convergency Test with (1) Divergency test and (2) Visual-Spatial Test 3**

In addition, Figure 8.3 [2] shows that there is a significant correlation between visual-spatial test 3 marks and the convergency test marks: at p <0.001 (r =0.41). The correlation between visual-spatial 3 with divergency is highly significant (r= 0.33). This is comparable to that obtained in chapter 6 between visual-spatial test 1 and divergency (r = 0.39). Assuming that the visual-spatial test is valid, these results raise interesting questions. Visual-spatial ability correlates with divergency *and* with convergency. If the results from Al-Qasmi (2006) are correct, then divergency is related in some way to the existence of usable links between ideas in long term memory. Perhaps, being visual-spatial also allows for more usable links. If the students is seeking find a specific answer or the goal for some problem (convergent behaviour), then the existence of many links increases the chances of finding a link which will be helpful.

## 8.8 Analysis: Year 8

The 153 students from grade 8 were those who, when in grade 7, had undertaken the measurements described in chapter 7. They were made up of a cross section of the school population, randomly selected from 13 schools.

Those students completed the convergent test but this group did not have divergent test and questionnaire data. However, they had visual-spatial test 2 scores from the previous year and the descriptive data are shown in table 8.16 and figure 8.4 (for convergency test)

**Table 8.13 Descriptive Data**

| Sample | Test | Minimum | Maximum | Mean | Standard Deviation |
|---|---|---|---|---|---|
| N=153 | Convergency test | 4 | 20 | 11.9 | 3.1 |
| N=152 | Visual-spatial 2 | 4 | 31 | 15.5 | 5.8 |

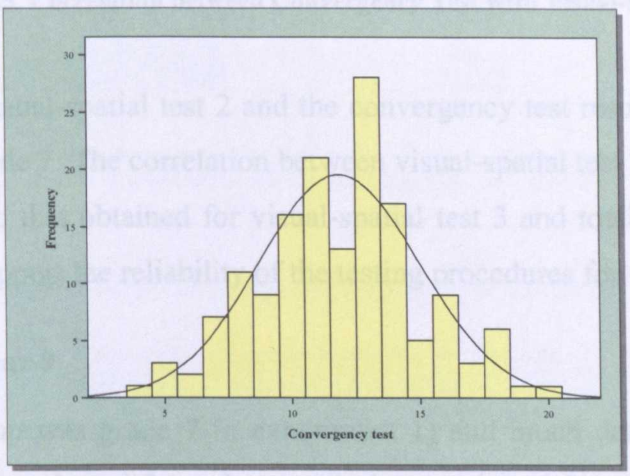



**Figure 8.4 Distribution of Grade 8 Sample in Convergency Test**

Table 8.14 shows the correlation between the six subject and two tests. The table shows that there is significant correlation between the six subjects individually with the convergent test, visual-spatial test 2 and standardized marks obtained in 2005 at p <0.001 for almost every correlation. However, the convergent test shows the higher correlations. Islamic Studies (p = 0.009) and Social Studies (p = 0.002) with the visual-spatial test 2 show slightly lower correlations similar to what was found in chapter 7.

**Table 8.14 Correlation for Grade 8**

| N =153 | Islam | Arabic | English | Math | Science | Social | Total 2006 | Convergency |
|---|---|---|---|---|---|---|---|---|
| *Convergency* | 0.40 | 0.44 | 0.42 | 0.42 | 0.46 | 0.38 | 0.46 | |
| *Total 2005* | 0.75 | 0.89 | 0.86 | 0.84 | 0.84 | 0.82 | 0.93 | 0.45 |
| *Visual-spatial 2* | 0.21 | 0.31 | 0.32 | 0.35 | 0.33 | 0.25 | 0.33 | 0.34 |

Similar to year 7, there is a correlation between convergency test and visual-spatial test 2 [r = 0.34, p <0.001] (Figure 8.5). The two visual-spatial tests are different but the correlations are very similar.

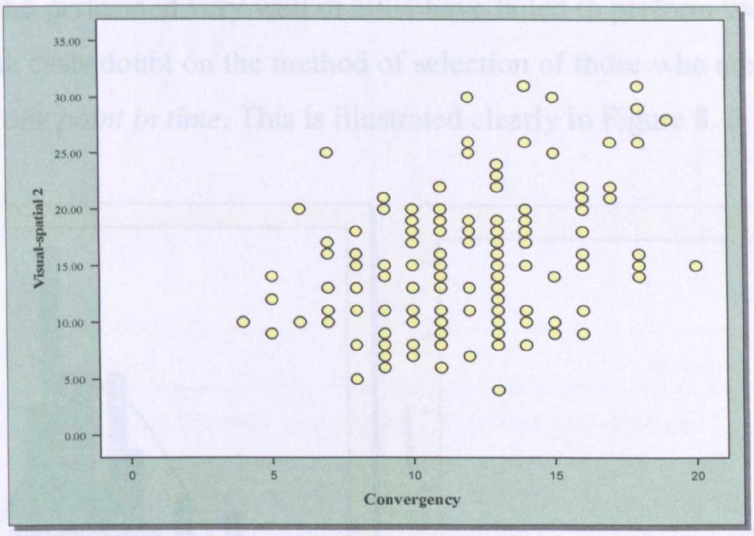



**Figure 8.5 Correlation between Convergency Test with Visual-Spatial 2**

The correlation of visual-spatial test 2 and the convergency test results is very similar to that obtained for Grade 7. The correlation between visual-spatial test 2 and the total marks is almost identical to that obtained for visual-spatial test 3 and total marks for Grade 7. These similarities support the reliability of the testing procedures for visual-spatial.

## 8.9 Analysis: Year 9

In grade 9 (the group was grade 7 in experiment 1) and much data from various tests exist. This group was selected from the sample in experiment 1 (chapter 6) by choosing those who had high tests results for working memory, divergency, field dependency and visual-spatial abilities. The group, therefore, contains a high proportion of those classified as 'gifted' under the Kuwaiti system. Having looked at the patterns of results from years 7 and 8 (which were randomly selected), it is helpful to see if the group which is dominated by those considered as 'gifted' is very different.

Table 8.15 shows the descriptive statistics for various measurements with this group.

**Table 8.15 Descriptive Statistics**

| Sample | Test | Minimum | Maximum | Mean | Standard Deviation |
|---|---|---|---|---|---|
| N=198 | Total marks 2004 | 85 | 99 | 91 | 3.3 |
| | Total marks 2006 | 41 | 99 | 85 | 13.9 |
| | Convergency test | 7 | 22 | 15.5 | 2.8 |
| | Divergency test | 16 | 77 | 39.8 | 10.1 |
| | Field dependency | 1 | 9 | 2.7 | 1.6 |
| | Visual-spatial 1 | 6 | 37 | 20.0 | 5.5 |

It is interesting to observe the way total test marks (in six subjects, using standard marks) differ over two years. While the mean has not dropped much, the lowest marks have dropped considerably, causing a considerable increase in standard deviation. Clearly, some students who performed very well in 2004 have failed to perform well in 2006. This observation alone casts doubt on the method of selection of those who are gifted by using school marks *at one point in time*. This is illustrated clearly in Figure 8. 6

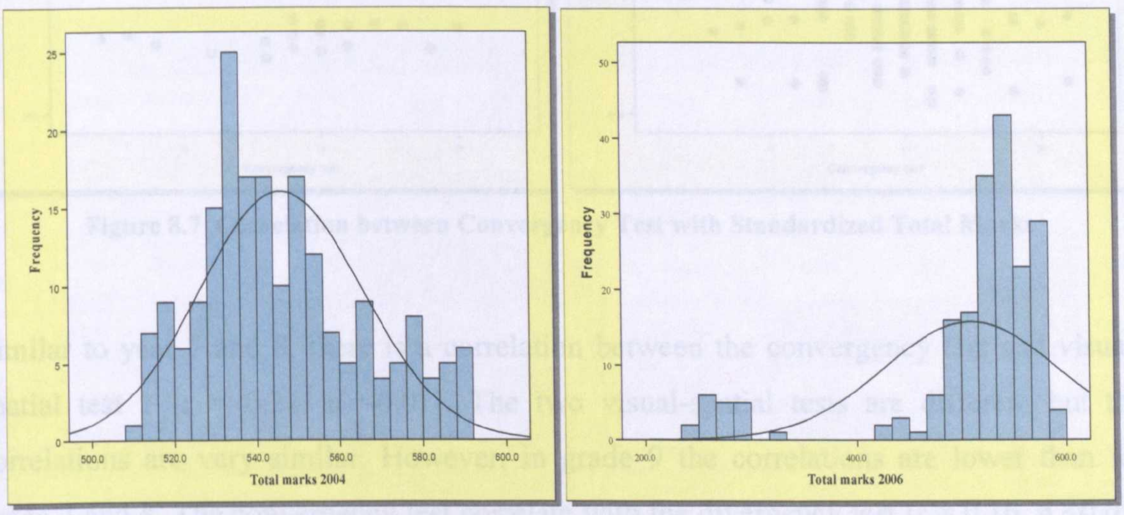



**Figure 8.6 Distribution of Grade 9 Sample in Total Marks**

Table 8.16 shows the correlations between the various measurements.

**Table 8.16 Separate Subject Correlations**

| N = 198 | Social 2006 | Islam 2006 | Math 2006 | Science 2006 | Arabic 2006 | English 2006 | Total marks 2006 | Total marks 2004 |
|---|---|---|---|---|---|---|---|---|
| ***Convergent*** | 0.16 | 0.18 | 0.24 | 0.16 | 0.23 | 0.17 | 0.20 | 0.17 |
| | < 0.05 | < 0.01 | < 0.01 | < 0.05 | < 0.01 | < 0.05 | < 0.01 | < 0.05 |
| ***Field dependency*** | -0.10 | -0.07 | 0.00 | -0.03 | -0.02 | -0.02 | -0.04 | 0.04 |
| | ns | ns | ns | ns | ns | ns | ns | ns |
| ***Divergent*** | 0.02 | 0.02 | 0.10 | 0.09 | 0.09 | 0.06 | 0.07 | 0.27 |
| | ns | ns | ns | ns | ns | ns | ns | < 0.001 |
| ***Visual-spatial 1*** | -0.03 | 0.03 | 0.16 | 0.08 | 0.08 | 0.12 | 0.08 | 0.14 |
| | ns | ns | < 0.05 | ns | ns | ns | ns | < 0.05 |

Looking at the values in table 8.16, the correlations are much lower than the similar correlations for years 7 and 8. This is simply because this group was selected on the basis of having high marks for visual-spatial ability, divergency and field dependency. This reduces discrimination markedly: students tend to perform consistently well in all tests.

However, some students who performed very well in 2004 have failed to perform well in 2006, but the correlations between the convergency test and total standardized marks for each of 2004 and 2006 are highly significant (Figure 8.7) although the values are not nearly as high as those for grade 7 and 8 (which were unselected populations). Again, grade 9 will show much less discrimination in marks as the students will tend to perform well in all tests.

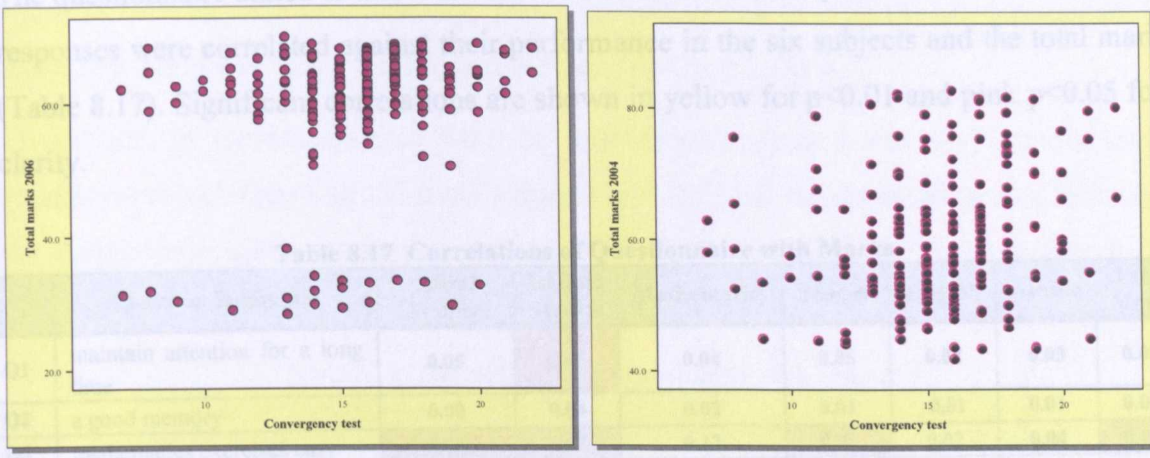



**Figure 8.7 Correlation between Convergency Test with Standardized Total Marks**

Similar to year 7 and 8, there is a correlation between the convergency test and visual-spatial test 1 [r = 0.22, p <0.01]. The two visual-spatial tests are different but the correlations are very similar. However, in grade 9 the correlations are lower than for grade 7 and 8. The convergency test correlate with the divergency test [r = 0.16, p <0.05] for grade 9 and again the value is lower than for the other grade.

Looking at figure 8.7 and scatterplot illustrating the correlation of the convergency test results with the marks for 2006, there is a very obvious divide in the marks. This shows how the students who were doing well in 2004, have shown a marked decline in 2006. This raises the very important question that high ability (as measured by examination performance) can change over time.

## 8.10 Cognitive Characteristics Questionnaire

The questionnaire aimed to allow the students to describe their preferred behaviour. Their responses were correlated against their performance in the six subjects and the total mark (Table 8.17). Significant correlations are shown in yellow for $p<0.01$ and pink $p<0.05$ for clarity.

**Table 8.17 Correlations of Questionnaire with Marks**

| | Question Summary | Social Studies | Islamic Studies | Mathematics | Science | English | Arabic | Total Mark |
|---|---|---|---|---|---|---|---|---|
| Q1 | maintain attention for a long time | 0.05 | 0.06 | 0.04 | 0.05 | 0.02 | 0.03 | 0.05 |
| Q2 | a good memory | 0.00 | 0.04 | 0.02 | 0.01 | -0.01 | 0.01 | 0.01 |
| Q3 | mathematics exercises easy | 0.06 | 0.07 | 0.13 | 0.06 | 0.02 | 0.04 | 0.07 |
| Q4 | concentrate well | 0.08 | 0.09 | 0.04 | 0.11 | 0.12 | 0.13 | 0.11 |
| Q5 | a wide interest in many topics, | 0.06 | 0.07 | 0.04 | 0.08 | 0.09 | 0.06 | 0.07 |
| Q6 | using different new vocabulary | 0.03 | 0.05 | 0.03 | 0.06 | 0.07 | 0.05 | 0.05 |
| Q7 | very sensitive about problems | 0.01 | 0.01 | 0.01 | 0.00 | -0.03 | -0.03 | -0.01 |
| Q8 | produce new ideas easily | 0.02 | 0.03 | 0.00 | 0.06 | 0.05 | 0.04 | 0.04 |
| Q9 | doing homework well | 0.14 | 0.12 | 0.10 | 0.11 | 0.13 | 0.11 | 0.13 |
| Q10 | prefer older friends | -0.02 | -0.02 | -0.01 | -0.02 | -0.03 | -0.03 | -0.03 |
| Q11 | good at jigsaw puzzles | 0.07 | 0.12 | 0.10 | 0.12 | 0.10 | 0.14 | 0.12 |
| Q12 | have own way to solve problems | 0.04 | 0.05 | 0.04 | 0.06 | 0.04 | 0.04 | 0.05 |
| Q13 | easy to imagine a story | 0.04 | 0.05 | 0.03 | 0.09 | 0.09 | 0.06 | 0.07 |
| Q14 | excellent sense of humour | 0.06 | 0.07 | 0.05 | 0.07 | 0.10 | 0.08 | 0.08 |
| Q15 | find out how things work | 0.02 | 0.01 | 0.02 | 0.03 | 0.02 | 0.03 | 0.02 |
| Q16 | see an image in mind for the topic. | 0.06 | 0.04 | 0.05 | 0.07 | 0.11 | 0.09 | 0.08 |
| Q17 | learn in a whole, rather than step by step. | 0.10 | 0.13 | 0.07 | 0.11 | 0.13 | 0.13 | 0.12 |
| Q18 | remember things in general but forget the details | 0.07 | 0.02 | 0.02 | 0.04 | 0.05 | 0.04 | 0.04 |
| Q19 | write word down to remember | 0.09 | 0.06 | 0.05 | 0.07 | 0.07 | 0.08 | 0.08 |
| Q20 | put parts together without instructions | -0.06 | -0.02 | -0.04 | -0.01 | -0.04 | -0.04 | -0.04 |
| Q21 | see a map for a place rather than describing it orally | -0.04 | -0.03 | -0.07 | -0.04 | -0.07 | -0.07 | -0.06 |

(pink) $p < 0.05$ (yellow) $p<0.01$

11 out of the 21 items are correlated significantly with the total standardised marks, although the correlations are very low.

The most interesting are items 9, 11, 17 and 19 (coloured in green) all of which show significant correlations with all subjects. However, even these correlations are not high. While doing homework is likely to correlate with examination success, being able to do jigsaws may reflect visual-spatial ability which has been found to correlate with examination success. The results for question 17 might suggest the ability to bring ideas together (visually or otherwise) and this might be related to the existence of usable links between ideas in long term memory. This is known to link to problem solving success in chemistry (Reid and Yang, 2002b) and biology (Al-Qasmi, 2006).

In addition, in the second part from the questionnaire; just 5 out of 12 items show significant correlation with the most subjects and the total standardised marks, although the correlations again are *very* low (See Table 8.18 which shows the correlations of question 1 to 12 which relate to field dependency and convergency/divergency).

**Table 8.18 Correlations of Questionnaire with Marks**

| | Social Studies | Islamic Studies | Mathematics | Science | English | Arabic | Total Mark |
|---|---|---|---|---|---|---|---|
| 1 | -0.02 | -0.03 | -0.02 | -0.02 | -0.03 | -0.03 | -0.02 |
| 2 | 0.05 | 0.05 | 0.05 | 0.05 | 0.04 | 0.06 | 0.06 |
| 3 | 0.12 | 0.11 | 0.08 | 0.10 | 0.12 | 0.10 | 0.12 |
| 4 | 0.04 | 0.01 | -0.03 | 0.02 | 0.04 | 0.01 | 0.02 |
| 5 | 0.08 | 0.07 | 0.07 | 0.09 | 0.06 | 0.06 | 0.08 |
| 6 | -0.12 | -0.11 | -0.07 | -0.10 | -0.10 | -0.11 | -0.11 |
| 7 | 0.11 | 0.10 | 0.06 | 0.10 | 0.11 | 0.12 | 0.11 |
| 8 | 0.06 | 0.06 | 0.08 | 0.06 | 0.04 | 0.02 | 0.05 |
| 9 | -0.01 | -0.03 | -0.03 | -0.03 | -0.03 | -0.03 | -0.03 |
| 10 | 0.01 | -0.02 | -0.04 | -0.01 | -0.01 | -0.05 | -0.02 |
| 11 | 0.01 | 0.03 | -0.00 | 0.02 | -0.02 | -0.00 | 0.01 |
| 12 | -0.01 | -0.02 | -0.03 | -0.05 | -0.02 | -0.03 | -0.03 |
| | $p < 0.05$ | | $p<0.01$ | | | | |

The most interesting are items 3, 6, and 7 (coloured in green see Table 8.19) all of which show significant correlations with most the subjects although these correlations are not high. See Table 8.9.

**Table 8.19 Items with Significant Correlations**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 3 | understand topics in a social context | 38 | 17 | 17 | 11 | 12 | information, charts and graphs |
| 6 | difficult to find the important point | 18 | 15 | 22 | 15 | 26 | able to define the important point |
| 7 | end point is the goal | 57 | 12 | 10 | 5 | 10 | no clear end point |

Items 3 and 6 were designed to refer to field dependency. Thus, those who say that they are able to understand topics in a social context and able to define the important point are those who tend to gain higher marks. Item 7 was designed to refer to convergency/divergency and indicates that those who see the end point as the goal tend to perform better in examinations. While these correlations are logical, their size is low and not too much can be made of this.

## 8.11 Conclusion

The new test for convergency was designed carefully against the specification of convergent behaviour derived from the literature. Nonetheless, the validity of the test is uncertain. Results from the test consistently correlate very highly with all examination marks (typically approaching 0.5). This is even higher than the parallel correlations obtained from the divergency test (typically about 0.4). Thus, if both tests are valid, then those students who are *both* convergent and divergent do best in examinations. What is even more surprising is that the two tests also correlate very significantly with each other (0.52).

An interpretation can be offered based on information processing. If divergency is related to links in long term memory, such links are known to enhance performance (see Al-Qasmi, 2006) and this might explain the link between divergency and performance. If convergency is the ability to move towards a final goal or target, then this skill is clearly important in examinations where the one right answer is being sought. The correlation between convergency and divergency is more difficult to explain.

The correlations involving the visual-spatial test 3 are very similar to those obtained for the previous two tests. The attempt to gain a measure of the various cognitive characteristics using a self report on preferred styles do not offer much useful information. It is clear that the students descriptions of their preferred styles do not seem to relate very well to any measurement of these styles.

# Chapter Nine

# Gender and Giftedness

## 9.1 Introduction

In chapters 6, 7, and 8, the samples were drawn from the Kuwaiti population of school students aged between 13 and 16. This is the period of adolescence and boys and girls are at very stages of development during this time. Although gender is not a major part of the study, this chapter highlights very briefly some comparisons in the data for the boys and girls.

Of course, this will involve looking again at data from the three previous chapters and table 9.1 summarises the sizes and characteristics of the samples which will be discussed. Only grade 7 students will be considered in that the grade 8 students in experiment 2 were drawn from grade 7 in experiment 1 while the grade 8 and 9 students in experiment three are drawn from previous grade 7 students.

**Table 9.1 The Data Description**

| Stages | Girls | Boys | Description |
|---|---|---|---|
| Experiment 1 | 311 | 330 | High proportion of "gifted" students |
| Experiment 2 | 71 | 113 | Randomly selected |
| Experiment 3 | 320 | 434 | Randomly selected |

The aim in this chapter is explore differences in performance of boys and girls in the various tests used and to see whether the relationships between these test data differ. The data from each of the grade 7 samples are considered in turn and then conclusions are drawn by looking at all three experiments, with special emphasis on those who are 'gifted'.

## 9.2 Experiment One

In the first experiment, working memory capacity and three cognitive characteristics were measured. The marks in six subjects were standardised and combined to give a total mark. The performance of girls and boys are now compared and table 9.2 shows the basic statistics for the sample.

**Table 9.2 Performance Data by Gender**

| | Gender | Sample | Mean | Standard Deviation |
|---|---|---|---|---|
| ***Total Marks*** | girls | 311 | 62.0 | 8.2 |
| | boys | 330 | 58.1 | 9.1 |
| ***Working Memory*** | girls | 311 | 4.1 | 1.6 |
| | boys | 330 | 4.3 | 1.6 |
| ***Field Dependency*** | girls | 289 | 2.3 | 1.8 |
| | boys | 316 | 1.8 | 1.4 |
| ***Divergency-Convergency*** | girls | 274 | 38.0 | 10.2 |
| | boys | 318 | 29.8 | 11.0 |
| ***Visual-Spatial 1*** | girls | 281 | 18.2 | 4.9 |
| | boys | 279 | 16.3 | 5.3 |

It appears that girls are superior to boys in all the measurements except those for the working memory capacity. The data were analysed, for each measurement, using a t-test. This statistic compares the means (taking into account the standard deviations) to indicate the extent to which the difference could have happened by chance. The differences are shown in table 9.3.

**Table 9.3 t-test Values for Experiment 1 Data**

| | t-test | Probability | Higher Performance |
|---|---|---|---|
| ***Standardized Marks*** | 5.7 | < 0.001 | g > b |
| ***Working Memory*** | -1.3 | ns | - |
| ***Field-dependency*** | 3.9 | < 0.001 | g > b |
| ***Divergency*** | 9.3 | < 0.001 | g >> b |
| ***Visual-Spatial 1*** | 4.3 | < 0.001 | g > b |

The table show there is a significant difference between the girls and the boys on all the measures in favour of the girls, except for working memory capacity. Working memory capacity is known to be the same for male and female (Baddely 2000). At this age, girls tend to outperform boys in examinations (Frey, 1991). However, girls are markedly superior to boys in the other three characteristics. At this age, girls are more field independent, divergent and have better visual-spatial abilities as measured by visual-spatial test 1, However, many researchers (e.g Broverman *et al*., 1968; Harris, 1978; Joseph, 2000; Kimura, 1993; Linn and Petersen, 1985; Thomas *et al*., 1973, ) recognized that human males excel over females across a variety of visual-spatial problem-solving and perceptual tasks. The results relating to visual-spatial characteristics measured in this study suggest that a developmental factor is operating; girls are more developed during the teenage years.

Working memory capacity and the three cognitive characteristics have all been shown to correlate with examination performance and, therefore, relate to 'giftedness' as defined in Kuwait. In that girls outperform boys in the three cognitive characteristics, they will tend to be selected as gifted more than boys. The real question is whether the relationship between these characteristics and performance is equal for both boys and girls. Table 9.4 shows the correlations found by looking at the genders separately.

**Table 9.4 Correlation Data by Gender**

| | | Field Dependency | Divergency | Visual-Spatial 1 | Total marks |
|---|---|---|---|---|---|
| *Girls* | Working Memory Capacity | 0.29<br>p < 0.001 | 0.23<br>p < 0.001 | 0.19<br>p < 0.001 | 0.15<br>p = 0.007 |
| | Field Dependency | | 0.21<br>p < 0.001 | 0.34<br>p < 0.001 | 0.16<br>p =0.006 |
| | Divergency/ Convergency | | | 0.37<br>p < 0.001 | 0.41<br>p < 0.001 |
| | Visual-Spatial Test 1 | | | | 0.30<br>p < 0.001 |
| *Boys* | Working Memory Capacity | 0.34<br>p < 0.001 | 0.28<br>p < 0.001 | 0.26<br>p < 0.001 | 0.31<br>p < 0.001 |
| | Field Dependency | | 0.26<br>p < 0.001 | 0.21<br>p < 0.001 | 0.14<br>p = 0.014 |
| | Divergency/ Convergency | | | 0.35<br>p < 0.001 | 0.62<br>p < 0.001 |
| | Visual-Spatial Test 1 | | | | 0.30<br>p < 0.001 |

Where the correlation values are markedly different in table 9.4, these are shown in colour. Thus, working memory capacity correlates more markedly for boys than girls with total marks (pink coloured). It is possible that girls are relying more on straightforward memorisation (they tend to be much more conscientious at this age (Steinberg, 2005)) while the boys are having to work things out to reach answers. The working memory is critical for the 'working out' process.

With field dependency and visual-spatial test 1, the correlation is higher for girls (buff coloured). This is more difficult to explain although, in the separate gender schools in Kuwait, there is a much more marked emphasis on the visual in the girls (use of visual aids) schools than in the boys and this might be the basis for the reason.

There is also a marked difference in the correlation values for divergency and total marks, the boys showing a much higher value the correlation (coloured yellow). Again, if boys are having to work things out more, then they will be searching through their long-term memory for possible ideas and answers and being divergent might offer many more links in long term memory (see Reid and Yang, 2002; Al-Qasmi, 2006) making being divergent a more powerful influence on likely success.

One overall effect, in terms of selection for giftedness is that, if performance in examinations in Kuwait is highly dependent on recall skills, then it places boys in a different position relative to girls in that characteristics like divergency are more important. Thus, boys who happen *not* to be divergent have extra disadvantages.

## 9.3 Experiment Two

The grade 7 group undertook visual-spatial test 2 and the performance for girls and boys in this test are compared. The basic statistics for the sample are shown.

**Table 9.5 Visual-spatial Test 2 by Gender**

| | Gender | Sample | Mean | Standard Deviation |
|---|---|---|---|---|
| Visual-Spatial 2 | Girls | 71 | 17.5 | 6.6 |
| | Boys | 113 | 15.2 | 5.6 |

Table 9.6 shows there is low significant difference between the boys and the girls in the visual-spatial test 2, again with the girls outperforming the boys.

**Table 9.6 t-test Values for Visual-Spatial Test 2 Data**

| | t-test | Probability | Higher Performance |
|---|---|---|---|
| Visual-Spatial Test 2 | 2.55 | p = 0.012 | g > b |

This is consistent with experiment 1 although the t-test value is lower. The sample for experiment 2 is not selected in any way. The result could simply be reflecting the impact of using more visual-spatial materials in the girls' schools than boys' schools.

**Table 9.7 Correlations by Gender**

| Gender | | Visual–Spatial Test 2 |
|---|---|---|
| Girls N = 71 | Total Marks | 0.35 |
| | | p = 0.003 |
| Boys N = 113 | Total Marks | 0.28 |
| | | p = 0.002 |

Table 9.7 shows that boys and girls tend to be similar in the way their visual-spatial ability (as measured by test 2) relate to performance in examinations, similar to experiment 1 data.

However, it is well established that human males excel over females across a variety of visual-spatial problem-solving and perceptual tasks (Broverman et al., 1968; Harris, 1978; Joseph, 1993, 2000; Kimura, 1993; Linn and Petersen, 1985; Thomas et al., 1973)

## 9.4 Experiment Three

The test data for experiment 3 for Grade 7 are now compared by gender

**Table 9.8 Test Data by Gender**

| | Gender | N | Mean | Standard Deviation |
|---|---|---|---|---|
| Total Marks | *Girls* | 320 | 62. 9 | 10.0 |
| | *Boys* | 434 | 57.9 | 9.4 |
| Convergency | *Girls* | 292 | 11.0 | 3.5 |
| | *Boys* | 366 | 9. 7 | 3.7 |
| Visual-spatial Test 3 | *Girls* | 138 | 11.3 | 3.1 |
| | *Boys* | 174 | 10.5 | 3.5 |
| Divergency | *Girls* | 162 | 31.6 | 10.7 |
| | *Boys* | 261 | 26.2 | 9.7 |

As before, the girls appear to outperform the boys in all tests. This is consistent with the pattern derived from experiment 1 where the sample contained a high proportion of 'gifted' students. The sample here is a cross-section of the population. Table 9.9 shows the t-test data for these comparisons.

**Table 9.9 t-test Values for Test Data**

| | t-test | Probability | Higher Performance |
|---|---|---|---|
| Total Marks | 7.04 | p < 0.001 | g > b |
| Convergency | 4.57 | p < 0.001 | g > b |
| Visual-Spatial 3 | 2.15 | p = 0.033 | g > b |
| Divergency | 5.33 | p < 0.001 | g > b |

This shows that the girls do, in fact, outperform the boys very significantly. This is consistent with the outcomes from experiment 1, with the added comparison for the new convergency test.

**Table 9.10 Correlations by Gender**

| Gender | | Convergency | Visual-spatial Test 3 | Divergency |
|---|---|---|---|---|
| *Girls* | ***Total Marks*** | 0.49 | 0.32 | 0.36 |
| | | p < 0.001 | p < 0.001 | p < 0.001 |
| | ***Convergency*** | | 0.39 | 0.52 |
| | | | p < 0.001 | p < 0.001 |
| *Boys* | ***Total Marks*** | 0.49 | 0.28 | 0.37 |
| | | p < 0.001 | p < 0.001 | p < 0.001 |
| | ***Convergency*** | | 0.39 | 0.52 |
| | | | p < 0.001 | p < 0.001 |

Unlike experiment 1, these data show that the correlations of the various tests with total marks are almost identical, this sample this time being a cross-section of the population.

## 9.5 Conclusions

In conclusion, the aim of this chapter is investigate a few of the differences between the girls and boys in several cognitive characteristics (field dependency, divergency, convergency and visual-spatial) as well as working memory capacity and examination performance in grade 7 in Kuwait. The results show there are very significant differences between the girls and boys in all these characteristics except for working memory capacity. It is perfectly possible that the superiority of the girls is due to more rapid development, given that the students are in the middle of adolescence when development moves so rapidly. Nonetheless, it means that girls have a very significant advantage in being selected as 'gifted' on the basis of examination marks.

With samples drawn from the whole population (experiments 2 and 3), the relationships between the cognitive characteristics and performance are similar for boys and girls. However, with the sample which contained a high proportion of those considered to be 'gifted' (experiment 1), the benefits of having a high working memory capacity and being divergent are very much more powerful for boys than for girls in relation to their examination performance. This might be explained in terms of the boys being less willing to work hard at memorisation and, therefore, being more dependent on having to work things out. However, this effect does not show with the whole population and this suggests that the high achiever boys are those who either choose or more equipped to work things out and rely less on memorisation. This needs much more exploration and may be very important when looking at 'giftedness'.

# Chapter Ten

# Conclusions, Limitations, and Recommendation

## 10.1 Introduction

In this chapter, some overall conclusions will be drawn from the results outlined in the previous chapters. The aim here is to look overall at the meaning of the data obtained, to discuss the outcomes, considering some of the implications arising out of the findings. The work will be reviewed critically and some recommendations will be made.

One of the most fundamental difficulties in all education is how to cope with the wide range of abilities which may be found in teaching groups. Indeed, enormous effort and energy has been expended by teachers in seeking to support the learners who are either having major difficulties or are moving so fast that they become bored with the pace of learning. In Kuwait, there has been considerable emphasis over the years in meeting the needs of the most able (known there as 'gifted') and, in recent years, this has led to the establishment of enrichment centres, offering programmes in the evenings and during holiday periods. This has meant the need to introduce procedures to identify those who are regarded as 'gifted' and much has depended on the use of formal examinations in six subjects along with various tests of IQ. The real issue is whether such approaches are appropriate and this has been the background against which this study has taken place.

## 10.2 Review of the Experiments

The whole study involved very large numbers of students from grades 7 to 9 (aged 13 to 15). Some of the samples were selected in such a way that they contained a significant proportion of those considered 'gifted' while others were randomly selected from the population.

**Table 10.1 Samples Involved**

| Schools | Student Classification | | | | | | Total |
|---|---|---|---|---|---|---|---|
| | Experiment 1 | Experiment 2 | | Experiment 3 | | | |
| | *Grade 7* | *Grade 7* | *Grade 8* | *Grade 7* | *Grade 8* | *Grade 9* | |
| 29 | 641 | 299 | 124 | 754 | 153 | 198 | 2169 |
| Selection | Selected | Random | Selected | Random | Random | Selected | |

The first experiment involved the collation of the marks from the six subjects and measuring the working memory capacity, extent of field dependency, extent of divergency and visual-spatial characteristics of a large sample of students aged 13, the sample being selected in such a way that it contained a significant proportion of those regarded as 'gifted'. It was found that all the cognitive characteristics correlated very significantly with examination performance in all subjects and that the examinations were all testing one skill, almost certainly recall.

In the second experiment, an attempt was made to see if self-report offered useful insights into three of the cognitive characteristics but this proved unsuccessful. The students of this age are either unable or unwilling to report clearly and it is possible that this simply reflects that they see themselves as they would like to be seen rather than as they actually are.

In the third experiment, another approach was taken to self-report while a new test for convergency was developed and applied along with a new test for visual-spatial. The self-reports tried to allow the students to describe how they *preferred* to work but, again, these did not give clear results. What was surprising was the finding that the data from the new convergency test correlated very strongly with examination performance and also with the data from the established divergency test, suggesting strongly that convergency is a different attribute and not simply the opposite of divergency.

## 10.3 Implications

In many previous studies (see Chandi, 2003, for a summary), working memory capacity has been found to be correlated with performance in the mathematics-sciences subjects and the results from experiment 1 are consistent with these studies. It has to be noted that working memory capacity will *only* correlate if the test questions actually make a demand on the working memory. Reid (2002) found an absence of correlation when she deliberately designed her test material so that the demand of all questions fell well within the capacity of her students. Similarly, Reuhkala (2001) did not find any correlation between working memory and mathematical skills and this may have occurred for the same reason. However, in the work described here the correlations tended to be around about 0.2 and this is low compared to most other studies. Almost certainly, these low values arise because the examinations are testing recalls skills and it is well known that the working memory becomes much more critical when higher levels of thinking are involved (Johnstone, 1997).

The correlation with field dependency was also fairly low. Field dependency is one aspect of the efficiency of use of working memory and the recall nature of the Kuwaiti examinations almost certainly only give a small advantage to those students who were field independent. The results are consistent with the general finding that being field independent is *never* a disadvantage in formal examinations (see Tinajero and Paramo (1997).

Most striking was the very high correlation between the results from the divergency a test and performance in all of the examinations and this can be interpreted in terms of the mechanisms for successful recall being dependent on the number of usable links in long-term memory, consistent with the findings of Al-Qasmi (2006).

A strong correlation was found between the results of the visual-spatial test and performance in all of the examinations. It does seem that being more visual-spatial is an advantage in recall situations and this can be interpreted in that the more visual-spatial the students, the more they tend to see things holistically and this enables them to find answers to questions more easily.

It is, therefore, clear that the students in middle schools in Kuwait tend to do better in all subjects if they are field independent, divergent, and visually spatial. The effect is slightly stronger with mathematics and science and sometimes with language. Thus, those selected as gifted into Kuwait will tend to be field independent, divergent, strongly visual-spatial, with high capacity working memories. The ANOVA analyses confirm this.

Grigorenko and Sternberg (1997) found that there were no differences in thinking style among groups of student at different ability levels, and that certain thinking styles contributed significantly to prediction of academic performance while Rogers (1986) found that the gifted are generally different in degree, not kind of cognition. Thus, gifted students tend to acquire and process information and solve problems better, faster, or at earlier ages than other students (Robinson, 1998).

Looking at the results here, it is possible that the higher levels in the four cognitive characteristics which had been measured give the students an advantage in acquiring and processing information more rapidly and more efficiently and, therefore, been able to recall the information more reliably.

Perhaps the most important outcome from experiment one is the observation that the selection of students as gifted is based largely on recalls skills and that these skills are related to certain cognitive characteristics. This raises the question: is giftedness to be seen largely in terms of recalls skills? Of course, being skilled at a recall *could* mean that the students can develop higher order thinking skills (like application, analysis and evaluation) more effectively but the research here cannot confirm this.

This second experiment aimed to explore the possibility that students could describe themselves accurately in relation to three of the cognitive characteristics. However, this does not appear to be the case and the use of self report questionnaires to explore field dependency, convergency-divergency and visual-spatial styles does not seem to be a useful way forward. The visual-spatial test was used again with minor modifications and an interesting outcome was observed. While the first version of the test correlated very significantly with the revised version, the actual correlation value was surprisingly low. There is the possibility that visual-spatial abilities are open to development with time and it is possible that curriculum experiences or, indeed, other experiences in life caused the abilities to change, this causing the moderate correlation rather than the expected very high correlation. This interesting possibility needs much further exploration.

The standard convergency-divergency test is essentially a test of divergent abilities, a poor mark being seen as evidence of convergency. This led to the need to develop a test specifically to explore convergency. Another outcome from this experiment is that with a completely random sample, correlations will tend to be higher in that there is a wider range of performance in all the tests and measurements used. Indeed, with samples which contain high proportions of students with high abilities, correlations can fall quite markedly in that most of the students score highly in most of the tests and examinations.

The fall in the value of the correlation coefficient when using samples which are not random was illustrated in the final experiment. The new test of convergency correlated extremely highly with random samples showing that whatever this test measured, these skills were highly related to the skills of recall on which examination performance depended. When the sample contained a high proportion of the gifted students the correlation value fell considerably although was still highly significant. The correlation with field dependency and visual-spatial abilities became non-significant and became much lower with the standard test for by divergency when samples were not random.

The most striking outcome from the final experiment was the finding that the standard test for divergency (originally seen as a test of divergency and convergency) correlated very highly with the new test which focused on convergency skills. Assuming that the new test for convergency is valid, this indicates that recalls skills are highly related to being *both* divergent and convergent.

The results suggest that achieving the highest marks in school examinations in Kuwait at this age are related to being visual-spatial in thinking, being divergent ***and*** convergent as well as tending to be field independent with a high working memory. There is also evidence of some students performing very differently in examinations with time. If the selection of those considered gifted is fixed at any point, it could mean that those not seen as gifted at one age might never have access to enrichment later. In fact, in Kuwait, students are re-assessed during their school career and enrichment is offered to those seen as gifted. This procedure raises a serious problem. There will be students who have been selected as gifted at one age who fail to be selected at a later stage. The demoralizing effect on such students could be considerable.

Although not the main aim of the study, the differences between the boys and the girls were explored briefly. Looking at the genders separately, girls out-perform boys in all measurements and examinations except for working memory capacity. It was found that working memory capacity correlated more markedly for boys than girls with total marks. The higher working memory correlations almost certain reflect the unwillingness of the boys to make the effort to two memorise and they depend much more on working things out, a process which is known to be highly dependent on working memory capacity.

When correlating the standard test for divergency with total marks, very high values are obtained. However, the correlation for the boys is *very* much higher than that for the girls. Again, this can be interpreted in terms of the greater reliance that boys place on working things out, being divergent having a greater advantage for them in seeking to find a suitable answer.

There are major implications for the selection of boys and girls in Kuwait. Based on the examination results, boys will be at a considerable disadvantage compared to girls in that, at these ages, girls outperformed boys so markedly. In fact, in Kuwait, things are arranged so that equal numbers of boys and girls are selected as gifted. Boys and girls are educated separately and the proportions of those selected are made to be roughly the same. This, of course, places some girls at a disadvantage in that they have outperformed boys who have been selected as gifted and been given enrichment experiences while these girls may have just missed being selected. Such problems are almost inevitable in any selection process in that some will just miss being selected and thus not enjoy the advantages given to those who have performed marginally better. This exposes the weaknesses of any selection process in terms of equal opportunities for all.

## 10.4 Interpretation in Terms of Information Processing

It is possible to interpret the data obtained in terms of information processing and the way the human brain is known to operate. The information processing model is shown again for clarity.

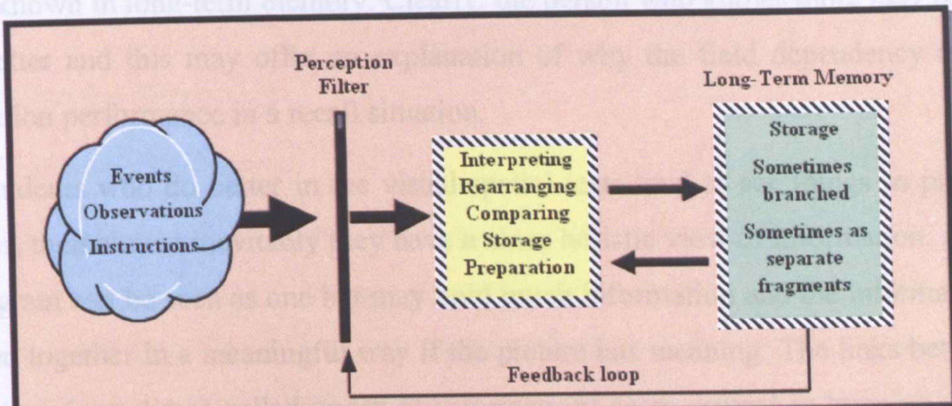



**Figure 10.1 Information Processing**

Those selected as gifted in Kuwait are those who tend to be:

(a) High working memory capacity;

(b) Field independent;

(c) More visually-spatially skilled;

(d) Divergent;

(e) Convergent.

The real question is whether these enhanced characteristics are indicators of high ability. Are they characteristics which give people advantages in the world of academic performance? It has to be recognised that examination performance in Kuwait is largely dependent on recall skills. Such skills will depend on the efficient memorisation of information and procedures as well as the ability to find the information and skills when stored on long-term memory and to apply them in an examination setting to give answers which will satisfy the examiners' intentions. Each of the five characteristics is now considered in turn and a possible interpretation is offered.

It is well established that working memory can often be a rate-controlling feature in the way information is processed, understood and accessed. The student with a high working memory capacity will always have an advantage when faced with situations when understanding, thinking, and searching long-term memory are involved. Field dependency has been related to the way working memory is used. The field independent person can select more efficiently and working memory overload much less likely. The inter-correlations between field dependency and working memory capacity measures would seem to confirm this (see Danili and Reid, 2004). The field independent person is using the perception filter more efficiently and effectively. This filter is controlled by what is already known in long-term memory. Clearly, the person who knows more may be able to select better and this may offer an explanation of why the field dependency relates to examination performance in a recall situation.

If the students who do better in the visual-spatial tests tend to see things as pictures or diagrams, then almost inevitably they have a more holistic view of information. A picture or a diagram can be seen as one but may hold much information and the information may be linked together in a meaningful way if the picture has meaning. The links between the information (sometimes called nodes of information) seem critical in learning situations (see Al-Qasmi, 2006) and it may well be that the presence of such links is a critical part of the recall process. This strong relationship between the extent of divergency and recall skills probably arises for the same reason: in other words, the student who can use links between ideas has a considerable advantage in being able to find answers in a recall situation.

The interpretation of convergency test data is more uncertain. Assuming that the new test of convergency is a valid measure of the skills defined as the characteristics of being a convergent person, then it would appear then being convergent is a considerable advantage in performance in examinations of a recall nature. This makes some sense. The recall examinations give the rewards to those who can get to the one right answer. Being a convergent person clearly has a huge advantage.

The more interesting question is what convergency actually means in terms of the way information is processed and stored. Does this reflect the way the working memory controls the search process? Of course, this might relate to some genetic aspect of working memory function but it also could be related to life experiences. If the rewards come from gaining the one right answer, then the learners will be encouraged to develop ways of thinking to achieve that result.

In all of this, there is an even more fundamental question. To what extent are these cognitive characteristics genetically determined and to what extent are they learned by means of formal education or life experiences? Working memory capacity is known to be genetically determined (see Baddeley, 2000) but the evidence about the other four characteristics is not clear cut although it is likely that some development with age will take place in that what is held in long-term memory influences future learning. It leaves unanswered the extent to which these characteristics are learned or developed by choice, consciously or subconsciously

## 10.5 Issues for Discussion

### *(a) A Problem of definitions*

In this study, emphasis was placed on the academically gifted, recognizing that that there are many other aspects of giftedness at school level. There are many other aspects of school life including the arts, music, sports and interior design; all are important. In Kuwait, giftedness is seen in terms of the six compulsory school subjects at this age and is measured by high achievement success in examinations. These tests, perhaps, largely measure how well the student can recall the information to put on to the answers sheet. Is this what is really required for giftedness? Perhaps the key elements of the concept of academic giftedness relate to understanding and the ability to use knowledge. This also requires a lot of higher thinking skills like analysis, synthesis of ideas, evaluation of ideas which may not be measured in conventional tests used in schools.

### *(b) Issues of Recall*

This study showed that academic performance in the six subjects is related to one factor, almost certainly recall skills. It has been suggested that recall skills involves three processes (inputs, outputs and codification). However, is recall the key to other academic skills? In other words, holding and being able to access knowledge might be the key to higher order thinking skills. This relates to the suggestion by Yang (2000) where she modified the Bloom's Taxonomy, showing the key place of knowledge underpinning other skills.

### *(c) Issues of Special Treatment*

The process of classifying students as 'gifted' and 'average' is intended to provide special care for these gifted students so that they can reach their full potential by means of enrichment by extra classes or withdrawal from mainstream for special activities.

However, what about the average student? In particular, what about the good student who does not quite make the 'gifted' category: do they not deserve special care? There is a real issue of equity. Special help is offered to those who face educational disadvantages and special help is offered to those who are most able (defined in some way). The majority are often offered nothing extra at all.

***(d) Academic Giftedness - developmental aspects (gifted in context)***

Many of the theories of giftedness have been discussed. However, there is the question of timing for learners. Some may show early signs of giftedness, for example in early reading, writing or language learning; however; some students are delayed but show excellence at later stages, perhaps even after school stages - at university or at work. Any selection process takes place at a given moment of time and may not suit all. Indeed, some may miss out entirely.

***(e) How do we assess Giftedness?***

Assuming mainstream enrichment or any type of special programmes for development of gifted students, the key question is: how do we assess giftedness? Will it be by examining performances, which often are not fixed, as demonstrated in the present study; or by using intelligence tests, which are open to much criticisms and warnings in use. Is teacher assessment sufficient and appropriate, or will it is simply reflect the individual teacher approach and the ways he/she gained success? What about higher order thinking skills. How can we assess these to see if knowledge recall is the real key to access?

***(f) Do we need to measure giftedness at all?***

Another issue that arises through the current study is whether we need to measure giftedness at all. It is only necessary if some kind of special provision is intended. So far, there is no evidence that programmes offered to the gifted students are not suitable for 'ordinary' students. Indeed, there is no clear cut evidence that such programmes actually bring benefits at all? Of course, in this, the nature of the benefits needs to be agreed. While there may be gains seen in academic terms, are there possible losses in social, emotional or attitudinal terms, especially if the entire population is considered? Labelling students can have major problems.

This lead on to some recommendations for Kuwait, to be seen as some kind of agenda for further work there:

- Why do we need to measure and separate? What is the purpose?

- Is there any evidence that special treatment actually enhances?
- Is there any evidence that special treatment hinders others?
- What skills are really important - simply recall?
- Why focus on academic giftedness, ignoring other aspects, especially leadership, critical thinking, creativity etc?
- Can we consider speed of processing rather than accuracy of recall?

## 10.6 Looking at the Study

Every piece of research has its owns strengths and weaknesses. Sometime, they depend on the nature of the work being undertaken and but much depends on what is possible to achieve in the real world of teaching and learning. This section seeks to reflect briefly on what has been done in this study.

(a) The current study involved very large samples, with very good cross sections of the populations under consideration. It was possible to follow the first sample into later stages, over a period two years, monitoring some of the changes that have occurred in the study variables. Such samples offer considerable confidence in reliability and possibility of generalising outcomes, at least for Kuwait.

(b) Some of samples contained high proportions of these considered to be 'gifted'. This allows a focus on the students with very high abilities.

(c) This study focused on the gifted students compared with the total population. This is not explored widely in other studies that have addressed the cognitive characteristics specifically for this age group.

(d) This study is strongly quantitative where results could offer numerical evidence for the study variables.

(e) The study has been set in a country where there is an established policy with regard to gifted students, thus facilitating the process of considering gifted students to specific criteria used in schools in Kuwait.

(f) The high correlations obtained offer some clear pictures of what is happening.

(g) The study was carried out in one country and there is no certainty that its conclusions can be applied elsewhere.

(h) One major issue relates to validity of the measurements. While the working memory capacity test, the test for field dependency and the test for divergency are all well established, the other tests were new. While steps were taken to establish validity, there can never be any certainty.

(i) There is the strange failure of questionnaire approaches when such approaches have been so successful elsewhere in attitude research. Perhaps, at age 13, students simply cannot see themselves accurately as they really are.

(j) Time did not permit for any detailed look at the enrichment curriculum.

## 10.7 Future Work

This study has raised many issues and the following areas are suggested for future work.

(1) Links between recall skills and higher order thinking skills: it is possible that recall skills are important as a basis for developing higher order thinking skills.

(2) Testing speed of processing – can this be done reliably and is it critical?

(3) Is there any evidence enrichment actually brings benefit and to whom?

(4) Why such a narrow range of enrichment: what about musical giftedness, art giftedness, etc as well as leadership, higher order generic skills?

(5) The important role of the visual-spatial - is the education system too much based on the symbolic?

(6) How constant is high ability over time?

This study has considered a few aspects related to those highly able learners in Kuwait. In many ways it is raised more issues that it has solved. It is hoped that the outcomes will offer some guidelines for future research programmes as well as the development of provision in Kuwait

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# Appendix A1

Figure Intersection Test

Notes

The Working Memory tests were presented to students as a booklet.

## Appendix A

The Study Tools

Experiment 1 and 2

A1-Working Memory Test

A2-Field dependent/independent Test

A3-Divergent Test

A4-Questioner 1

A5-Arabic Edition Tools

A6-Visual-Spatial Answer Sheet

# Figure Intersection Test

This test is a test of your ability to find the overlap of simple shapes.
There are two sets of simple geometric shapes, one on the right and the left. The set on the left contains the same shapes (as on the right) but overlapping, so that exists a common area which is inside all of the shapes.
Look fore and shade in the common area of overlap.
Note: these points:

The shapes on the left may differ in size or position from those on the right, but they match in shape and proportions.
In some items on the left some extra shapes appear which are not present in the right hand set, and which do not form a common area of intersection with all of the other shapes. These are present to mislead you to ignore them.
The overlap should be shaded clearly by using a pen.
The results of this test will not affect your schoolwork in any way.

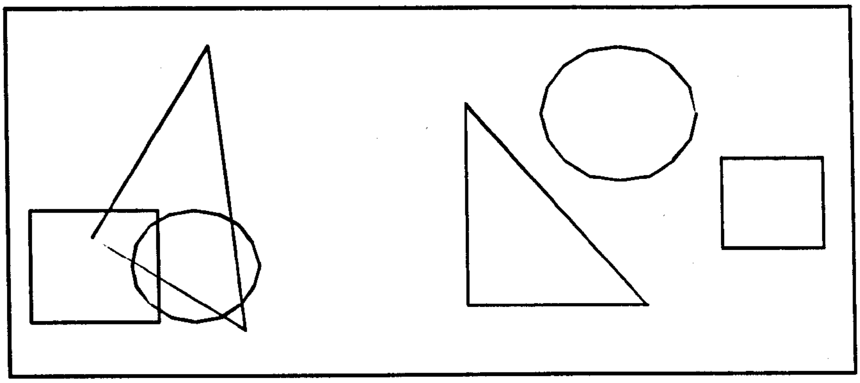
Name: ..........................................................................................................

School: ..........................................................................................................

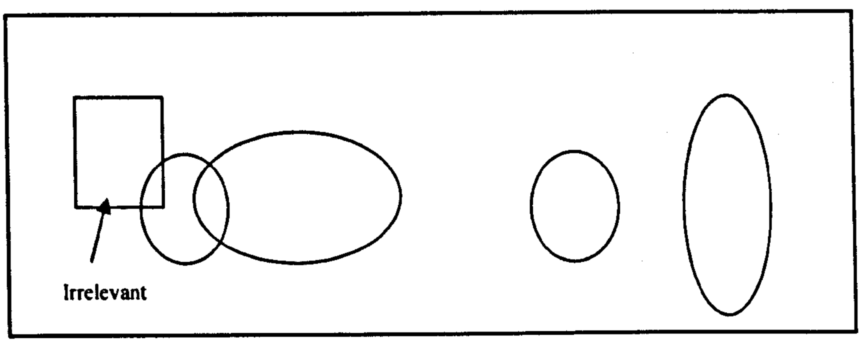
Class: ..........................................................................................................

Her are some samples to get you started.

Examle (1):



Example (2)



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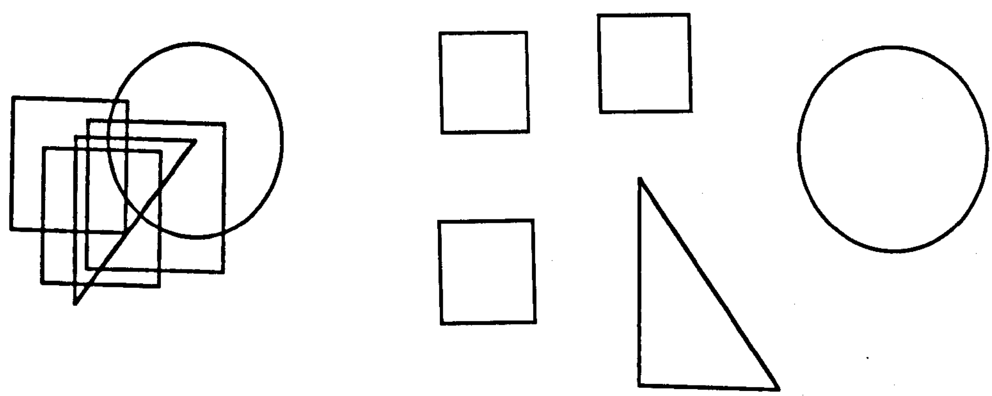
| 1 |  |
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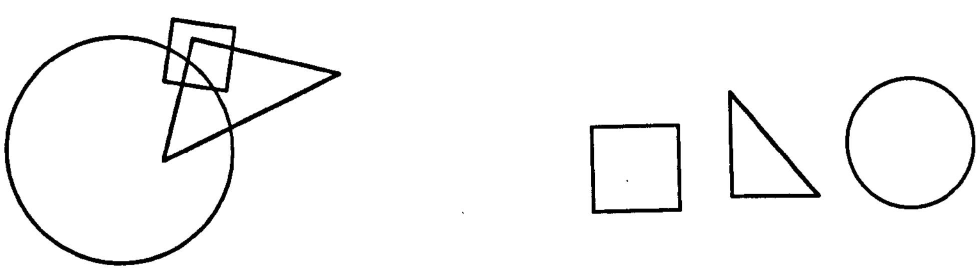
| 3 |  |

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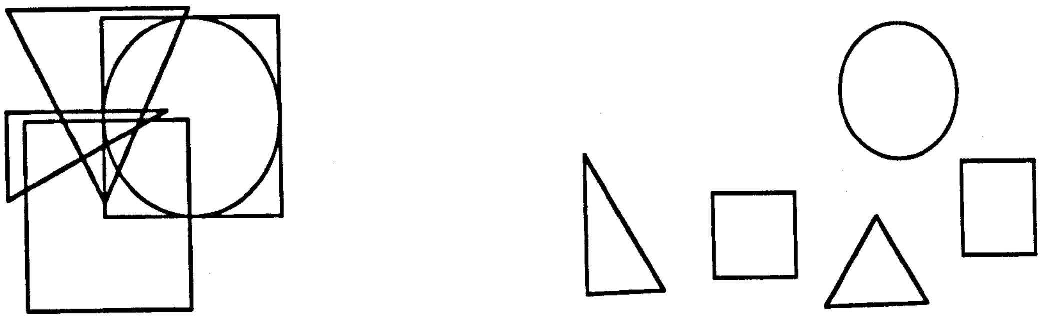
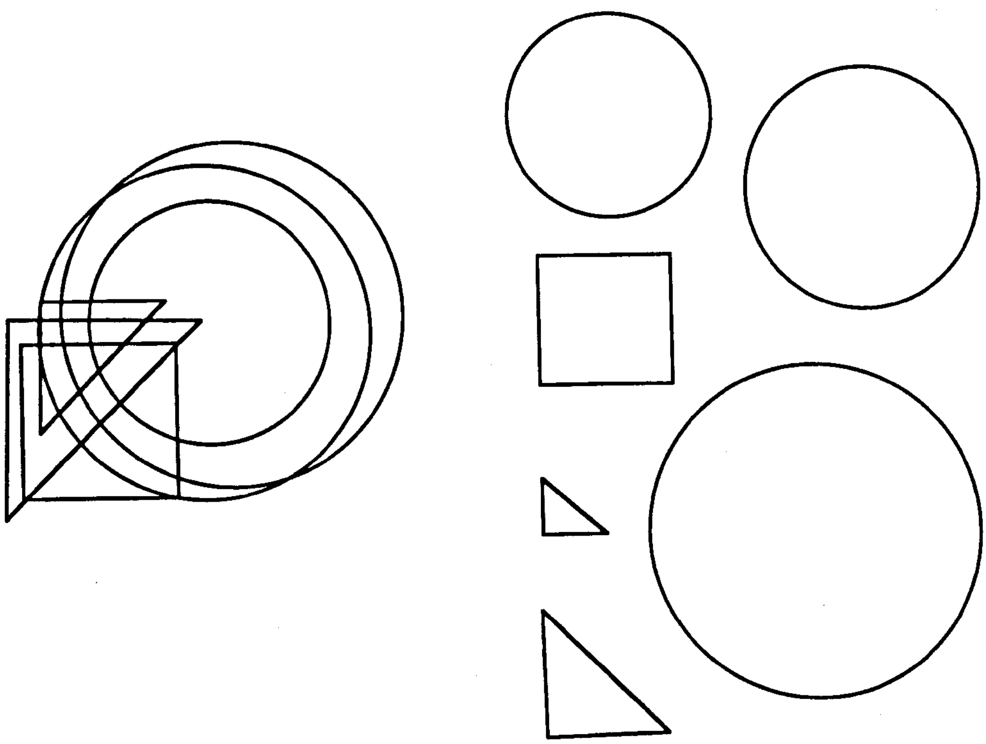
| 4 |  |
| 5 |  |

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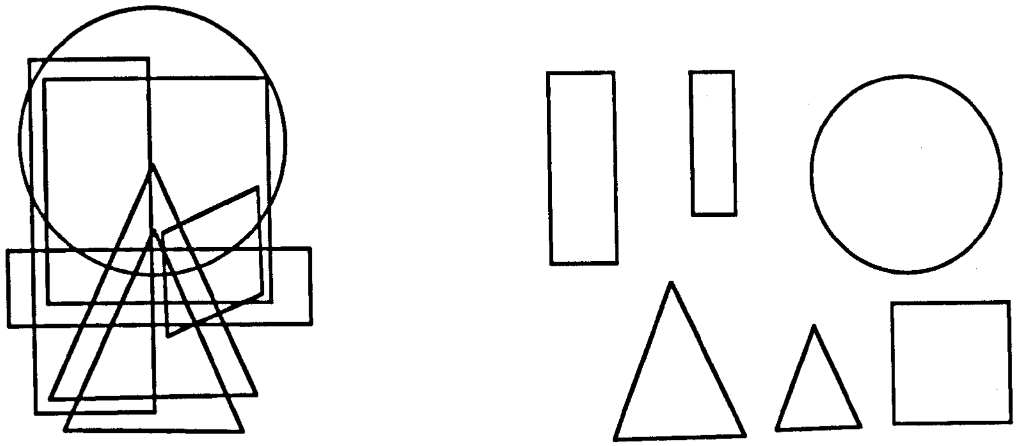
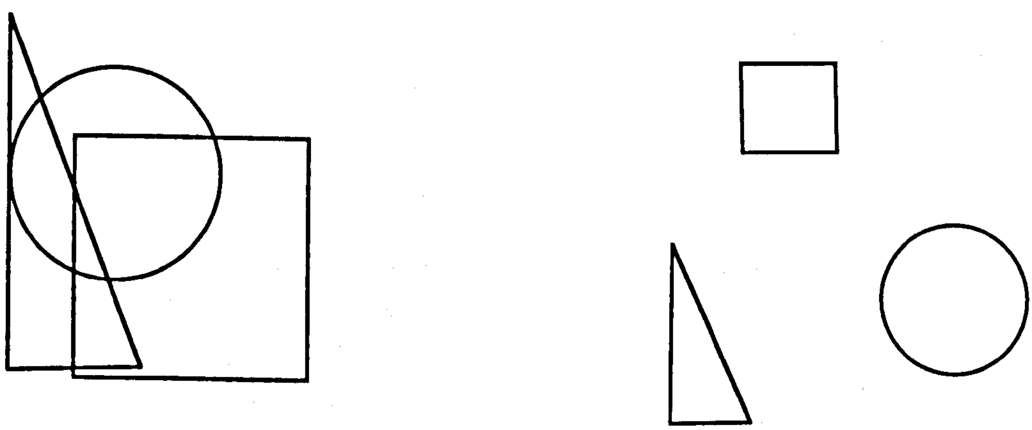
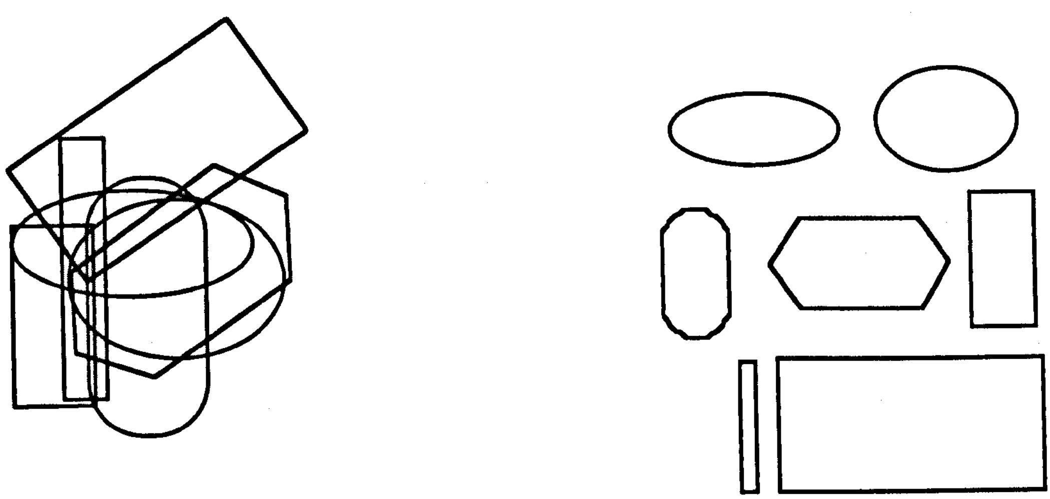
| 6 |  |
| 7 |  |
| 8 |  |

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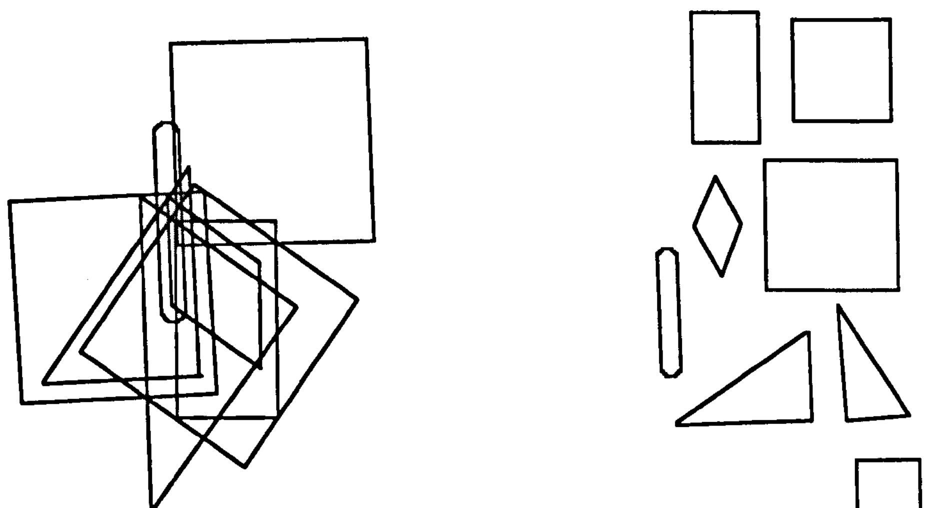
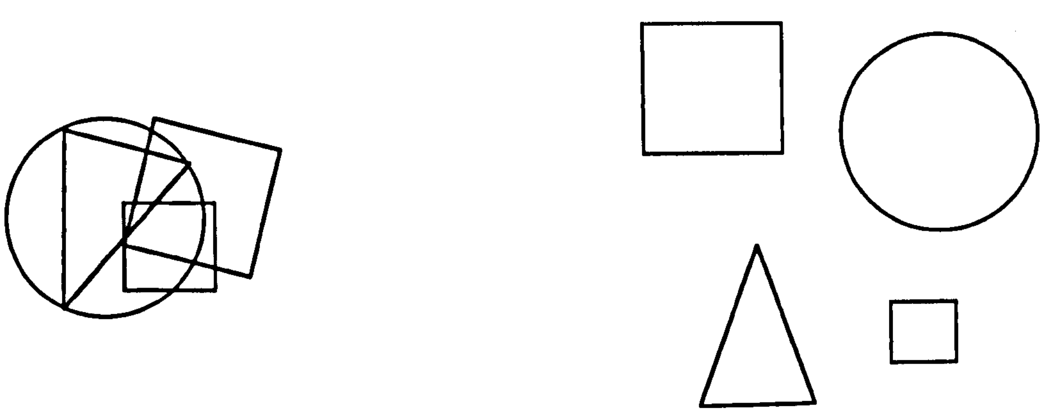
| 10 |  |
| 11 |  |

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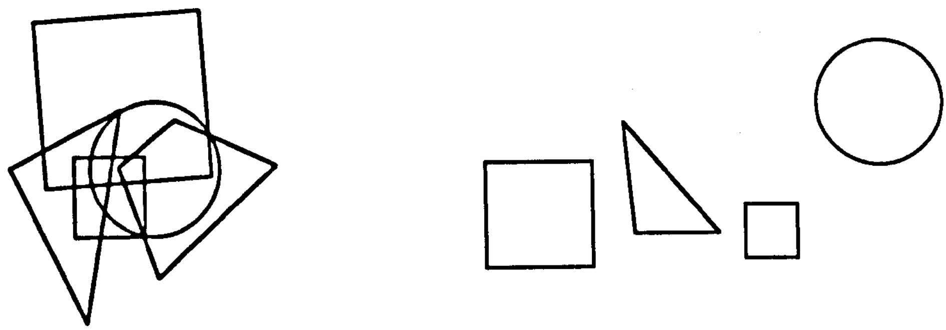
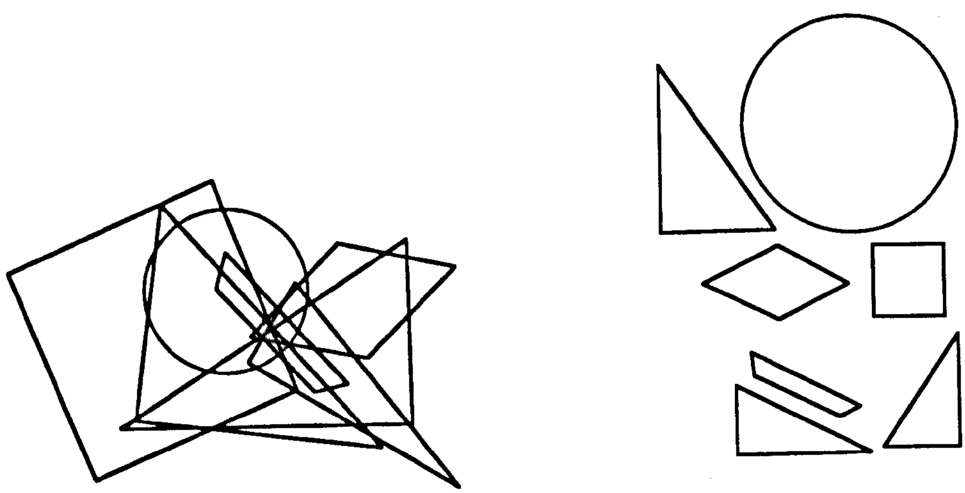
| 12 |  |
| 13 |  |
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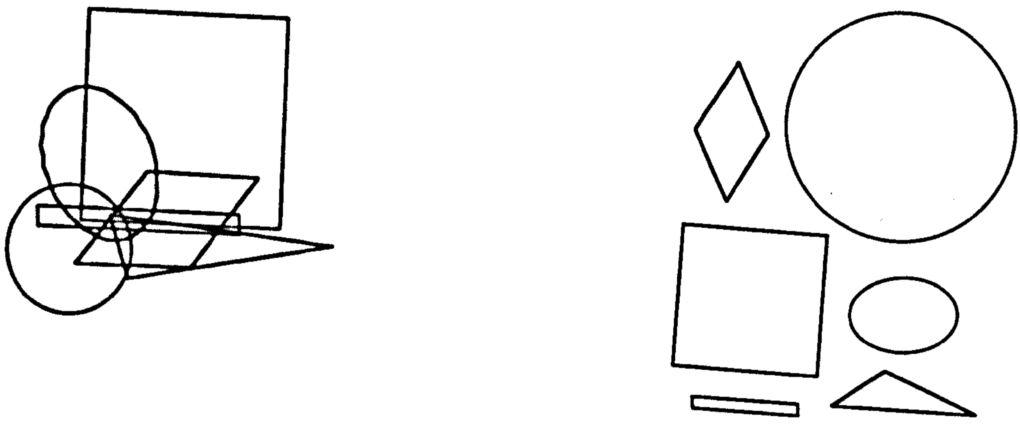
| 15 |  |
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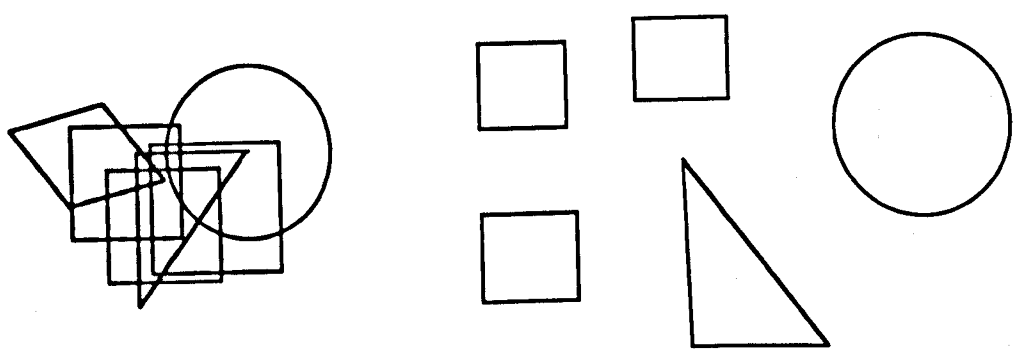
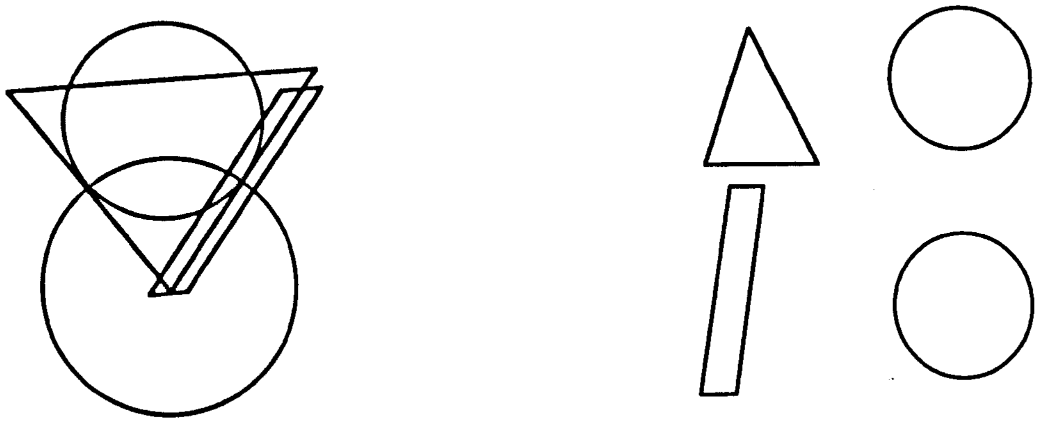
| 17 |  |
| 18 |  |

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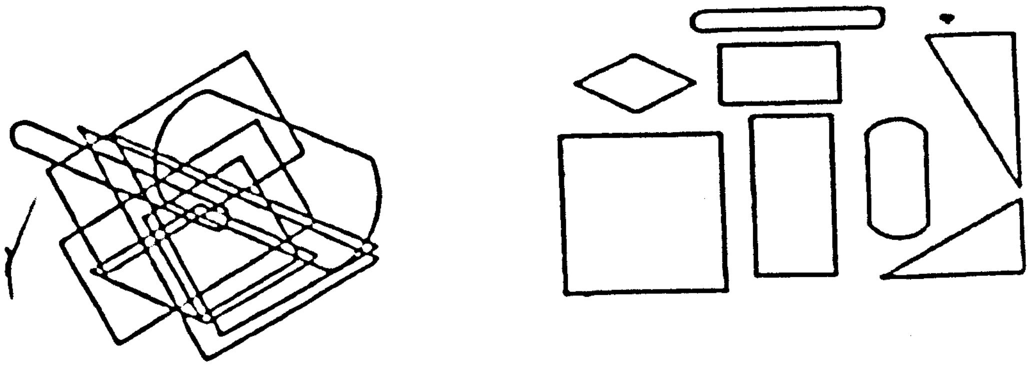
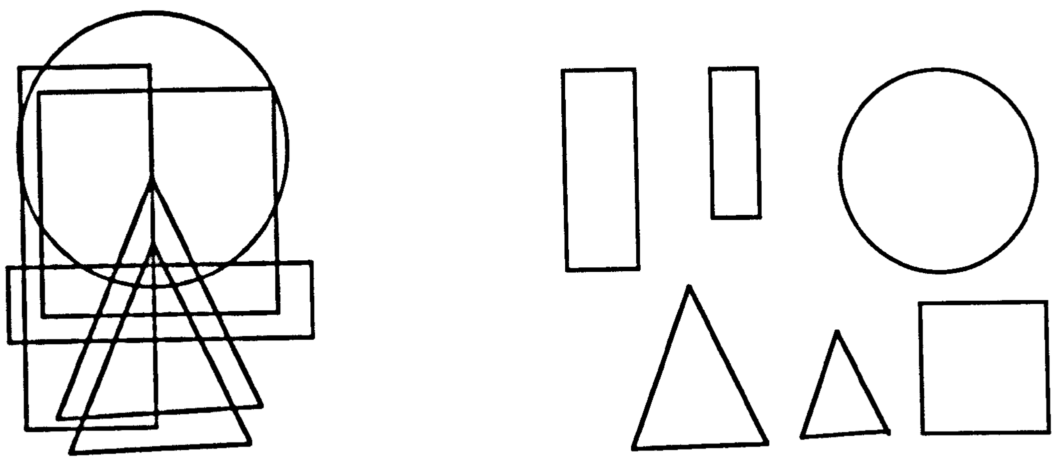
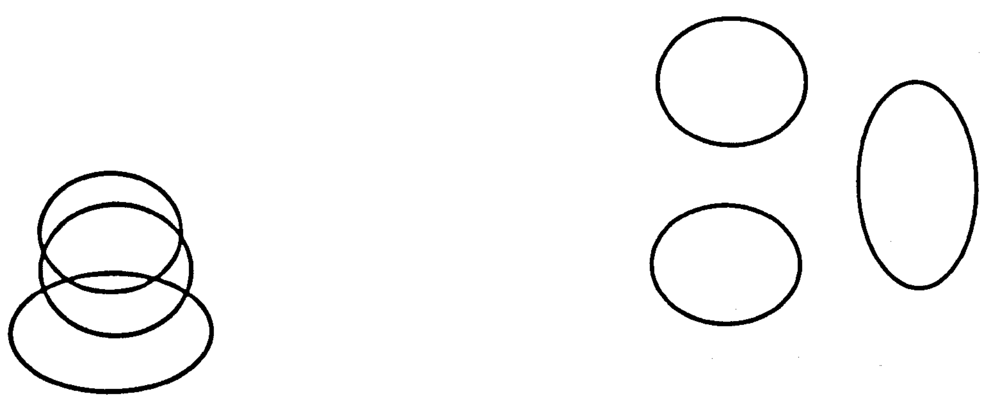
| 19 |  |
| 20 |  |
| 21 |  |

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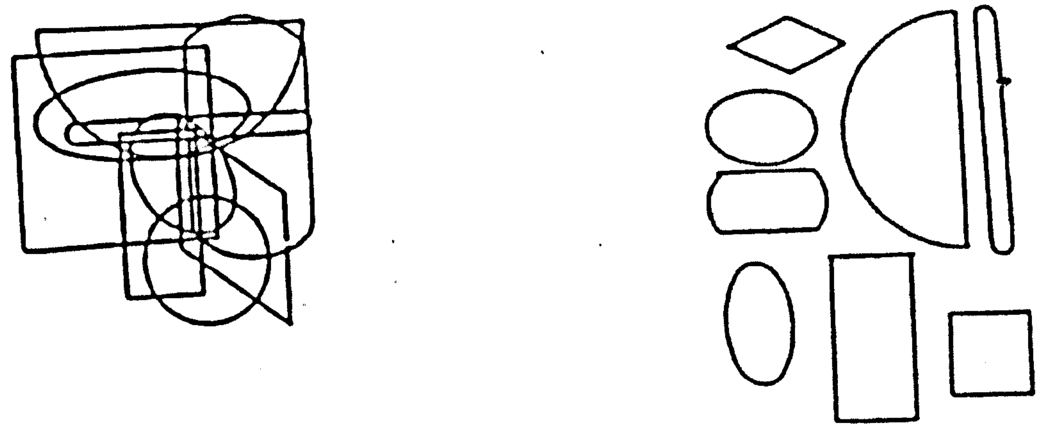
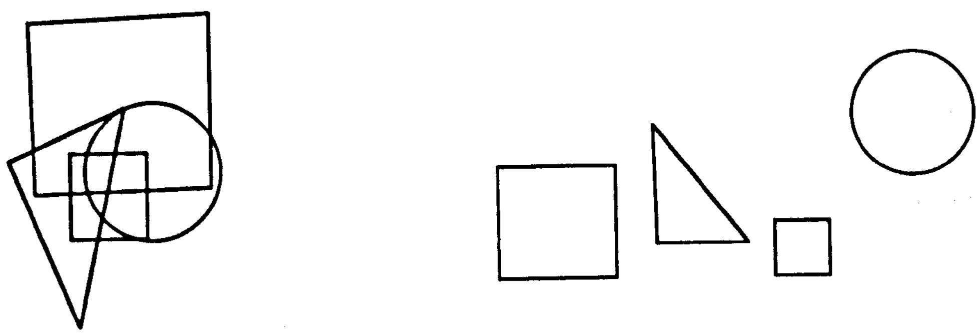
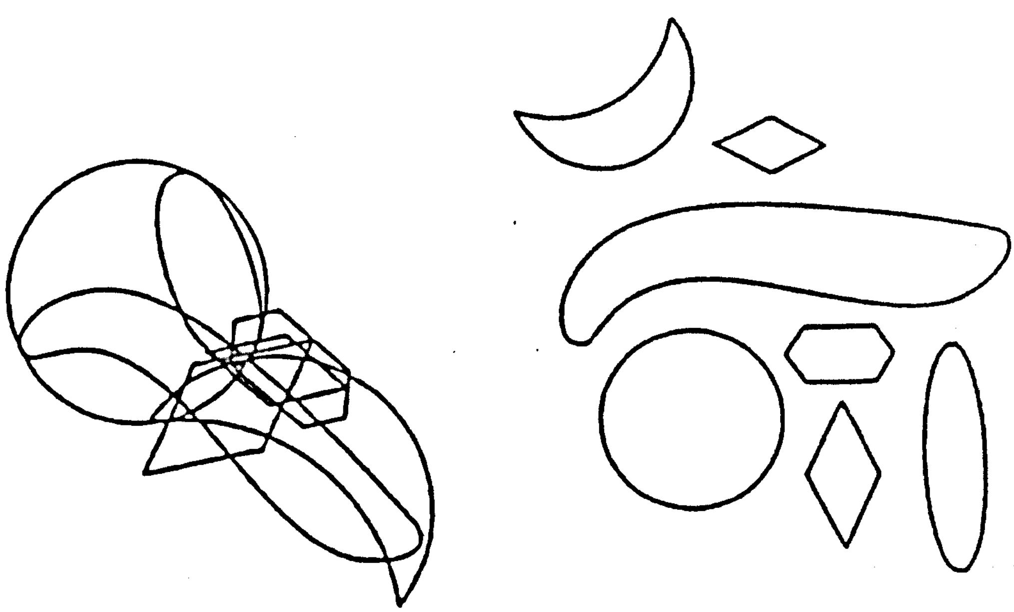
| 22 |  |
| 23 |  |
| 24 |  |

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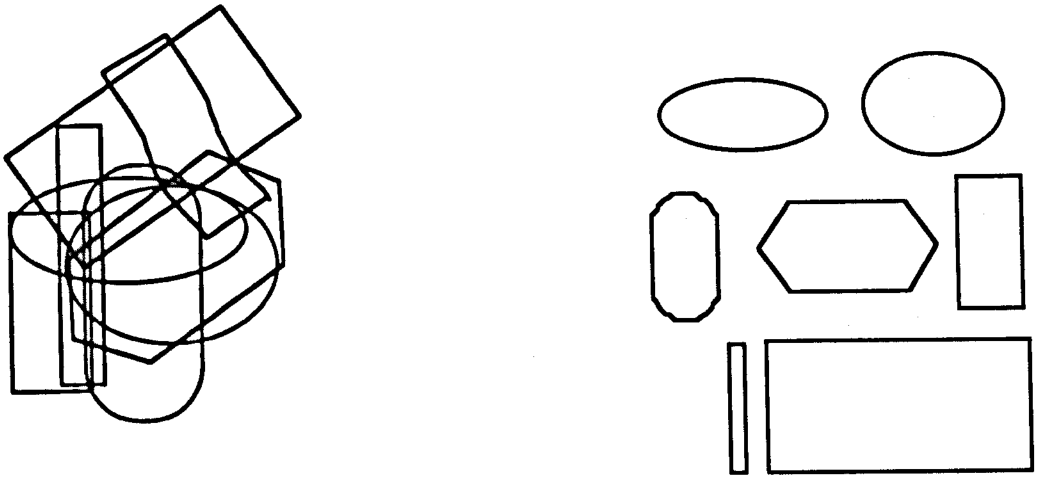
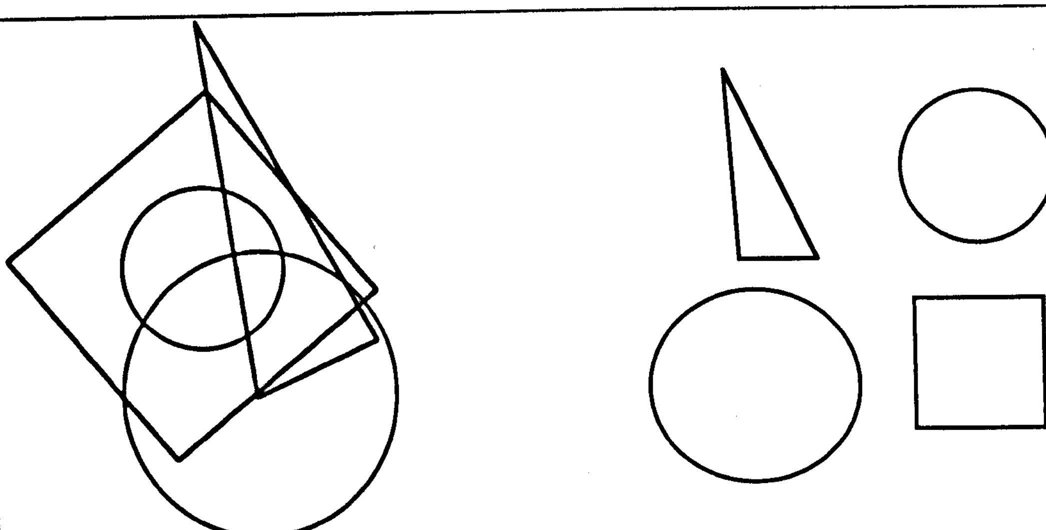
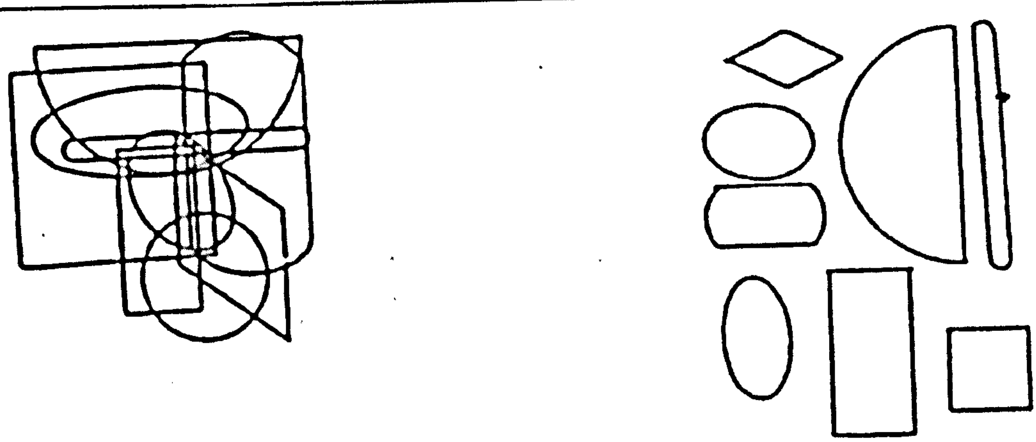
| 25 |  |
| 26 |  |
| 27 |  |

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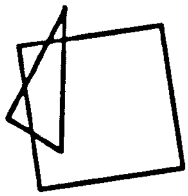
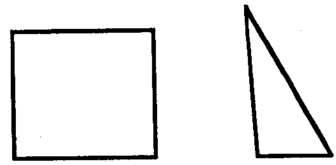
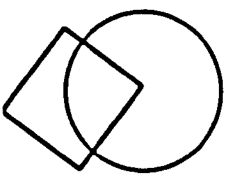
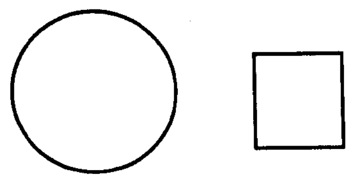
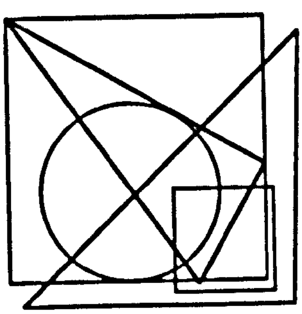
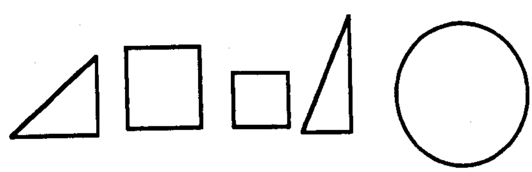
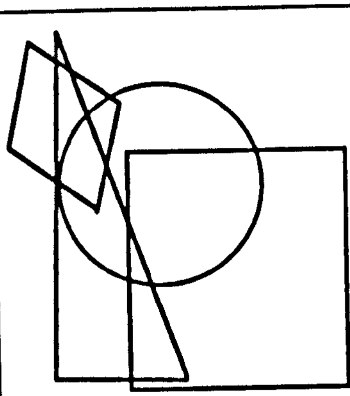
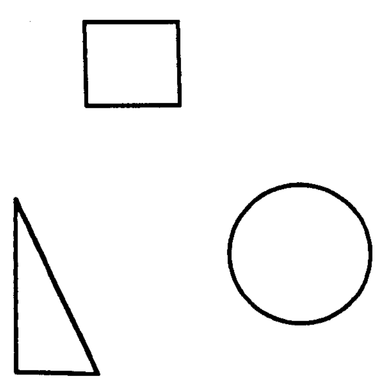
| 28 |  |  |
| 29 |  |  |
| 30 |  |  |
| 31 |  |  |

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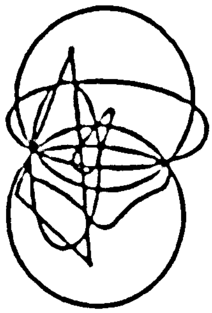
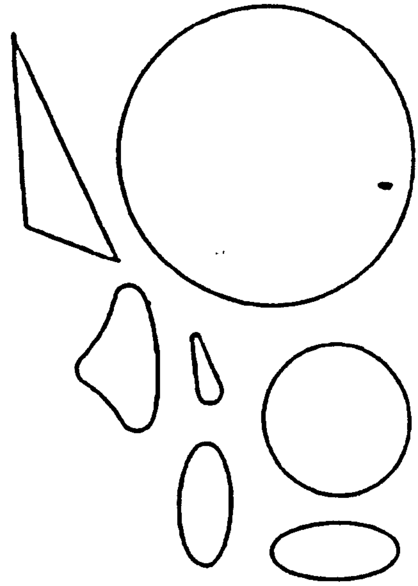
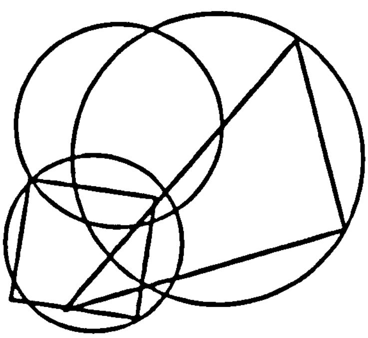
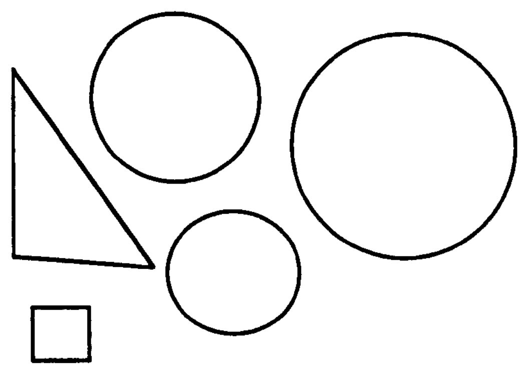
| 32 |  |  |
| 33 |  |  |

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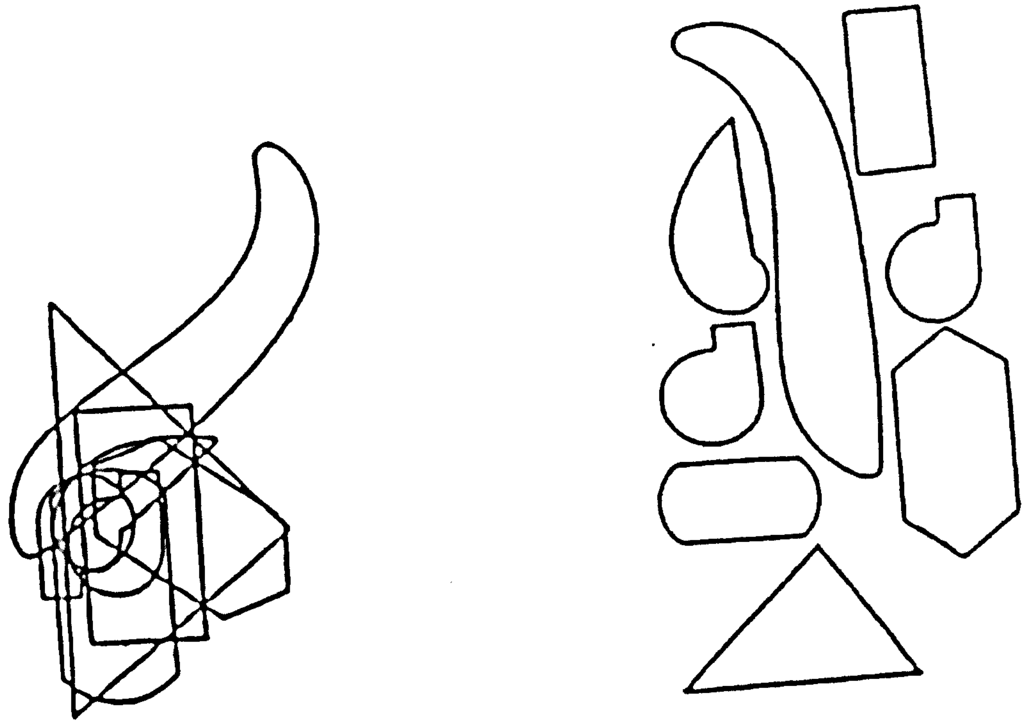
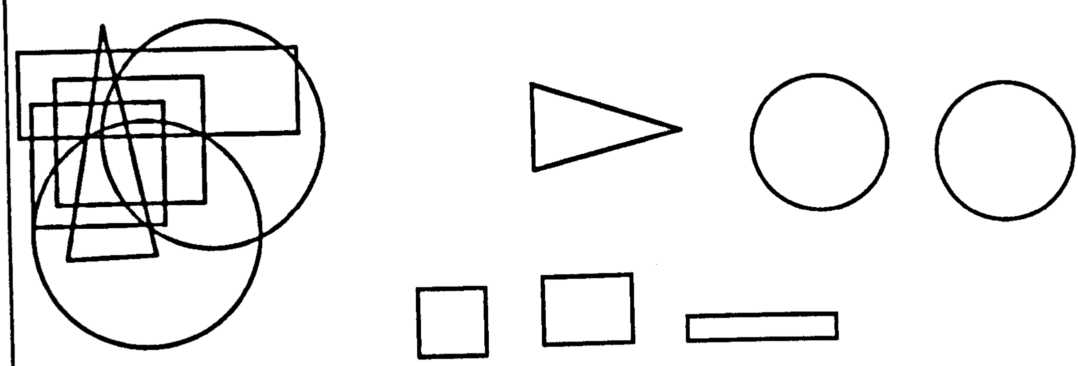
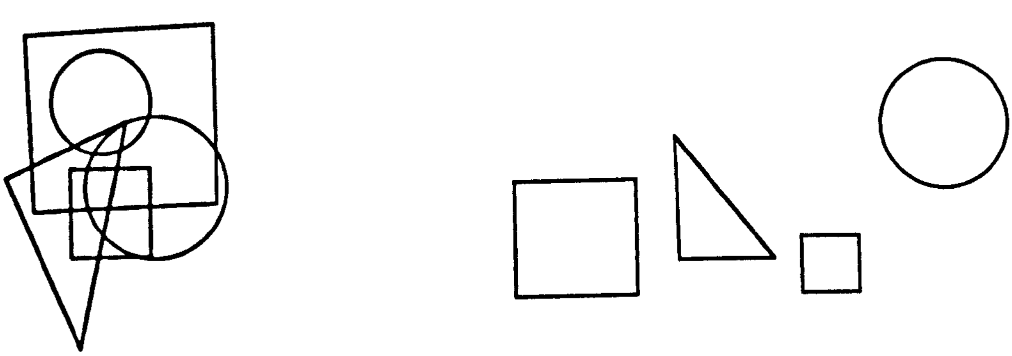
| 34 |  |
| 35 |  |
| 36 |  |

# Appendix A2

# The Hidden Figure Test

Notes

The FD/FIND tests were presented to students as a booklet.

The answers to the Shapes are included, beginning on page appendix. A-31

# Shapes

Shape Recognition within Complex Patterns

This is a test of your ability to recognize simple SHAPES, and to pick out and trace HIDDEN SHAPES within complex patterns. The results will not affect your course assessment in any way.

You are allowed only 20 minutes to answer all the items.

Try to answer every item, but don't worry if you can't.

Do as much as you can in the time allowed.

Don't spend too much time on any one item

Name: ..........................................................................................................

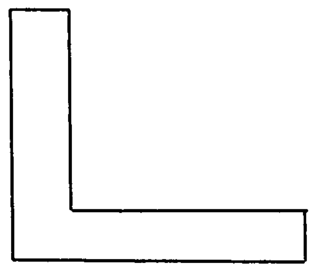
School: ..........................................................................................................

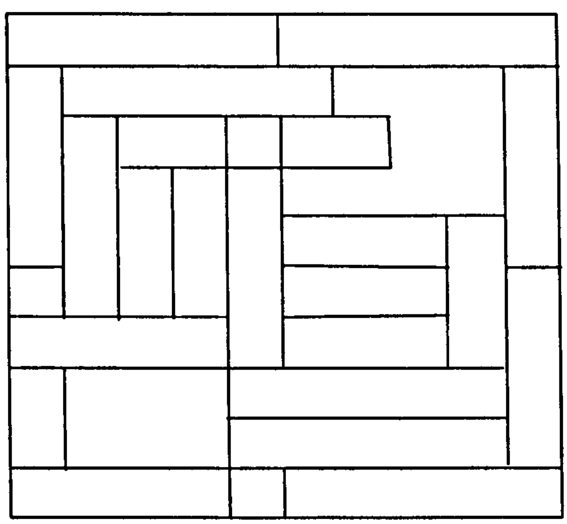
Class: ..........................................................................................................

DO NOT START UNTIL YOU ARE TOLD TO DO SO

LOOKING FOR HIDDEN SHAPES

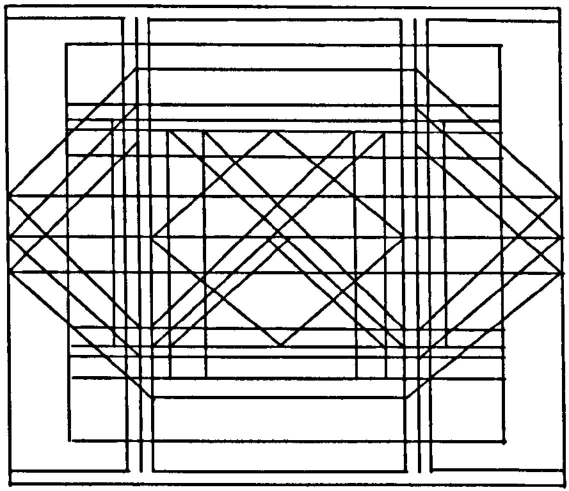
A simple geometric figure can be 'hidden' by embedding it in a complex pattern of lines. For example, the simple L-shaped figure on the left has been hidden in the pattern of lines on the right. Can you pick it out?





Using a pen, trace round the outline of the L- shaped figure to mark the position.

The same L-shaped figure is also hidden within the more complex pattern below. It is the same size, the same shape and faces in the same direction as when it appears alone. Mark its position by tracing round its outline using a pen.



More problems of this type appear on the following pages. In each case, you are required to find a simple shape 'hidden' within a complex pattern of lines, and then, using a pen, to record the shape's position by tracing its outline.

There are TWO patterns on each page. Below each pattern there is a code letter (A, or B, or C etc.) to identify which shape is hidden in that pattern.

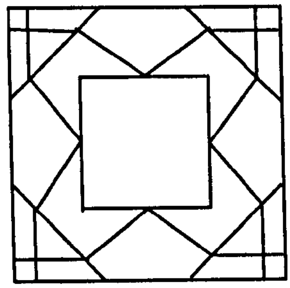
In the last page of this booklet, you will see all the shapes you have to find, along with their corresponding code letters. Keep this page opened out until you have finished all the problems.

Note these points:

- You can refer to the page of simple shapes as often as necessary.
- When it appears within a complex pattern, the required shape is always:
- The same size,
- Has the same proportion,
- And faces in the same direction as when it appears alone
- Within each pattern, the shape you have to find appears only once.
- Trace the required shape and only that shape for each problem.
- Do the problems in order – don't skip one unless you are absolutely stuck.

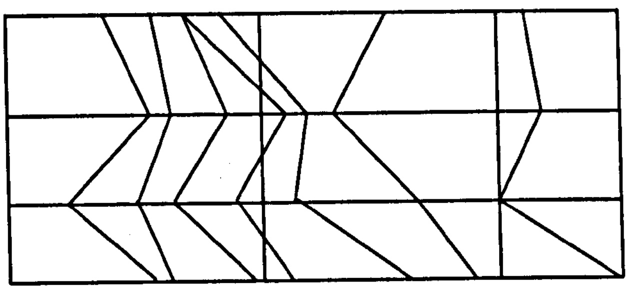
---

START NOW



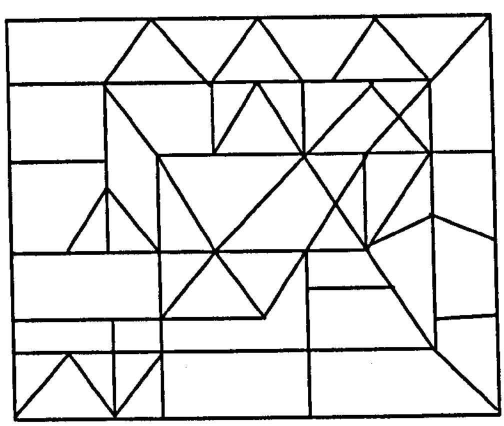
Find shape B

---



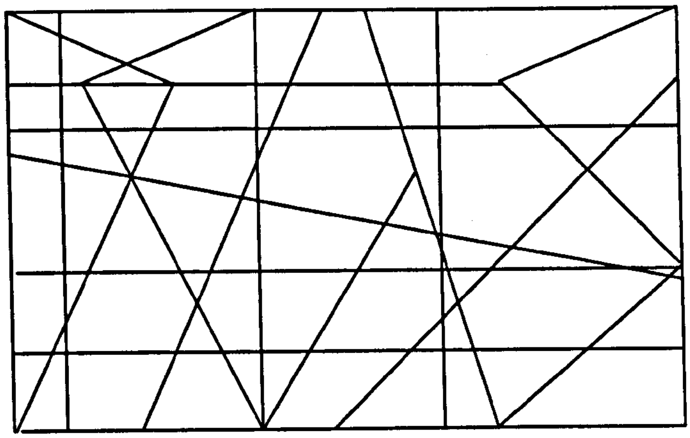
Find shape D

---

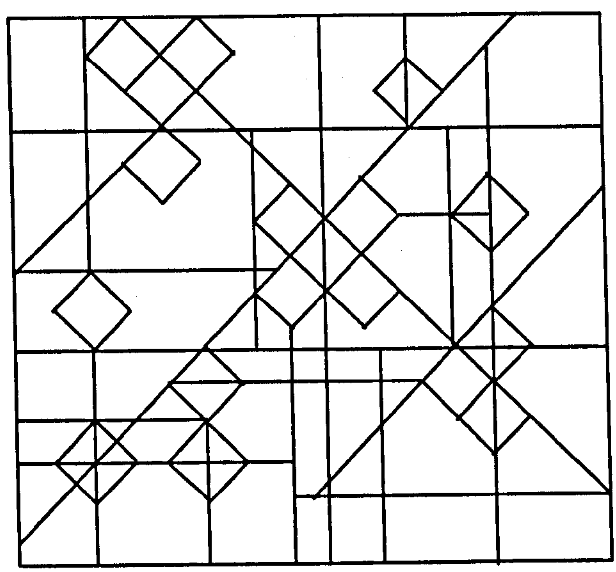


Find shape H

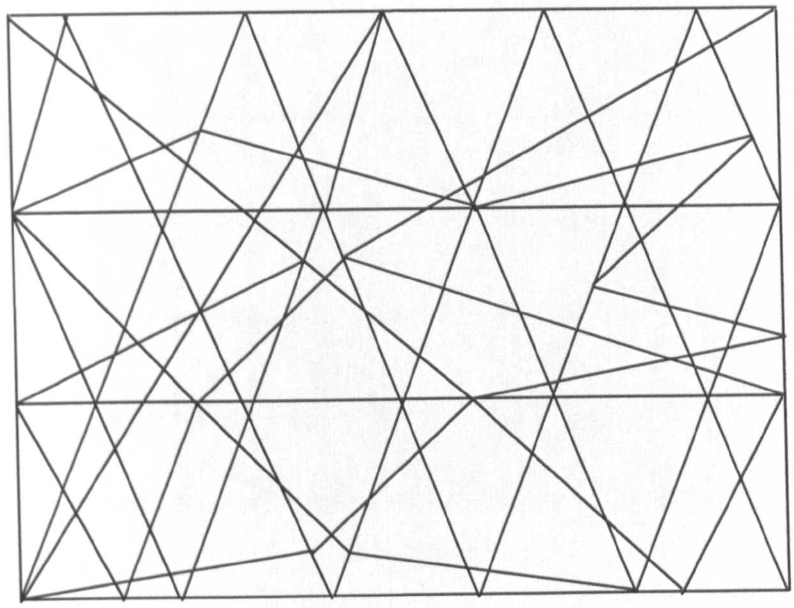
---



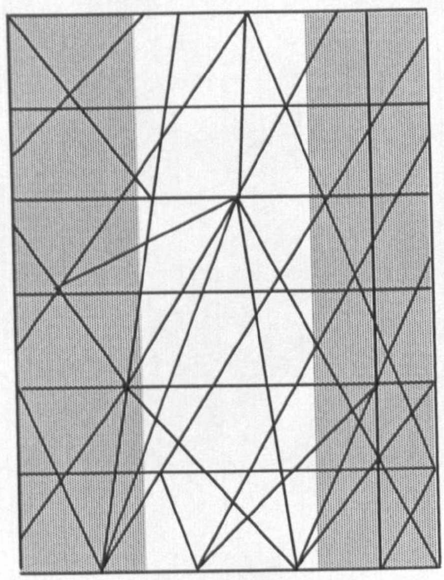
Find shape E



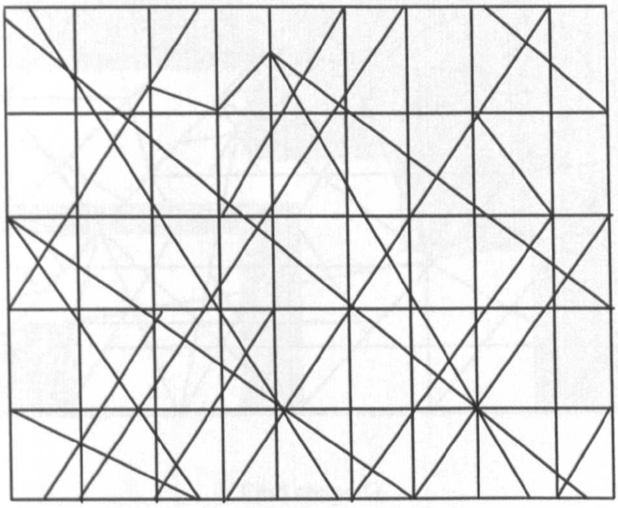
Find shape F



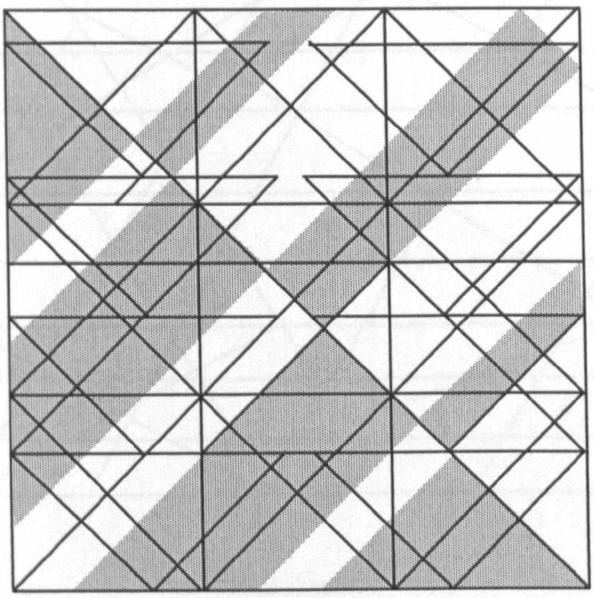
Find shape A



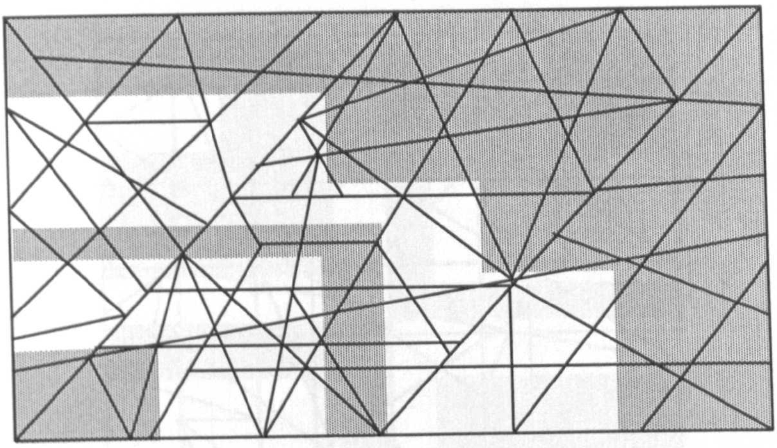
Find shape E



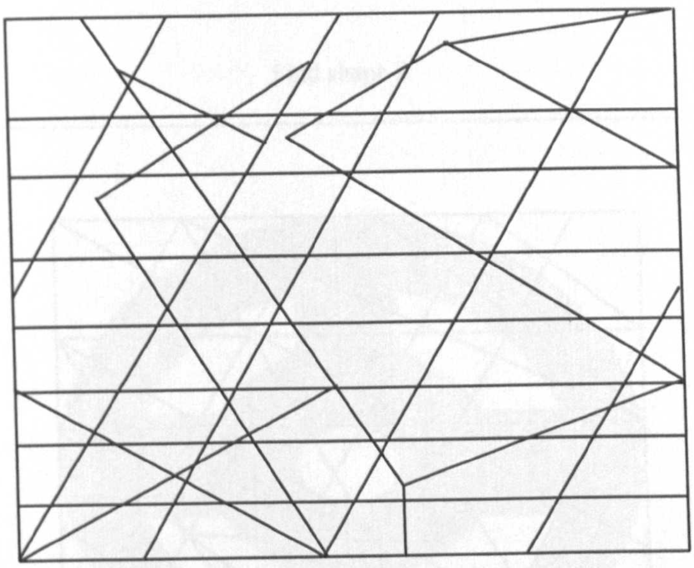
Find shape H



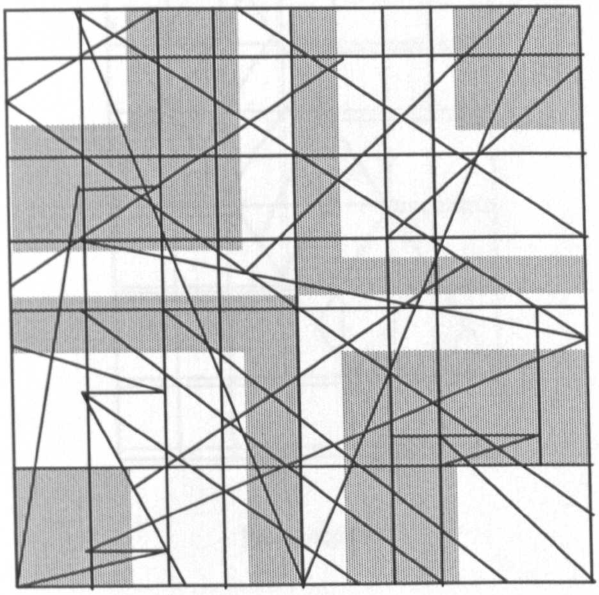
Find shape D



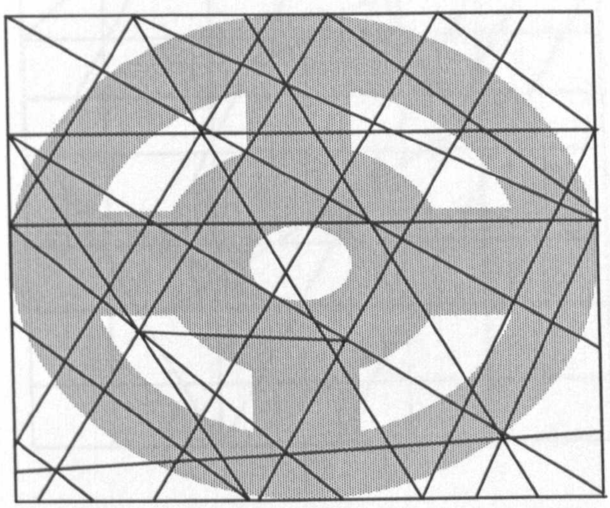
Find shape G



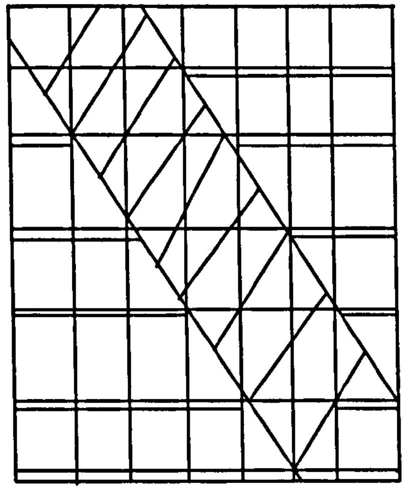
Find shape C



Find shape B



Find shape G



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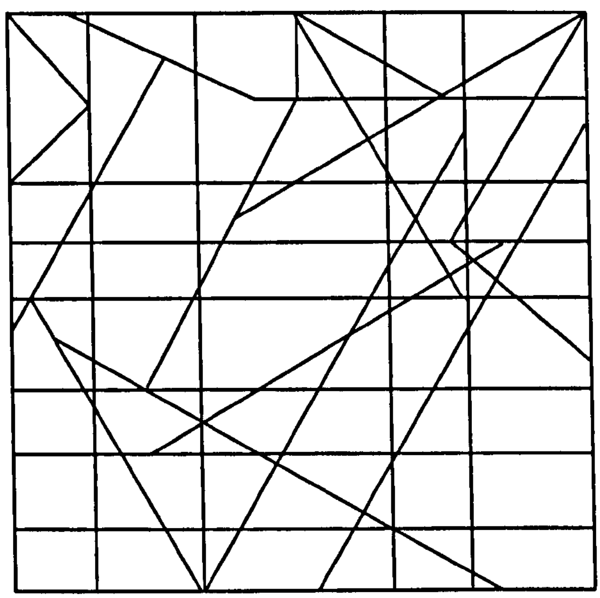
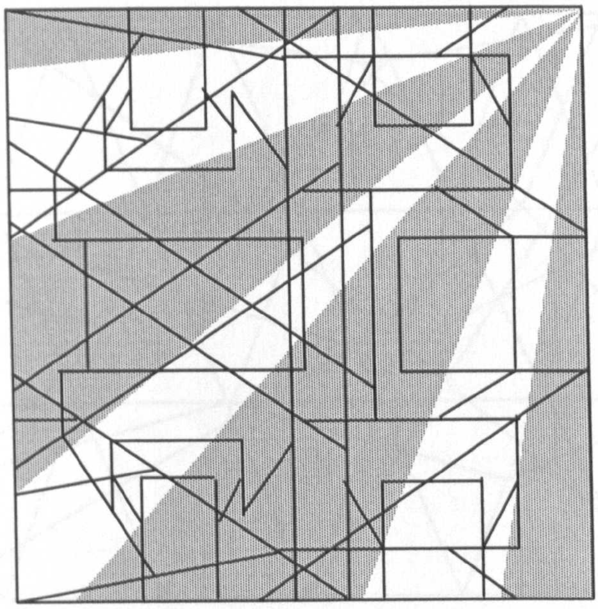
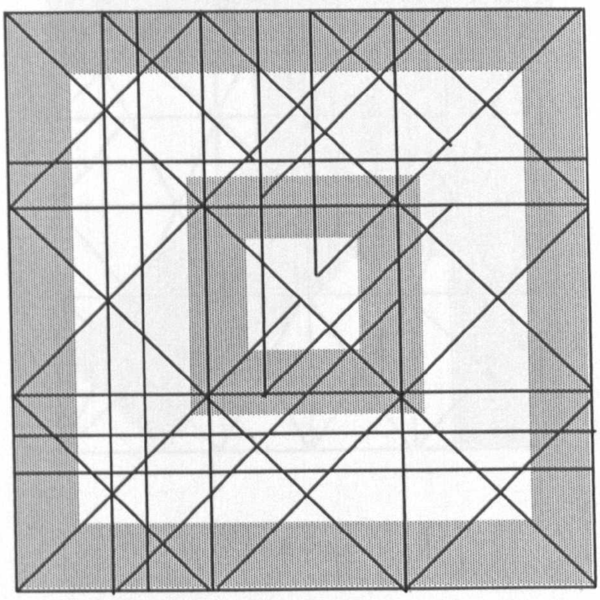


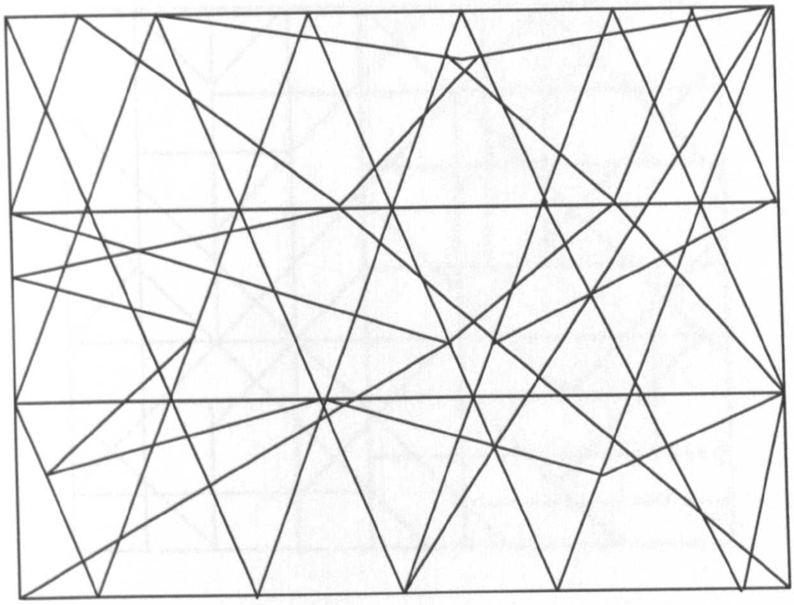
Find shape C



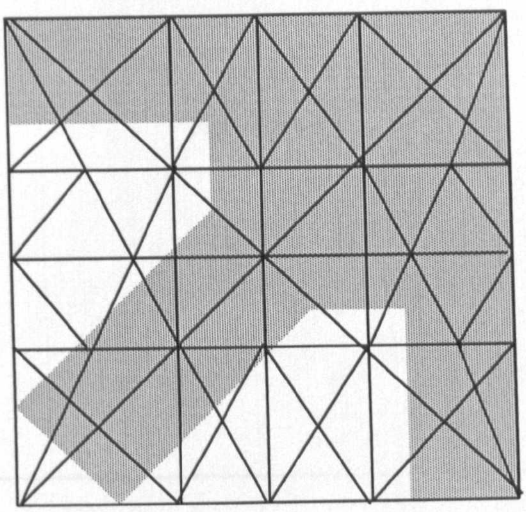
Find shape B



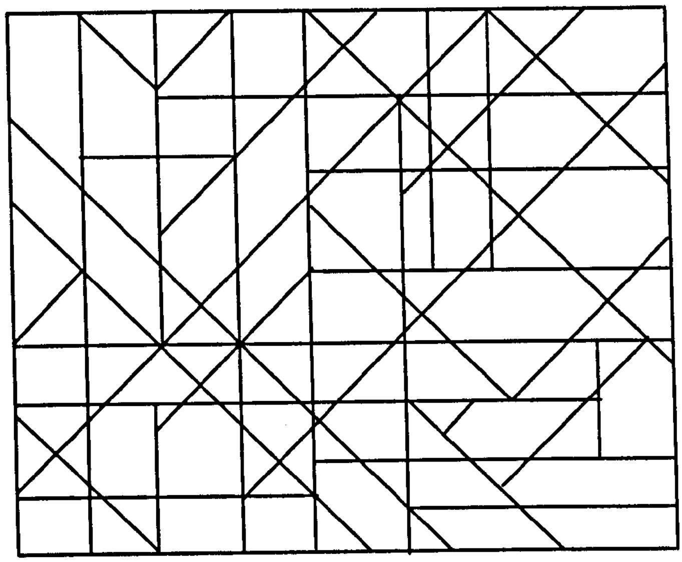
Find shape D



Find shape A

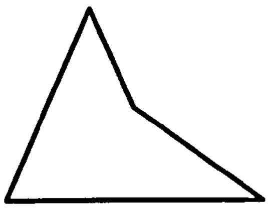


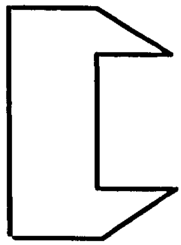
Find shape E

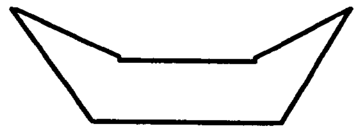


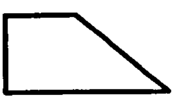
Find shape F

The shapes you have to find


A


B


C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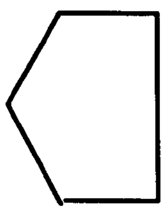
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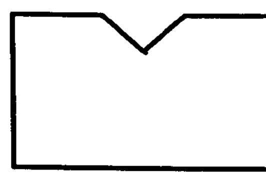
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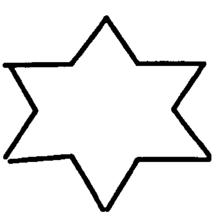
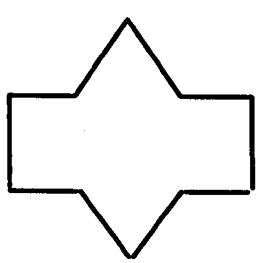
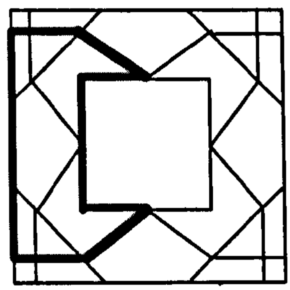
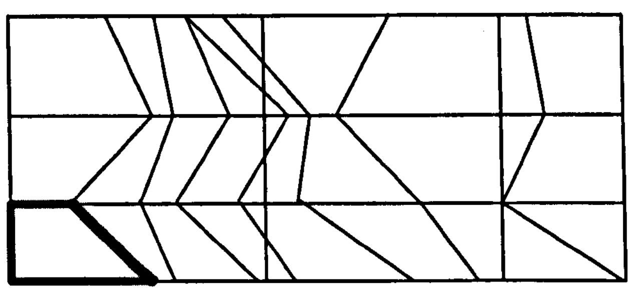

G


H

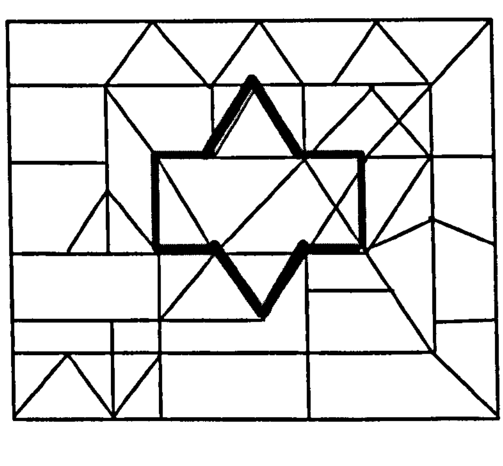
ANSWERS TO SHAPES



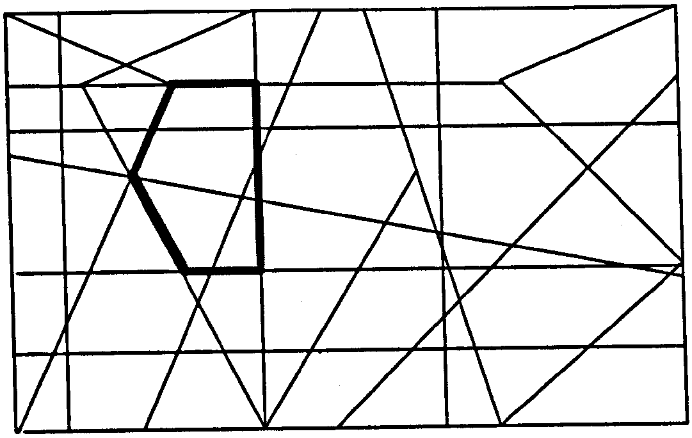
Find SHAPE B



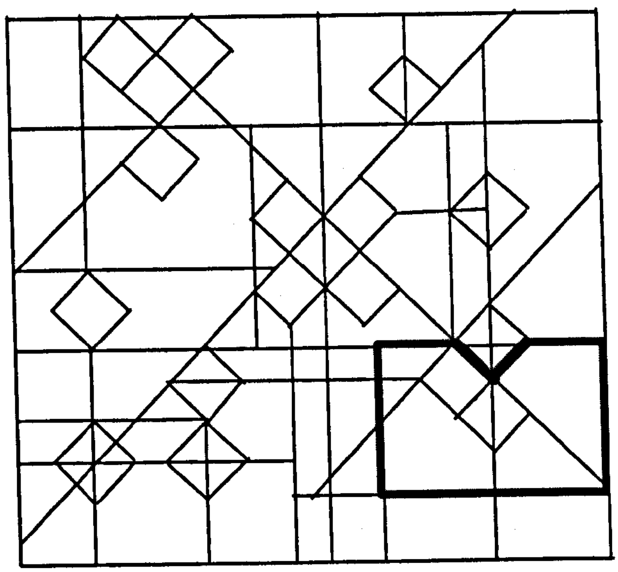
Find SHAPE D



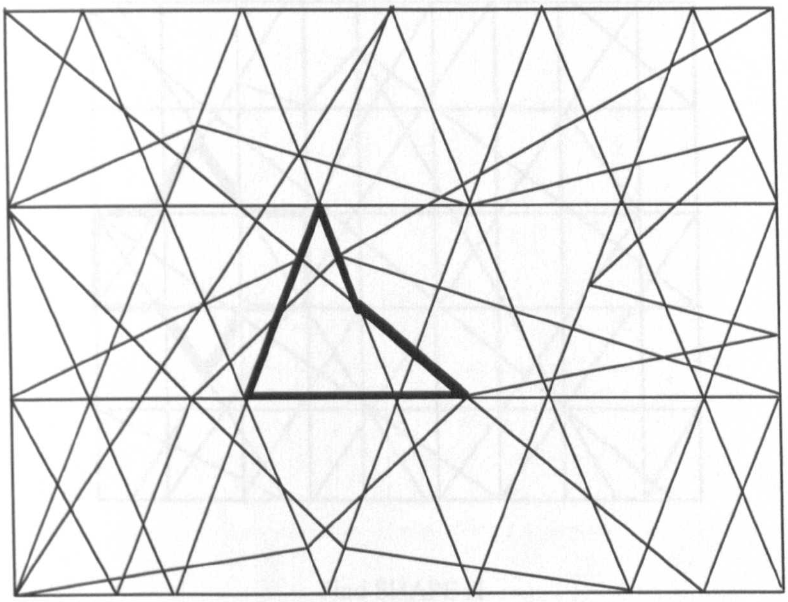
Find SHAPE H



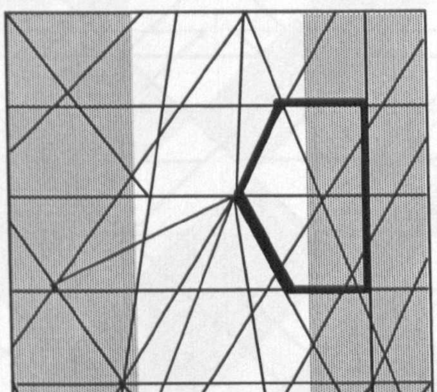
Find SHAPE E



Find SHAPE F



Find SHAPE A



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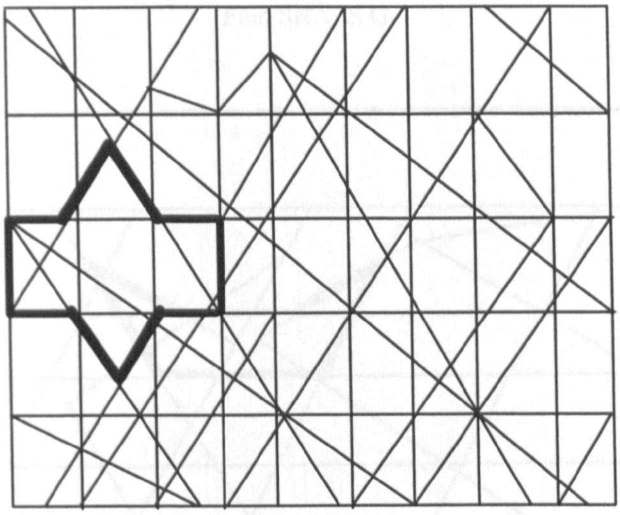

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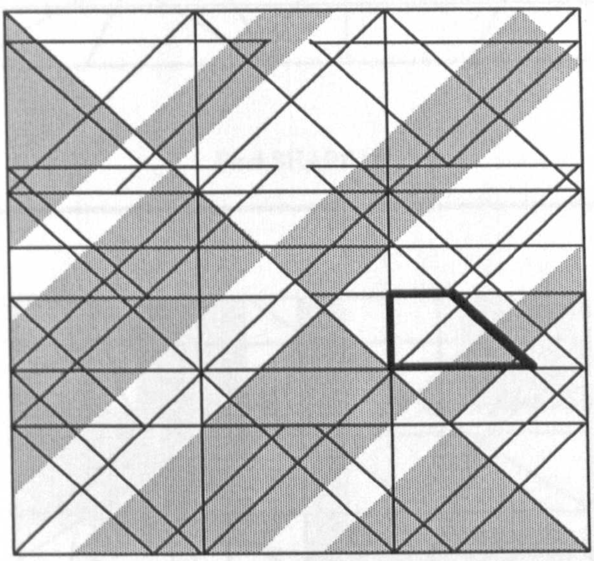

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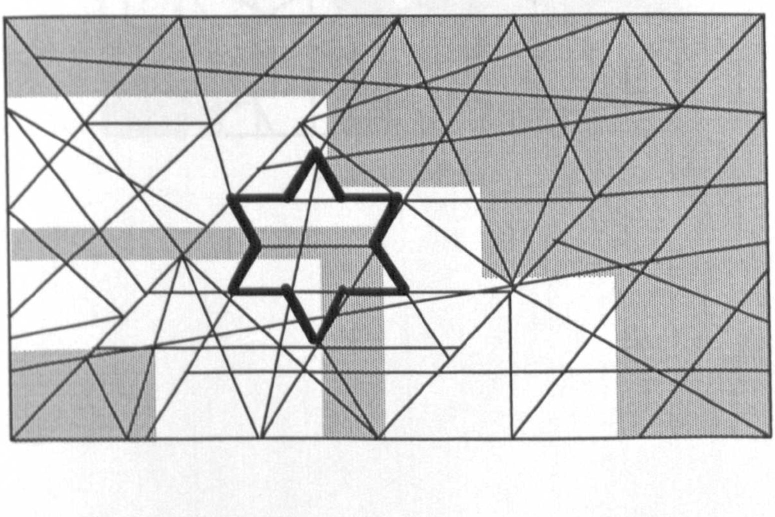
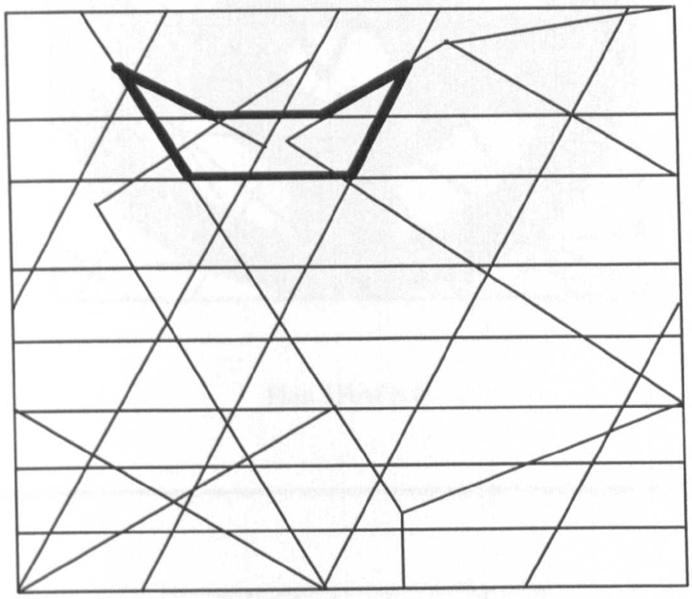
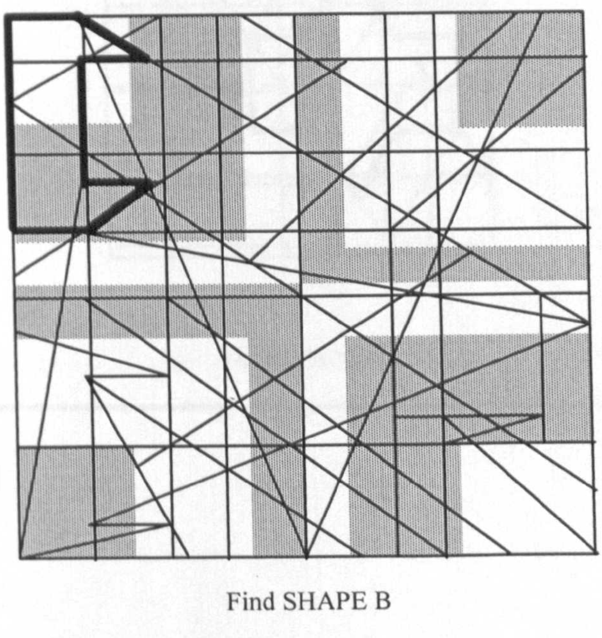


Find SHAPE G



Find SHAPE C



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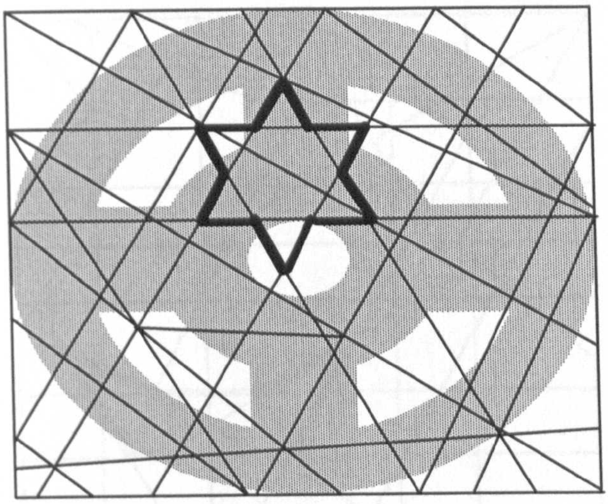
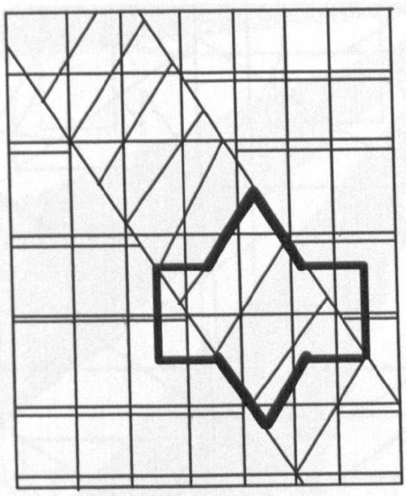


Find SHAPE G



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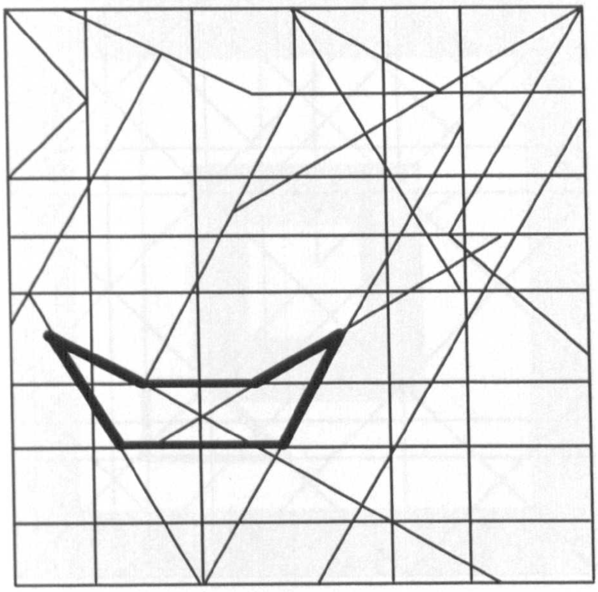
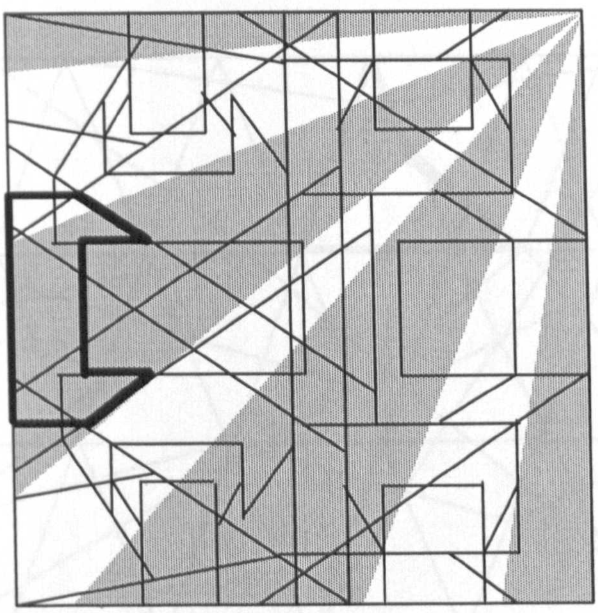


Find SHAPE C



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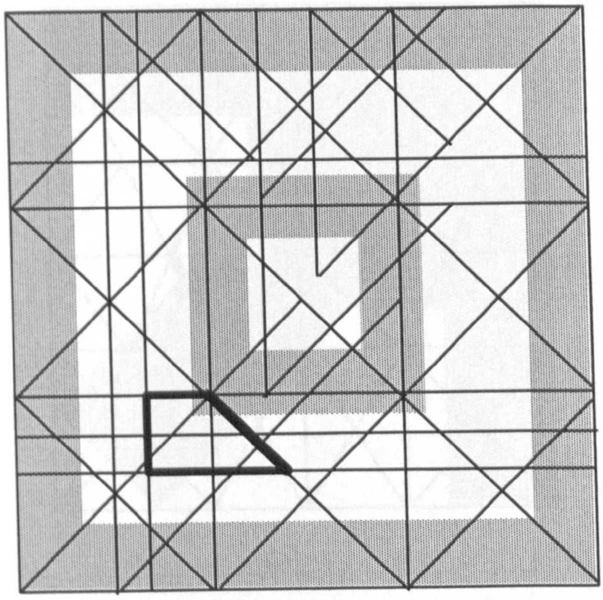
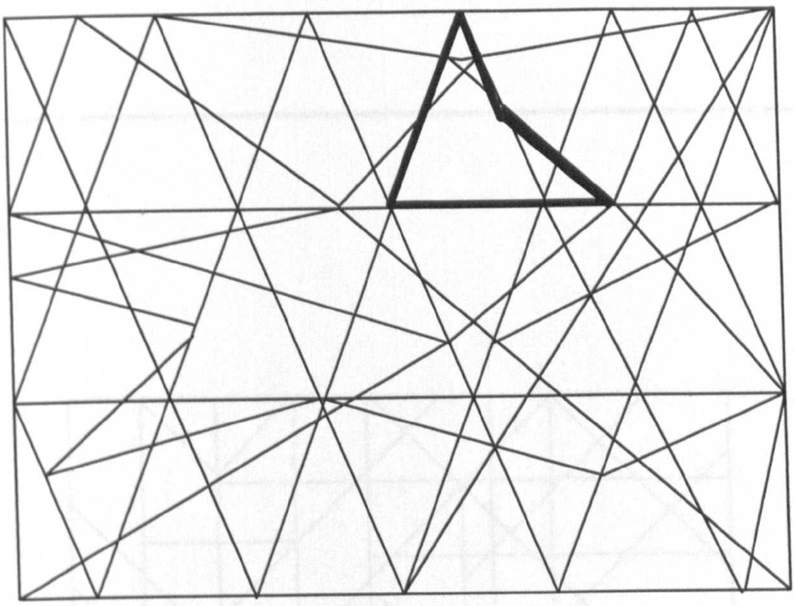
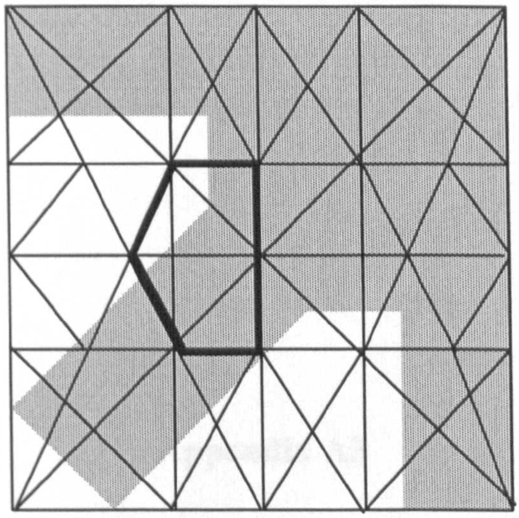


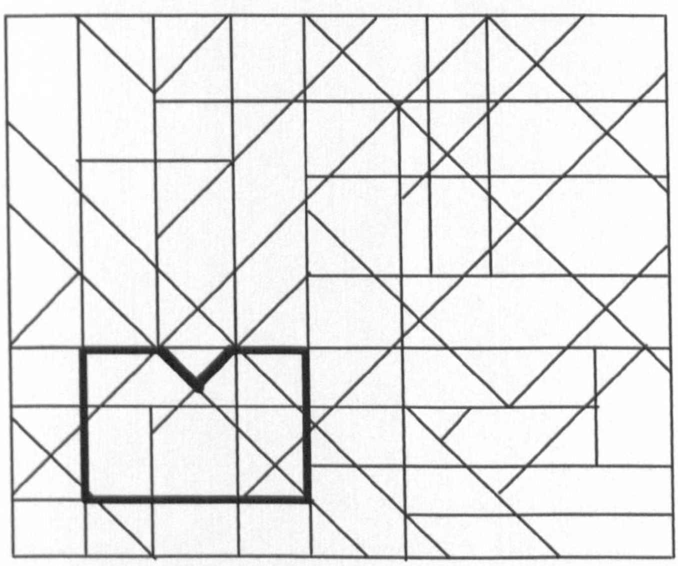
Find SHAPE D



Find SHAPE A



Find SHAPE E



Find SHAPE F

# Appendix A3

The Convergence Tests

Notes

The English Version of the Convergent and Divergent Test

# The Convergent and Divergent Test

These tests aim to measure your ways of thinking.
The results will NOT affect your academic work or exams in any way.

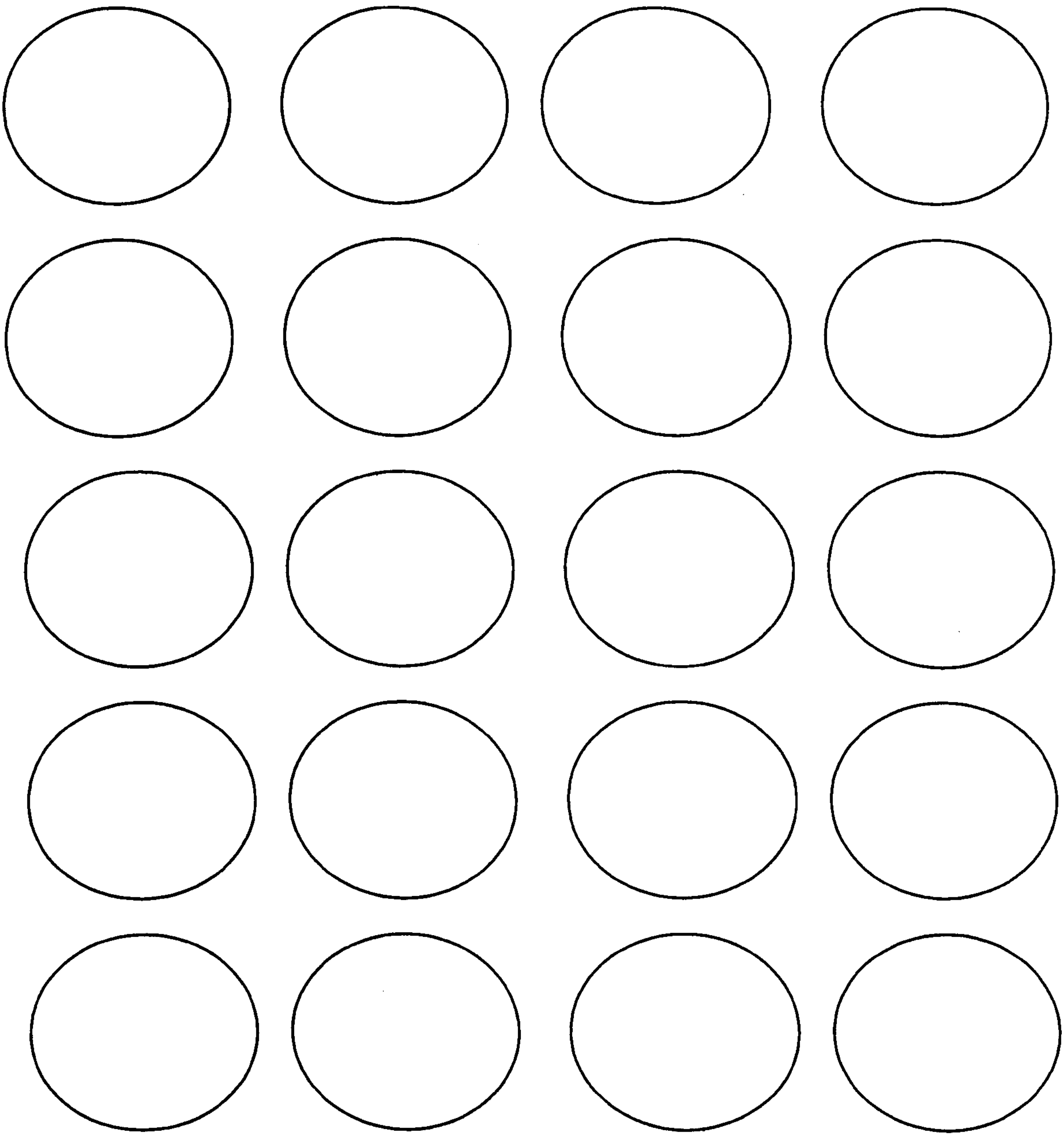
Name: ..............................................................................................................

School: ............................................................................................................

Class: ..............................................................................................................

Test 1

1. Use the each circles to draw as many pictures as much as you can.
2. Try to draw different pictures in each circle.
3. Use the circle as part from the picture, drawing inside or outside the circle.



4 Minutes

Test 2

In this test you will be asked to write as many sentences as you can. Each sentence should contain the four words mentioned and any other words you choose:

For example:

TAKE FEW LAND LITTLE

1. Few crops take little land.
2. A few little boats supplies to land.
3. Could you take a few little people with you to see my green land?

All the four words are used in each sentence. The words must be used in the form that is given; for example, you cannot use 'taking' instead of 'take'. Notice that the sentences may be of any length. All sentences must differ from one another by more than merely one or two changed words, such as different pronouns or adjectives.

Now try the following words. Remember to number each new sentence as was done in the example above.

1. WRITE WORDS pin OFTEN

..........................................................................................................................

..........................................................................................................................

..........................................................................................................................

..........................................................................................................................

2. FRIEND MAN YEAR CATCH

..........................................................................................................................

..........................................................................................................................

..........................................................................................................................

..........................................................................................................................

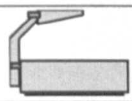
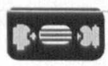
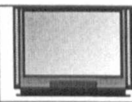
4 Minutes

Test 3

This is a test of your ability to think up a number of different symbols that could be used to stand for certain words or ideas.

For example:

The word is 'electronics'. This word could be represented by many symbols or drawings as shown below. As you know there are many other symbols that could represent the word 'electronics'?

| | | | | |
|---|---|---|---|---|
|  |  |  |  |  |

Now draw as many symbols as you can think of (up to five) for each word or subject below.

Each drawing can be a complicated or as simple as you choose. (No artistry required)

1. Energy

| | | | | |
|---|---|---|---|---|
| | | | | |

2. Happiness

| | | | | |
|---|---|---|---|---|
| | | | | |

3. Transport

| | | | | |
|---|---|---|---|---|
| | | | | |

4. Happeness

| | | | | |
|---|---|---|---|---|
| | | | | |

5 Minutes

Test 4

This is a test to see how many things you can think of that alike in some way.

For example:

What things are always red or that are red more than any other colour? You may use one word or several words to describe each thing.

tomatoes bricks blood

Go ahead and write all the things that are *'round'* or that are round more often than any other shape.

................ ................ ................ ................

................ ................ ................ ................

................ ................ ................ ................

Write all the things that are '*yellow*' or that are yellow more often than any other colour

................ ................ ................ ................

................ ................ ................ ................

................ ................ ................ ................

2 Minutes

Test 5

This is a test of your ability to think rapidly of as many words as you can that begin with one letter and end with another.

For example:

The words in the following list all begin with 'S' and end with 'T'.
in Arabic the Answer is
Car- ship - ……

Now try thinking of words beginning with 'F' and ending with 'R'. Write them on the lines below. Names of people or places are not allowed.

| | | | |
|---|---|---|---|
| ……………… | ……………… | ……………… | ……………… |
| ……………… | ……………… | ……………… | ……………… |
| ……………… | ……………… | ……………… | ……………… |

Now try thinking of words beginning with 'M' and ending with 'H'. Write them on the lines below. Names of people or places are not allowed.

| | | | |
|---|---|---|---|
| ……………… | ……………… | ……………… | ……………… |
| ……………… | ……………… | ……………… | ……………… |
| ……………… | ……………… | ……………… | ……………… |

2 Minutes

TEST 6

This is a test to see how many ideas you can think of about a topic. Be sure to list all the ideas you can think about a topic whether or not they seem important to you. You are not limited to one word. Instead you may use a word or a phrase to express each idea.

For example:

'*Car journey*'. Examples are given below of ideas about a topic like this.

Number of miles suitcases the stations people in the high ways

Now list all the ideas you can think about 'working in sea'.

| | | | |
|---|---|---|---|
| ................. | ................. | ................. | ................. |
| ................. | ................. | ................. | ................. |
| ................. | ................. | ................. | ................. |

3 Minutes

# Appendix A 4

## What is your Learning style?

Name:………………………………………………………………………………..
Classroom ……………………………………………………………………………
School ………………………………………………………………………………..

---

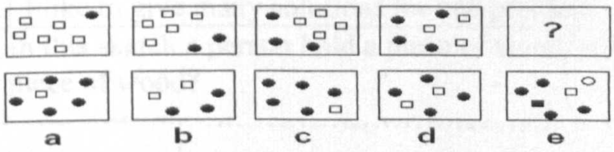
This questionnaire seeks to find out how you prefer to learn
Your answers will not affect your school marks in any way
No one will see the information you provide except the researcher
Answer each statement in the following manner:

| SA – Strongly Agree | A – Agree | N – Neutral | D – Disagree | SD – Strongly |
|---|---|---|---|---|

*Put a mark (✓) in the suitable square.*

| | | SA | A | N | D | SD |
|---|---|---|---|---|---|---|
| 1 | In school I prefer subjects like art, technical drawing, and geometry. | | | | | |
| 2 | I like using a camera or video camera to capture the world around me. | | | | | |
| 3 | I navigate well and use maps with ease. Rarely I get lost. | | | | | |
| 4 | I have a good sense of direction. I usually know which way North is. | | | | | |
| 5 | I can easily visualise objects, buildings, situations etc from plans or descriptions. | | | | | |
| 6 | I find myself drawing or doodling on a notepad when thinking. | | | | | |
| 7 | I use diagrams and scribbles to communicate ideas and concepts. | | | | | |
| 8 | I love using colour pen when I am studying. | | | | | |
| 9 | I like pulling things apart, and I usually put things back together. | | | | | |
| 10 | I like visual arts, painting, and sculpture. | | | | | |
| 11 | I like jigsaws and mazes. | | | | | |
| 12 | I have a good sense of colour. | | | | | |

13. Find a possible answer for the last box (from a-b-c-d-e).




Your Answer ……………………………………………………………………………

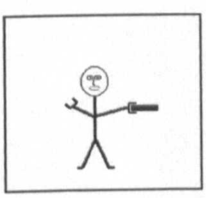
| | Items | SA | A | N | D | SD |
|---|---|---|---|---|---|---|
| 1 | I have no problem concentrating amid noise and confusion. | | | | | |
| 2 | I enjoy analysing grammar structures. | | | | | |
| 3 | I feel I must understand every word of what I read or hear. | | | | | |
| 4 | I think that every word said in class has a value in the learning process | | | | | |
| 5 | I prefer working alone to working with other people. | | | | | |
| 6 | Receiving feedback from other people really doesnt affect my learning at all. | | | | | |
| 7 | I need a quiet environment in order to concentrate well. | | | | | |
| 8 | I find grammar analysis tedious and boring. | | | | | |
| 9 | I dont mind reading or listening without understanding every single word as long as I "catch" the main idea. | | | | | |
| 10 | I think communication is the key to effective language learning. | | | | | |
| 11 | I really enjoy working with other people in pairs or groups. | | | | | |
| 12 | I find feedback useful as a means of understanding my problem areas. | | | | | |

13. If you are a taxi driver, going to airport with Norman and Rex, from the airport going to a hotel with Mark and his wife Margaret and his daughter Emma., what is the taxi driver's name?..........................................................................................................

..........................................................................................................

| | Items | SA | A | N | D | SD |
|---|---|---|---|---|---|---|
| 1 | I am good at the practical application of ideas. | | | | | |
| 2 | I am specialise in physical science and classics. | | | | | |
| 3 | I prefer formal materials. | | | | | |
| 4 | I prefer a logical argument. | | | | | |
| 5 | I have ability to focus on hypothetical-deductive reasoning on specific problems. | | | | | |
| 6 | I am better in abstract experimentation. | | | | | |
| 7 | I hold conventional attitudes. | | | | | |
| 8 | I like unambiguity. | | | | | |
| 9 | I am good at generating ideas and seeing things from different perspectives. | | | | | |
| 10 | I experiment in the arts. | | | | | |
| 11 | I am better with concrete experience. | | | | | |
| 12 | I hold unconventional attitudes. | | | | | |
| 13 | I am strong in imaginative ability. | | | | | |
| 14 | I like to give many solutions for one problem. | | | | | |

15. In this sketch a person hold a piece of wood, what do you think will happen if he let go of the piece of wood?



..........................................................................................................
..........................................................................................................
..........................................................................................

# APPENDIX A 5

ARABIC EDITION

1. Arabic Cover Page Working Memory Test
2. Arabic Cover Field Dependent/Independent
3. Arabic Cover Page Divergent Test
4. Arabic Edition Visual-Spatial Test (SEE DVD)
5. Arabic Edition Questioner 1

# تحديد نقاط التقاطع بين الأشكال

عزيزي: الطالب / الطالبة

النموذج الذي بين يديك عبارة عن أداة للبحث العلمي، من المهم أن تعرف أنه ليس له تأثير على درجاتك ، وانه لن يطلع عليها أحد سوى الباحث . لذا أرجو تعاونك في الإجابة على هذا النموذج وفقا للتعليمات التالية:

أبدأ الإجابة عندما يخبرك الباحث بذلك .

حاول قدر الإمكان الاستفادة من الوقت المسموح لك به.

انتقل إلى بند أخر عندما تواجهك صعوبة في أي من البنود.

ضع القلم عندما يطلب منك ذلك، فليس مطلوب منك الإجابة على جميع البنود.

تذكر إن الوقت المسموح به للإجابة هو 20 دقيقة.

المدرسة:..............................................................................

الصف :...............................................................................

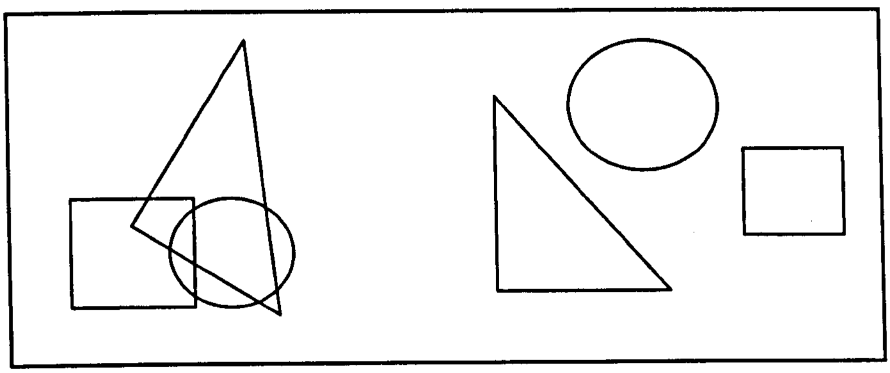
الرقم :...............................................................................

أقلب الصفحة الآن وانتبه مع الباحث لمعرفة كيفية الإجابة

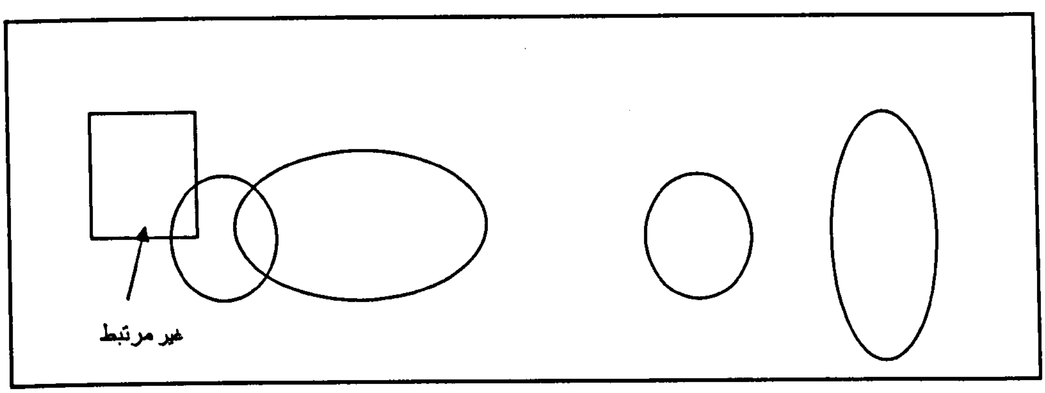
اكتشف منطقة التقاطع بين الأشكال وقم بتظليلها بالقلم.

انتبه للنقاط التالية :

قد يختلف الشكل الذي على الجهة اليسرى عن الشكل الذي في الجهة اليمنى من حيث الحجم أو الوضع.



بعض نماذج الجهة اليسرى تحتوي على أشكال إضافية غير ظاهره بالجهة اليمنى ولا تتداخل مع باقي الأشكال ، تنبه لذلك حتى لا يكون لها تأثير في إجابتك .




هل أنت مستعد للاجابة ☺ اقلب الصفحة عندما يطلب منك ذلك .

# تمييز شكل محدد من بين مجموعة أشكال

عزيزي: الطالب / الطالبة

النموذج الذي بين يديك عبارة عن أداة للبحث العلمي، من المهم أن تعرف أنه ليس له تأثير على درجاتك ، وانه لن يطلع عليه أحد سوى الباحث . لذا أرجو تعاونك في الإجابة على هذا النموذج وفقا للتعليمات التالية:

أبدأ الإجابة عندما يخبرك الباحث بذلك .

حاول قدر الإمكان الاستفادة من الوقت المسموح لك به.

انتقل إلى بند أخر عندما تواجهك صعوبة في أي من البنود.

ضع القلم عندما يطلب منك ذلك، فليس مطلوب منك الإجابة على جميع البنود.

تذكر أن الوقت المسموح به للإجابة محدود .

المدرسة:..............................................................................

الصف :..................................................................................

الرقم :...................................................................................

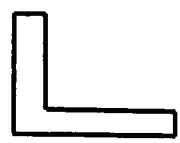
اقلب الصفحة الآن وانتبه مع الباحث لمعرفة كيفية الإجابة

اكتشف بعض الأشكال المخفية من بين مجموعة متداخلة من الخطوط.

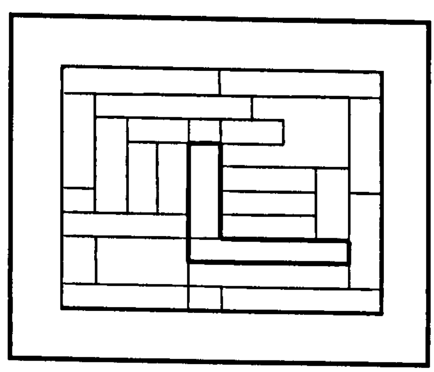
انتبه لشرح الباحث للمثالين التاليين من اجل التعرف على كيفية الإجابة.

المثال الأول :

هذا النموذج لشكل يمكن تسميته (هـ )



الشكل (هـ) مخفي داخل مجموعة من الأشكال المتداخلة.



حاول تحديد الشكل (هـ) بالقلم، لاحظ انه لابد أن يكون :

بنفس الحجم

بنفس الوضع

بنفس الاتجاه

يوجد شكل واحد في كل نموذج

هل أنت مستعد للإجابة ☺ اقلب الصفحة عندما يطلب منك ذلك .

## أسلوب التفكير التقاربي والتباعدي

عزيزي: الطالب / الطالبة

النموذج الذي بين يديك عبارة عن أداة للبحث العلمي، من المهم أن تعرف أنه ليس له تأثير على درجاتك ، وانه لن يطلع عليه أحد سوى الباحث . لذا أرجو تعاونك في الإجابة على هذا النموذج وفقا للتعليمات التالية:

أبدأ الإجابة عندما يخبرك الباحث بذلك .

حاول قدر الإمكان الاستفادة من الوقت المسموح لك به.

انتقل إلى بند أخر عندما تواجهك صعوبة في أي من البنود.

التزم بالوقت المحدد لكل نموذج وضع القلم عندما يطلب منك ذلك .

تذكر أن الوقت المسموح به للإجابة 20 دقيقه .

المدرسة:..........................................................................

الصف :..............................................................................

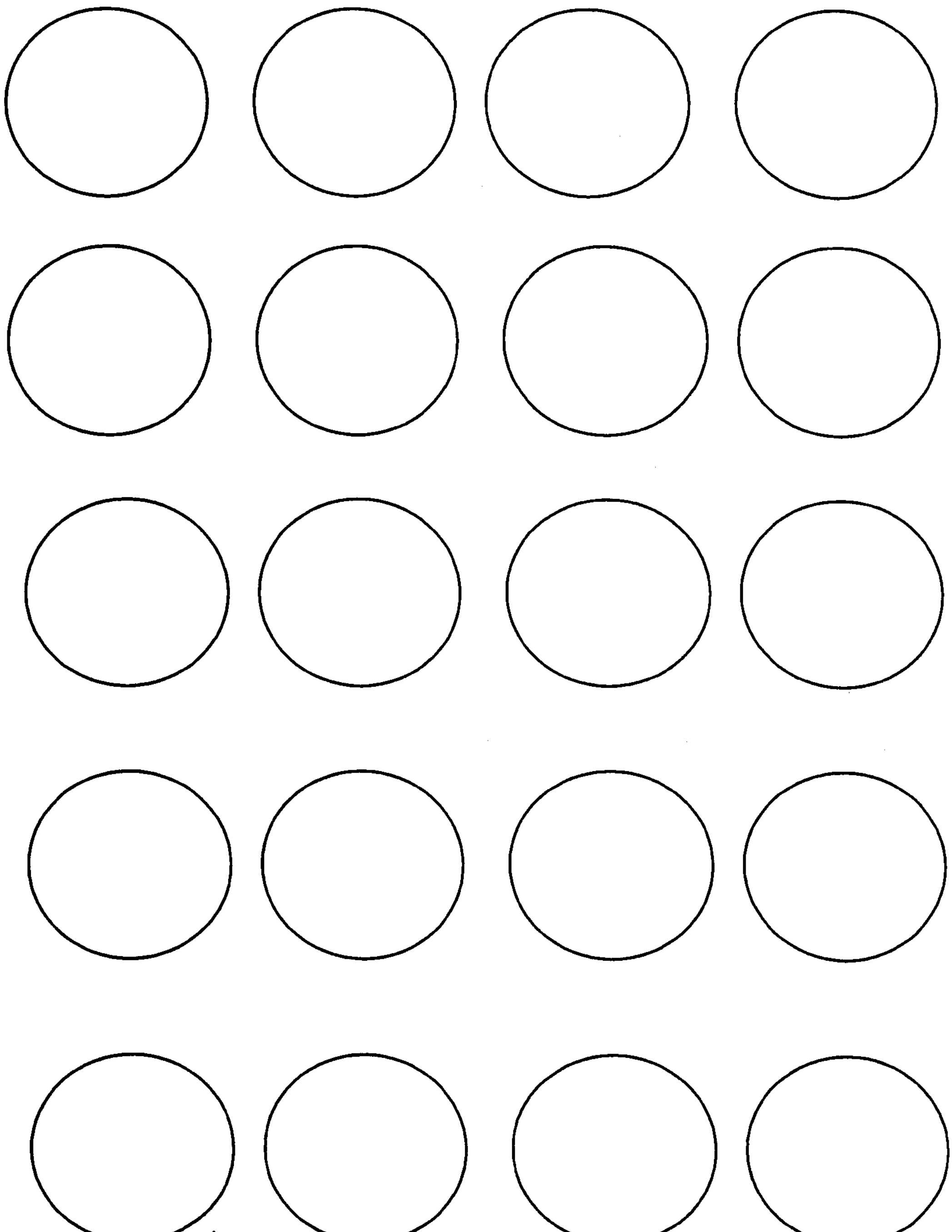
الرقم :.............................................................................

اقلب الصفحة الآن وانتبه مع الباحث لمعرفة كيفية الإجابة

## Appendix A5: Divergency Test

النموذج الأول

مطلوب من أن تستخدم الدوائر في هذا النموذج لرسم اكبر عدد ممكن من الأشكال ، ويمكن وضع تفاصيل الرسم داخل أو خارج الدائرة بحيث يعطي صوره متكاملة للفكرة المرسومة .



الوقت 4 دقائق

أقلب الصفحة

النموذج الثاني

مطلوب منك أن تكتب اكبر عدد ممكن من الجمل ، كل جملة تتكون من أربع كلمات أساسية سوف تعطى لك، وعليك أن تصيغها صياغة صحيحة مع إضافة إي عدد من الكلمات التي تختارها .

مثال : أخذ ، قليل ، مساحة ، بعض

الاجابة :

تأخذ بعض البضائع مساحة قليلة عند تخزينها .

بعض المساكن المتعددة الأدوار تأخذ مساحة قليلة تساعد بتوفير الأراضي السكنية .

قليلا ما يسمح لبعض السفن ذات المساحة الصغيرة بدخول الميناء .

---

اكمل الأن البنود التالية:

غالبا ، كتب ، كلمات ، قلم

-----------------------------------------------------

-----------------------------------------------------

-----------------------------------------------------

-----------------------------------------------------

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صديق ، سنة ، الإنسان ، حصل

-----------------------------------------------------

-----------------------------------------------------

-----------------------------------------------------

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الوقت 3 دقائق　　　　　　　　اقلب الصفحة

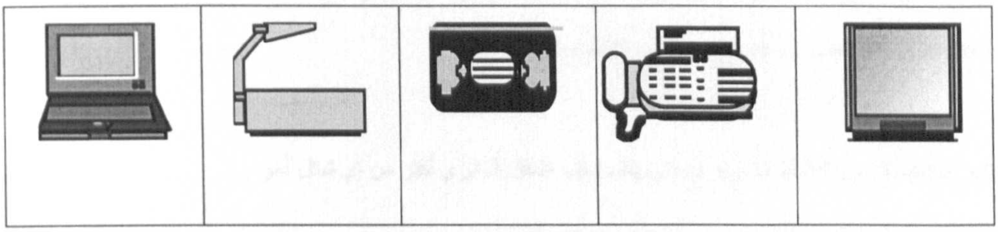
النموذج الثالث

## Appendix A5: Divergency Test

هذا النموذج عبارة عن بعض الكلمات المطلوب منك أن تعبر بالرسم عن ما يمكن أن يرتبط بها .

ليس المطلوب  أن يكون الرسم دقيقا و إنما يعبر عن الفكرة .

مثال :أجهزة



---

أكمل البنود التالية:

طاقة

| | | | | |
|---|---|---|---|---|
| | | | | |

أحداث

| | | | | |
|---|---|---|---|---|
| | | | | |

مواصلات

| | | | | |
|---|---|---|---|---|
| | | | | |

السعادة

| | | | | |
|---|---|---|---|---|
| | | | | |

الوقت 6 دقائق　　　　　　　　　　اقلب الصفحة

النموذج الرابع:

مطلوب منك أن تكتب اكبر عدد ممكن من الكلمات التي تربطها علاقة واحدة والتي تتضح من خلال ما يطلب في كل بند .

مثال :

ما هو الشيء الذي دائما يكون احمرا ، أو يغلب عليه اللون الأحمر اكثر من اي لون آخر .

الإجابة : الطماطم ، الكتشب ، الدم ، سيارة الإطفاء ، .......

البنود

1- اذكر اكبر عدد ممكن من الأشياء الدائرية أو التي يغلب عليا الشكل الدائري أكثر من إي شكل آخر .

------------ ------------ ---------- --------- ---------

------------ ------------ ---------- --------- ---------

------------ ------------ ---------- --------- ---------

2- اذكر اكبر عدد ممكن من الأشياء التي يكون لونها اصفر او يغلب عليها اللون الأصفر اكثر من اي لون آخر .

------------ ------------ ---------- --------- ---------

------------ ------------ ---------- --------- ---------

------------ ------------ ---------- --------- ---------

الوقت : 2 دقيقة

اقلب الصفحة

النموذج الخامس

مطلوب منك أن تذكر اكبر عدد ممكن من الكلمات تبدأ بحرف محدد وتنتهي بآخر محدد .

مثال :

اذكر الكلمات التي تبدأ بحرف السين وتنتهي بتاء مربوطة .

الإجابة : سفينة ، سيارة ، سجادة ، سحابة ، سرية .......

---

البنود

1- اذكر اكبر عدد من الكلمات التي تبدأ بحرف ( الفاء ) وتنتهي بحرف ( الراء ).

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---------- ---------- ----------- ------------ -------------

---------- ---------- ----------- ------------ -------------

2- اذكر اكبر عدد من الكلمات التي تبدأ بحرف ( الميم ) وتنتهي بحرف (الحاء )

---------- ---------- ----------- ------------ -------------

---------- ---------- ----------- ------------ -------------

---------- ---------- ----------- ------------ -------------

الوقت 2 دقيقه

اقلب الصفحة

النموذج السادس

مطلوب منك أن تذكر أكبر عدد ممكن من الأفكار المتعلقة بموضوع سوف يحدد لك .

مثال :

السفر براً .

الأفكار : محطات وقود ، حدود ، نقاط تفتيش ، جوازات ، استراحات ومطاعم ، أغنام وإبل ترعى ، سراب ، مناطق سكنيه ، طرق فرعية ورئيسية .

---

البنود :

1. العمل في المجال البحري

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الوقت 3 دقائق

شكرا لتعاونك معنا

## ما هو أسلوبك في التعلم ؟؟!

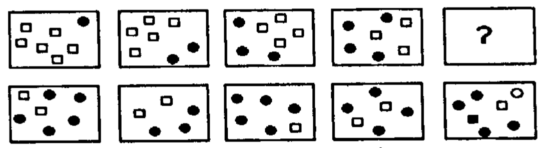
اسم الطالب :-------------------------------------------------------------------------------

المدرسة:-------------------------------------- ------------------------------- الصف

لكل إنسان إسلوبه في التعلم ومن خلال هذه الاستماره نود أن نتعرف على أسلوبك وذلك من خلال إجابتك على العبارات التالية بتحديد مدى انطباقها عليك بأن تضع علامة عند مستوى انطباقها عليك مع العلم انه لا يوجد إجابة صحيحة وأخرى خطأ.

| | العبارات | لا تنطبق تماما | لا تنطبق | تنطبق الى حد ما | تنطبق على | تنطبق تماما |
|---|---|---|---|---|---|---|
| 1 | من المواد الدراسيه التي أحبها ما يرتبط بالفن والديكور والهندسه. | | | | | |
| 2 | أحبُ إستعمال آلةالتصوير أو آلة التصويربالفيديو للاحتفاظ بالصور لمختلف الأشياء التي تحيط بي . | | | | | |
| 3 | نادرا ما أضل الطريق فأنا احسن استعمال الخرائط وأتخيل الطرق بمجرد الوصف . | | | | | |
| 4 | عندي القدره على تحديد الإتجاهات بسهوله حيث يمكنني تحديد الشمال من الجنوب وغيره في أي مكان أتواجد فيه . | | | | | |
| 5 | يمكنني تصور الأفكار و الأجسام بسهوله من خلال الوصف كالمباني والمدن. | | | | | |
| 6 | أجيد الرسم ، وأجدني أرسم عندما أنهمك في التفكير . | | | | | |
| 7 | عند المذاكره أرتب الأفكار بمخططات مختلفه لتكوين صوره سهلة لتذكر المعلومه لاحقا. | | | | | |
| 8 | أحب استخدام الاقلام الملونه عند المذاكره لتحديد أهم الافكار . | | | | | |
| 9 | يسهل علي فك وتركيب الأجهزة مرة أخرى. | | | | | |
| 10 | أحبُ مختلف الفنون كالرسم والنحت والزخرفه . | | | | | |
| 11 | أستمتع بحل الألغاز وتركيب الصور المقطعة والمتاهات. | | | | | |
| 12 | لدي إحساسُ جيدُ بالألوان وتناسقها. | | | | | |

1- حاول ان تجد الاجابة الصحيحة من بين الاختيارات الخمسة (A-B-C-D-E) مكان المربع الذي يحتوي على علامة الاستفهام



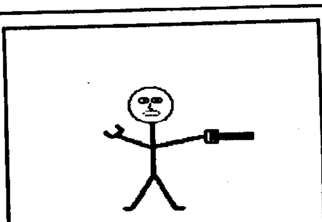

a b c d e

| | العبارات | لا تنطبق تماما | لا تنطبق | تنطبق الى حد | تنطبق على | تنطبق تماما |
|---|---|---|---|---|---|---|
| 1 | لا أجد أي صعوبه في التركيز مع وجود ضوضاء من حولي. | | | | | |
| 2 | استمتع بالمواد التي تحتوي على قواعد محدده كمادة النحو والمعادلات الرياضيه. | | | | | |
| 3 | اشعر بأنه يجب ان افهم كل كلمة أقرأها او أسمعها. | | | | | |
| 4 | أعتقد أن كل حرف يقال في الفصل له قيمه في عملية التعلم. | | | | | |
| 5 | أفضل العمل بمفردي على العمل مع الأخرين. | | | | | |
| 6 | لا يؤثر على تعليمي ما يقوم الأخرين بإعطائي من معلومات وملاحظات. | | | | | |
| 7 | أحتاج الى العمل في مكان هادئ لأتمكن من التركيز | | | | | |
| 8 | لا أفضل المواد التي تعتمد على القواعد والتحليل فهو عمل ممل. | | | | | |
| 9 | لأهتم عند القراءة او الأستماع لأي موضوع الى متابعة كل كلمه طالما التقطت الفكرة الرئيسة. | | | | | |
| 10 | أعتقد أن التواصل مع الأخرين وأخذ ملاحظاتهم وتوجيهاتهم هو أساس عملية التعلم. | | | | | |
| 11 | أستمتع بالعمل مع الأخرين كفريق ثنائي أو مجموعات. | | | | | |
| 12 | أحرص على أن أتلقى الملاحظات من الأخرين لمعرفة نقاط الضعف لدي. | | | | | |

2- إذا كنت سائق تاكسي، وتوجهت الى المطار ومعك أحمد وعلي و موسى، ثم ركبت عائلة تود الذهاب إلى الفندق مكونة من الأب سعيد والأم نوره والأبن اسمه خالد فما إسم سائق التاكسي الذي قام بتوصيلهم جميعا حيث يريدون.

| | العبارة | لا تنطبق تماما | لا تنطبق | تنطبق الى حد | تنطبق على | تنطبق تماما |
|---|---|---|---|---|---|---|
| 1 | أميل الى المواد الدراسية التي تحتوي على معلومات علميه وأدبيه اكثر من تلك التي تحتوي مهارات . | | | | | |
| 2 | أفضل أن أدرس الكتب المدرسية فقط دون محاولة البحث عن المعلومة من مصادر أخرى . | | | | | |
| 3 | أفضل النقاش المنطقي الذي تكون نهايته معقوله وواضحه. | | | | | |
| 4 | لدي القدره على التركيز على القضايا التي تعتمد على الافتراضات والاستنتاجات. | | | | | |
| 5 | أعتقد بأنني جيد في إستيعاب المفاهيم المجرده الغير محسوسه. | | | | | |
| 6 | أشعر بأنني لا أختلف عن وجهة نظر غالبية وجهات نظر الزملاء والاصدقاء. | | | | | |
| 7 | أحب الأشياء الواضحة الغير غامضة. | | | | | |
| 8 | أختلف عن الأخرين بطرح أفكارقد لا يراها غيري من جوانب عدة. | | | | | |
| 9 | أميل إلى المواد التي تحتوي على جوانب فنية مختلفة. | | | | | |
| 10 | أشعر بأنني أفضل في الخبرات التي تكون لها نتيجة ملموسه. | | | | | |
| 11 | أميل الى التوسع في بعض المعلومات حتى لوإضطررت الى الرجوع الى كتب مختلفة. | | | | | |
| 12 | أختلف عن الزملاء في وجهات النظر تجاه نفس الموضوع. | | | | | |
| 13 | أفضل أن أطرح أفكار متعدده لشيئ واحد في نفس الوقت . | | | | | |
| 14 | لا أمانع في التفكير ببعض الأمور الغامضه حتى أتوصل لحلها أو فهمها . | | | | | |

3- في الصورة التي أمامك مخطط لشخص يحمل قطعة من الخشب ، ماذا تتوقع أن يحدث لو فتح قبضة يده عن هذه القطعه الخشبية.



# Appendix A 6

Visual–Spatial Answer Sheet

1. Answer sheet in English
2. Answer sheet in Arabic

## Visual-Spatial test Answer Sheet

Follow the question in the computer screen then write down your answer in this sheet.

| N | ITEMS | ANSWER |
|---|---|---|
| 1 | Which one is a different shape | |
| 2 | Which one is a different shape | |
| 3 | Which one is a different shape | |
| 4 | Which one is a different shape | |
| 5 | How many objects? | |
| 6 | How many objects? | |
| 7 | How many objects? | |
| 8 | How many objects? | |
| 9 | Which figure is the correct answer | |
| 10 | Which figure is the correct answer | |
| 11 | Match each lettered piece to each numbered position<br>1<br>2<br>3<br>4<br>5<br>6<br>7 | |
| 12 | Match each lettered piece to each numbered position<br>1<br>2<br>3<br>4<br>5<br>6<br>7 | |
| 13 | Find the place each lettered piece can replace each numbered position<br>1<br>2<br>3<br>4<br>5 | |
| 14 | Find the place each lettered piece can replace each numbered position<br>1<br>2<br>3<br>4<br>5 | |
| 15 | What will the square look like when the paper in unfolded? | |
| 16 | What will the square look like when the paper in unfolded? | |
| 17 | What will the square look like when the paper in unfolded? | |
| 18 | What will the square look like when the paper in unfolded? | |
| 19 | What will the square look like when the paper in unfolded? | |
| 20 | What is opposite each numbered view from each lettered view<br>1<br>2<br>3 | |
| 21 | What is opposite each numbered view from each lettered view<br>1<br>2<br>3 | |
| 22 | What will a pattern look like when it is folded into cube | |
| 23 | What will a pattern look like when it is folded into cube | |
| 24 | Find a square is hidden in the dots | |
| 25 | Find circle is hidden in the dots . | |
| 26 | Find a parallelogram is hidden in the dots | |
| 27 | Which a rabbit nearest than others to the tree | |
| 28 | Which a rabbit nearest than others to the tree | |
| 29 | Which a rabbit nearest than others to the tree | |
| 30 | Which one are the nearest than others to the lake | |
| 31 | Which plant will crash with the green planet | |
| 32 | How many time will the green plant meet with a blue one | |
| 33 | Which skyrocket will arrive the moon | |
| 34 | Which one are arrive to a destination first | |
| 35 | How many floor in this building | |

Thanks

# Visual-Spatial test Answer Sheet

Follow the question in the computer screen then write down your answer in this sheet.

| N | ITEMS | | ANSWER |
|---|---|---|---|
| Example | Find a parallelogram is hidden in the dots | | |
| Example | Which a rabbit nearest than others to the tree | | |
| 1 | Which one is a different shape? | | |
| 2 | Which one is a different shape? | | |
| 3 | Which one is a different shape? | | |
| 4 | Which one is a different shape? | | |
| 5 | How many objects | | |
| 6 | How many objects | | |
| 7 | How many objects | | |
| 8 | How many objects | | |
| 9 | Which figure is the correct answer | | |
| 10 | Which figure is the correct answer | | |
| 11 | Match each lettered piece to each numbered position | | |
| | A | | |
| | B | | |
| | C | | |
| | D | | |
| 12 | Match each lettered piece to each numbered position: | | |
| | A | | |
| | B | | |
| | C | | |
| | D | | |
| 13 | Find the place where each lettered piece can replace each numbered position | | |
| | A | | |
| | B | | |
| | C | | |
| | D | | |
| 14 | Find the place where each lettered piece can replace each numbered position | | |
| | A | | |
| | B | | |
| | C | | |
| 15 | What will the square look like when the paper in unfolded? | | |
| 16 | What will the square look like when the paper in unfolded? | | |
| 17 | What will the square look like when the paper in unfolded? | | |

| | | |
|---|---|---|
| 18 | What will the square look like when the paper in unfolded? | |
| 19 | What will the square look like when the paper in unfolded? | |
| 20 | What is opposite each numbered view from each lettered view | |
| | 1 | |
| | 2 | |
| | 3 | |
| 21 | What is opposite each numbered view from each lettered view | |
| | 1 | |
| | 2 | |
| | 3 | |
| 22 | What will a pattern look like when it is folded into cube | |
| 23 | What will a pattern look like when it is folded into cube | |
| 24 | Find a square is hidden in the dots | |
| 25 | Find circle is hidden in the dots . | |
| 26 | Which a rabbit nearest than others to the tree | |
| 27 | Which a rabbit nearest than others to the tree | |
| 28 | Which one are the nearest than others to the lake | |
| 29 | Which plant will crash with the green planet | |
| 30 | How many time will the green plant meet with a blue one | |
| 31 | Which skyrocket will arrive the moon | |
| 32 | Which one are arrive to a destination first | |
| 33 | How many floor in this building | |

Thanks

# Visual-Spatial test Answer Sheet

Follow the question in the computer screen then write down your answer in this sheet.

| N | ITEMS | ANSWER |
|---|---|---|
| Example | Find a parallelogram is hidden in the dots | |
| Example | Which a rabbit nearest than others to the tree | |
| 1 | Which one is a different shape? | |
| 2 | Which one is a different shape? | |
| 3 | Which one is a different shape? | |
| 4 | Which one is a different shape? | |
| 5 | How many objects | |
| 6 | How many objects | |
| 7 | How many objects | |
| 8 | How many objects | |
| 9 | Which figure is the correct answer | |
| 10 | Which figure is the correct answer | |
| 11 | Match each lettered piece to each numbered position | |
| | A | |
| | B | |
| | C | |
| | D | |
| 12 | Match each lettered piece to each numbered position | |
| | A | |
| | B | |
| | C | |
| | D | |
| 13 | Find the place where each lettered piece can replace each numbered position | |
| | A | |
| | B | |
| | C | |
| | D | |
| 14 | Find the place where each lettered piece can replace each numbered position | |
| | A | |
| | B | |
| | C | |
| 15 | What is opposite each numbered view from each lettered view | |
| | 1 | |
| | 2 | |
| | 3 | |
| 16 | What is opposite each numbered view from each lettered view | |
| | 1 | |
| | 2 | |
| | 3 | |
| 17 | What will a pattern look like when it is folded into cube | |
| 18 | What will a pattern look like when it is folded into cube | |
| 19 | Find a square is hidden in the dots | |
| 20 | Find circle is hidden in the dots . | |
| 21 | Which a rabbit nearest than others to the tree | |
| 22 | Which a rabbit nearest than others to the tree | |
| 23 | How many floor in this building | |
| 24 | What will the square look like when the paper in unfolded? | |
| 25 | What will the square look like when the paper in unfolded? | |
| 26 | What will the square look like when the paper in unfolded? | |
| 27 | What will the square look like when the paper in unfolded? | |
| 28 | What will the square look like when the paper in unfolded? | |
| 29 | Which one are the nearest than others to the lake | |
| 30 | Which plant will crash with the green planet | |
| 31 | How many time will the green plant will meet with a blue one | |
| 32 | Which skyrocket will arrive the moon | |
| 33 | Which one are arrive to a destination first | |
| 34 | which pictures is reflect the composite water | |
| 35 | How many apples does the farmer pick to fill three box | |

Thanks

# ورقة الاجابة لاختبار القدرة الصورية المكانية

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تابع السؤال من خلال شاشة الكمبيوتر ثم اجب بوضع الاجابة الصحية في مكان الاجابة في الجدول.

| الرقم | السؤال | الاجابة |
|---|---|---|
| 1 | ما الشكل المختلف ؟ | |
| 2 | ما الشكل المختلف ؟ | |
| 3 | ما الشكل المختلف ؟ | |
| 4 | ما الشكل المختلف ؟ | |
| 5 | كم عدد الاشكال ؟ | |
| 6 | كم عدد الاشكال ؟ | |
| 7 | كم عدد الاشكال ؟ | |
| 8 | كم عدد الاشكال ؟ | |
| 9 | ما النموذج الذي تم تكوينه من من الاشكال ؟ | |
| 10 | ما النموذج الذي استخدم لتركيب الشكل ؟ | |
| 11 | ما ظل الاشكال التالية :<br>1<br>2<br>3<br>4<br>5<br>6<br>7 | |
| 12 | ما ظل الاشكال التالية :<br>1<br>2<br>3<br>4<br>5<br>6<br>7 | |
| 13 | ما المكان الصحيح للأشكال التالية :<br>1<br>2<br>3<br>4<br>5 | |
| 14 | ما المكان الصحيح للأشكال التالية<br>1<br>2<br>3<br>4<br>5 | |
| 15 | ما شكل الورقة قبل طيها ؟ | |
| 16 | ما شكل الورقة قبل طيها ؟ | |
| 17 | ما شكل الورقة قبل طيها ؟ | |
| 18 | ما شكل الورقة قبل طيها ؟ | |
| 19 | ما شكل الورقة قبل طيها ؟ | |
| 2 | ما الشكل المقابل للاشكال التالية :<br>1<br>2<br>3 | |
| 21 | ما الشكل المقابل للاشكال التالية<br>1<br>2<br>3 | |
| 22 | ما المكعب الصحيح؟ | |
| 23 | ما المكعب الصحيح؟ | |
| 24 | ما النقاط المكونه لشكل المستطيل | |
| 25 | ما النقاط المكونه لشكل الدائره | |
| 26 | ما النقاط المكونه لمتوازي الاضلاع | |
| 27 | اي الارانب اقرب للشجرة؟ | |
| 28 | اي الارانب اقرب للشجرة؟ | |
| 29 | اي الارانب اقرب للشجرة؟ | |
| 30 | اي المستكشفين الثلاث اقرب للبحيرة؟ | |
| 31 | ما لون الكوكب الذي يصطدم بالكوكب الاخضر | |
| 32 | كم مره تلتقي الكواكب السيارة؟ | |
| 33 | ما رقم الصاروخ الذي وصل القمر ؟ | |
| 34 | من الذي وصل اولا لجهة الوصول التي يقصدها ؟ | |
| 35 | كم عدد الادوار في المبنى الهرمي؟ | |

الاسم :

الصف:

شكرا لتعاونكم مع تمنياتي لكم بالتوفيق

# ورقة الاجابة لاختبار القدرة الصورية المكانية

تابع السؤال من خلال شاشة الكمبيوتر ثم اجب بوضع الاجابة الصحية في مكان الاجابة في الجدول.

| الرقم | السؤال | | الاجابة |
|---|---|---|---|
| مثال | ما النقاط المكونه لمتوازي الاضلاع | | |
| مثال | اي الارانب اقرب للشجرة؟ | | |
| 1 | ما الشكل المختلف ؟ | | |
| 2 | ما الشكل المختلف ؟ | | |
| 3 | ما الشكل المختلف ؟ | | |
| 4 | ما الشكل المختلف ؟ | | |
| 5 | كم عدد الاشكال ؟ | | |
| 6 | كم عدد الاشكال ؟ | | |
| 7 | كم عدد الاشكال ؟ | | |
| 8 | كم عدد الاشكال ؟ | | |
| 9 | ما النموذج الذي تم تكوينه من من الاشكال ؟ | | |
| 10 | ما النموذج الذي استخدم لتركيب الشكل ؟ | | |
| 11 | ما رقم الشكل المشابه للاشكال التالية : | | |
| | | A | |
| | | B | |
| | | C | |
| | | D | |
| 12 | ما رقم الشكل المشابه للاشكال التالية : | | |
| | | A | |
| | | B | |
| | | C | |
| | | D | |
| 13 | ما المكان الصحيح للأشكال التالية : | | |
| | | A | |
| | | B | |
| | | C | |
| | | D | |
| 14 | ما المكان الصحيح للأشكال التالية : | | |
| | | A | |
| | | B | |
| | | C | |
| 15 | ما شكل الورقة قبل طيها ؟ | | |
| 16 | ما شكل الورقة قبل طيها ؟ | | |
| 17 | ما شكل الورقة قبل طيها ؟ | | |
| 18 | ما شكل الورقة قبل طيها ؟ | | |

| | | | |
|---|---|---|---|
| 19 | ما شكل الورقة قبل طيها ؟ | | |
| 20 | ما الشكل المقابل للاشكال التالية : | | |
| | | 1 | |
| | | 2 | |
| | | 3 | |
| 21 | ما الشكل المقابل للاشكال التالية | | |
| | | 1 | |
| | | 2 | |
| | | 3 | |
| 22 | ما المكعب الصحيح؟ | | |
| 23 | ما المكعب الصحيح؟ | | |
| 24 | ما النقاط المكونه لشكل المستطيل | | |
| 25 | ما النقاط المكونه لشكل الدائره | | |
| 26 | اي الارانب اقرب للشجرة؟ | | |
| 27 | اي الارانب اقرب للشجرة؟ | | |
| 28 | اي المستكشفين الثلاث اقرب للبحيرة؟ | | |
| 29 | ما لون الكوكب الذي يصطدم بالكوكب الاخضر | | |
| 30 | كم مره تلتقي الكواكب السيارة؟ | | |
| 31 | ما رقم الصاروخ الذي وصل القمر ؟ | | |
| 32 | من الذي وصل اولا لجهة الوصول التي يقصدها ؟ | | |
| 33 | كم عدد الادوار في المبنى الهرمي؟ | | |

الاسم :

الصف:

شكرا لتعاونكم مع تمنياتي لكم بالتوفيق

# ورقة الاجابة لاختبار القدرة الصورية المكانية

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تابع السؤال من خلال شاشة الكمبيوتر ثم اجب بوضع الاجابة الصحية في مكان الاجابة في الجدول.

| الرقم | السؤال | الاجابة |
|---|---|---|
| مثال | ما النقاط المكونه لمتوازي الاضلاع | |
| مثال | اي الارانب اقرب للشجرة؟ | |
| 1 | ما الشكل المختلف ؟ | |
| 2 | ما الشكل المختلف ؟ | |
| 3 | ما الشكل المختلف ؟ | |
| 4 | ما الشكل المختلف ؟ | |
| 5 | كم عدد الاشكال ؟ | |
| 6 | كم عدد الاشكال ؟ | |
| 7 | كم عدد الاشكال ؟ | |
| 8 | كم عدد الاشكال ؟ | |
| 9 | ما النموذج الذي تم تكوينه من من الاشكال ؟ | |
| 10 | ما النموذج الذي استخدم لتركيب الشكل ؟ | |
| 11 | ما رقم الشكل المشابه للاشكال التالية : | |
| | A | |
| | B | |
| | C | |
| | D | |
| 12 | ما رقم الشكل المشابه للاشكال التالية : | |
| | A | |
| | B | |
| | C | |
| | D | |
| 13 | ما المكان الصحيح للأشكال التالية : | |
| | A | |
| | B | |
| | C | |
| | D | |
| 14 | ما المكان الصحيح للأشكال التالية : | |
| | A | |
| | B | |
| | C | |
| 15 | ما الشكل المقابل للاشكال التالية : | |
| | 1 | |
| | 2 | |
| | 3 | |
| 16 | ما الشكل المقابل للاشكال التالية | |
| | 1 | |
| | 2 | |
| | 3 | |

| | | |
|---|---|---|
| 17 | ما المكعب الصحيح؟ | |
| 18 | ما المكعب الصحيح؟ | |
| 19 | ما النقاط المكونه لشكل المستطيل | |
| 20 | ما النقاط المكونه لشكل الدائره | |
| 21 | اي الارانب اقرب ل لشجرة؟ | |
| 22 | اي الارانب اقرب للشجرة؟ | |
| 23 | كم عدد الادوار في المبنى الهرمي؟ | |
| 24 | ما شكل الورقة قبل طيها ؟ | |
| 25 | ما شكل الورقة قبل طيها ؟ | |
| 26 | ما شكل الورقة قبل طيها ؟ | |
| 27 | ما شكل الورقة قبل طيها ؟ | |
| 28 | ما شكل الورقة قبل طيها ؟ | |
| 29 | اي المستكشفين الثلاث اقرب للبحيرة؟ | |
| 30 | ما لون الكوكب الذي يصطدم بالكوكب الاخضر | |
| 31 | كم مره تلتقي الكواكب السيارة؟ | |
| 32 | ما رقم الصاروخ الذي وصل القمر ؟ | |
| 33 | من الذي وصل اولا لجهة الوصول التي يقصدها ؟ | |
| 34 | ذرات الماء هي | |
| 35 | كم عدد التفاحات في الصناديق الثلاثة ؟ | |

الاسم :

الصف:

شكرا لتعاونكم مع تمنياتي لكم بالتوفيق

# Appendix B

## Experiment 3

- Convergency test (Arabic Edition )
- Questionnaire (Arabic Edition)
- Questionnaire ( English Edition)
- Visual-Spatial test 3 (Arabic Edition)
- Visual-Spatial test 3 (English Edition)

Convergency test (Arabic Edition)

## مسائل تفكير متنوعة

عزيزي الطالب / الطالبة

النموذج الذي بين يديك عبارة عن اداة للبحث العلمي ، من المهم أن تعرف أنه ليس له تأثير على درجاتك ، وانه لن يطلع عليه أحد سوى الباحث . لذا ارجو تعاونك في الاجابة على هذا النموذج وفقا للتعليمات التالية :

- أبدأ الاجابة عندما يخبرك الباحث بذلك .
- حاول قدر الإمكان الاستفادة من الوقت المسموح لك به .
- انتقل الى بند أخر عندما تواجهك صعوبة في اي من البنود .
- التزم بالوقت المحدد لكل نموذج وضع القلم عندما يطلب منك ذلك .
- تذكر أن الوقت المسموح به للإجابة 20 دقيقة .

المدرسة :.............................................................................................................

الصف:.............................................................................................................

الاسم :.............................................................................................................

السؤال الاول

يوجد في الجدول الأتي أكثر من علاقة تربط بعض الاسماء ببعض ، حاول ايجاد علاقتين فقط،

| | | | | |
|---|---|---|---|---|
| **المغرب** | **ايران** | **عمان** | **قطر** | **لبنان** |
| **الرباط** | **طهران** | **بيروت** | **مسقط** | **الدوحة** |
| **مصر** | **باكستان** | **فرنسا** | **بريطانيا** | **اسبانيا** |
| **القاهرة** | **كراتشي** | **مدريد** | **باريس** | **لندن** |

1- اكتب الاسماء مع ذكر نوع العلاقة التي ربطتهما ببعض في المكان المخصص للاجابة.

العلاقة الاولى :..........................................................................................

العلاقة الثانية :..........................................................................................

2- رتب الاحرفة التالية بحيث تكون منها كلمة ذات معنى:

- ر - ف - د - ت ..................................................................

- د - ق - ي - ص ..................................................................

- م - ل - س - ا ..................................................................

امامك ثلاث مجموعات من الارقام وأكتب الرقم الاخير في المربع ثم أكتب سبب اختيار الاجابة .

- 2.....4......8.......☐

السبب :..........................................................................................

- 1.......3.....6........10......15........☐

السبب:..........................................................................................

- 1.......4.......9........16.......☐

السبب:..........................................................................................

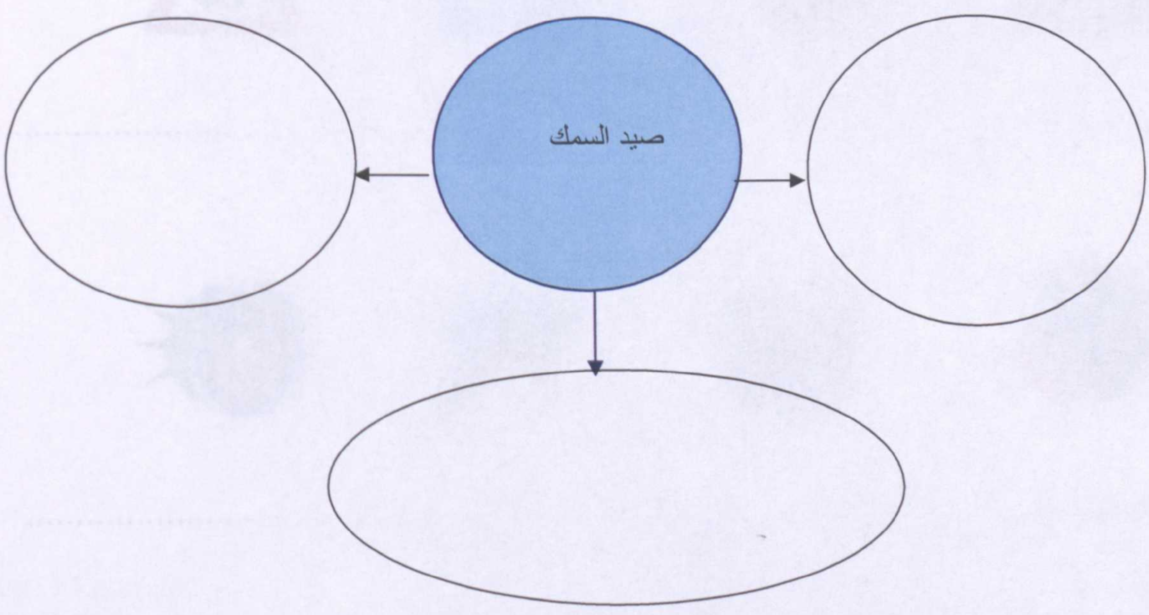
**وقت الاجابة 5 دقائق**

السؤال الثاني :

- امامك موضوع قصير ، حاول ايجاد ثلاث افكار رئيسة منه .
- بعد قراءة الموضوع ضع الافكار التي توصلت لها في المخطط أدناه بحيث تعبر كل دائره عن فكره استخرجتها من الموضوع .

أحب أكل السمك

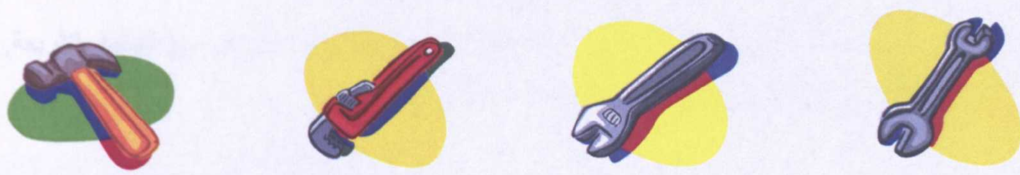
نشأت دولة الكويت بين الصحراء والبحر ، فكما هناك حرف بريه كالرعي هناك حرف بحريه فكلاهما له تأثير كبير على الهوية الكويتيه. فمهنة صيد الاسماك منتشره على امتداد الشريط الساحلي لدولة الكويت .كنتيجة طبيعية لوجود سكان قرب البحر . فقد كانت مهنة صيد السمك المصدر الرئيسي للدخل والغذاء للكويتيين قبل اكتشاف النفط .وقد تركز صيد السمك في السابق بعمق خمسة اميال الى داخل البحر من الشاطئ حيث ان السفن الصغيره لم تكن قادرة على دخول المياه العميقة وقد استخدموا ادوات صيد بسيطة وتقليدية كالحضره والقرقور ، وأغلب هذه الأدوات مازالت مستخدمة حتى الأن مع بعض التطوير البسيط وعلى الرغم من هذه الوسائل التقليدية الا انها مازالت تنتج محصول وفير من السمك .و نجد اليوم ان الكويت تصطاد اكثر من 8,000 طن سنويا من الاسماك بما في ذلك 2,200 طن من الروبيان ،ويتم صيد السمك بشكل تجاري حيث ينحصر غالبا في الشركة المتحدة للثروة السمكية وقد شعرت الكويت منذ أمد بعيد بأهمية إبقاء الثروة السمكية كمصدر طبيعي ثاني للدخل القومي ، ويتميز قسم الزراعة و الثروة السمكية في معهد الكويت للأبحاث العلمية بأن لديه أحد أكبر البرامج المتكاملة في الشرق الأوسط لتربية الأسماك خصوصا الزبيدي والهامور فقد بدأ معهد الكويت للأبحاث العلمية تجربة منذ مايو سنة 1997 بحيث تنقل البيض المخصب في البحر الى احواض تفقيس تابعة لمعهد الابحاث العلمية ثم تعاد مرة اخرى للبحر .




وقت الاجابة 5 دقائق

السؤال الثالث:

• استبعد العنصر المختلف واذكر السبب



السبب.................................................................................................

• السبب.................................................................................................

• السبب.................................................................................................

• السبب.................................................................................................

وقت الاجابة 3 دقائق

<u>السؤال الرابع</u>

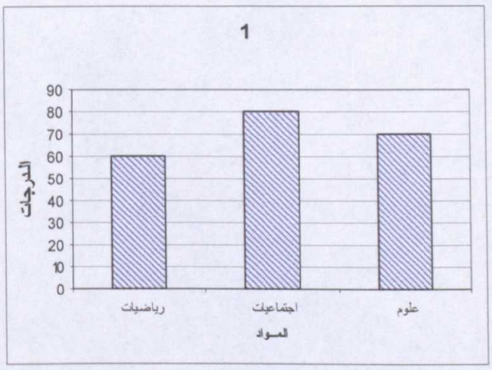
- أمامك أربعة رسوم بيانية متشابهة في كثير من الجوانب .

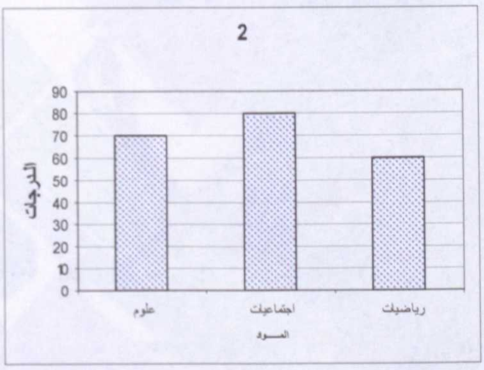
مثال:

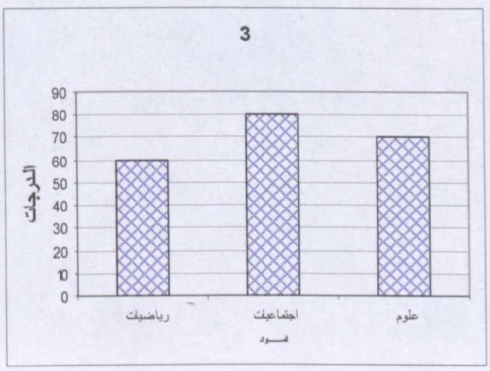
اولا: تتشابه بمحور المواد حيث إن جميع الرسوم تتناول ثلاث مواد.

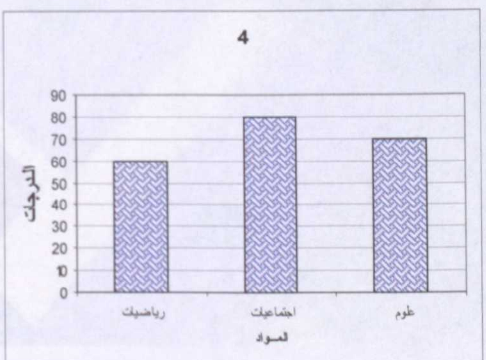
ثانيا : محور الدرجات حيث ان الدرجة النهائية هي ( 90) درجة في الرسوم البيانية الأربعة.

حاول ايجاد جوانب اخرى متشابهة في الرسم البياني .




.1 ..........................................................................................................

.2 ..........................................................................................................

وقت الاجابة 2 دقيقة

السؤال الخامس

حاول مساعدة شخص يقف عند نقطة البداية الموضحة على الخريطة ويريد الذهاب الى روضة الاطفال ومن ثم الى السوق المركزي وتلك نقطة النهاية .

المطلوب منك:

1. تحديد خط السير على الخريطة .


2. قم بوصف خط السير الذي رسمته بإختصار بحيث تحدد الطرق والاتجاهات التي تم اتباعها للوصول الى الأماكن المحددة.

.......................................................................................................................................
.......................................................................................................................................
.......................................................................................................................................
.......................................................................................................................................
.......................................................................................................................................
.......................................................................................................................................
.......................................................................................................................................

وقت الاجابة 5 دقائق

**Questionnaire (Arabic Edition)**

## كيف تفضل أن تتعلم

الاسم ..........................................................................................................
المدرسة ......................................................................................................
الصف ..........................................................................................................

---

صممت هذه الإستمارة للتعرف على الاسلوب الذي تفضل ان تتعلم به، إن ذلك سوف يساعدنا في التعرف على الأسلوب الذي يتميز به غالبية الطلبة.

(إن إجابتك لا تؤثر في أي حال على درجاتك)

اولا : الرجاء الإجابة عن كل الأسئلة الآتية وذلك بوضع الإشارة (✓) في المربع المناسب :

| الرقم | العبارات | اوافق بشدة | اوافق | غير متأكد | لا اوافق | لا اوافق بشدة |
|---|---|---|---|---|---|---|
| 1 | لدي القدره على التركيز لفترة طويلة. | | | | | |
| 2 | اتذكر اي شيء بسهولة. | | | | | |
| 3 | استطيع القيام باي عملية حسابية بسهولة. | | | | | |
| 4 | استمر بعمل الشيئ الذي اهتم به الى ان أتم انجازه . | | | | | |
| 5 | اهتم بكثير من المواضيع حتى لو لم تكن ضمن المقررات الدراسية. | | | | | |
| 6 | كثيرا ما استعمل الفاظ قد لا نكون تعلمناها في المدرسة. | | | | | |
| 7 | أتأثر كثيرا عند سماع الاخبار وتشغل فكري قضايا العالم. | | | | | |
| 8 | لدي القدره على ايجاد الكثير من الافكار الجديدة. | | | | | |
| 9 | احرص دائما على ان يكون ادائي للواجب على اكمل وجه. | | | | | |
| 10 | دائما يكون اصدقائي اكبر مني سنا. | | | | | |
| 11 | اميل الى حل الألغاز. | | | | | |
| 12 | استطيع ان اجد لنفسي طريقة خاصة لحل الكثير من المسائل . | | | | | |
| 13 | أستطيع ان أ روي قصه من الخيال بكل سهولة . | | | | | |
| 14 | اميل الى سماع النكت وتأليف بعضها. | | | | | |
| 15 | لدي فضول لمعرفة كل شيئ | | | | | |
| 16 | عندما افكر بموضوع ما أشعر وكأنني أرى صور لهذاالموضوع. | | | | | |
| 17 | اتعلم أفضل اذا عرفت فكرة الموضوع بشكل عام قبل الدخول في التفاصيل. | | | | | |
| 18 | اتذكر بشكل جيد اي موضوع بشكل عام ولكنني انسى تفاصيل الموضوع. | | | | | |
| 19 | اذا اردت حفظ كلمات جديده لابد من كتابتها لتنطبع صورتها في ذاكرتي | | | | | |
| 20 | أستطيع تركيب أي مجسم بمجرد أن انظر إليه دون الحاجه إلى قراءة التعليمات | | | | | |
| 21 | أفضل أن أرى خريطه للمكان الذي اود الذهاب له على ان يوصف لي الطريق شفويا . | | | | | |

اقلب الصفحة ☜

**ثانيا: ضع علامة صح( ✓ ) في المربع المناسب كما هو موضح في المثال والذي يبين كيفية وضع الاشارة بين العبارات.**

| | | | | | | |
|---|---|---|---|---|---|---|
| اقوم بحل المسألة في الغالب قبل ان يشرح المدرس نموذج لطريقة الحل | 5 | 4 | 3 | 4 | 5 | انتظر حتى يكمل المدرس شرح المسائل المطلوب تعلمها قبل ان ابدأ بالاجابة |
| | | | | ✓ | | |
| إختيار رقم (4) من اليسار يعني انك اقرب في اسلوبك للعبارة التي على اليسار من العبارة التي على اليمين كأنك تقول انك تنتظر حتى ينهي المعلم حل الامثلة ثم تقوم بحل المسائل المطلوبه منك اي موافق ولكن ليس بشده . | | | | | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| أفضل أن يكون هناك تعليمات واضحة تنظم أي عمل. | | | | | | أفضل أن اضع الخطة التي تنظم العمل بنفسي |
| أفضل ان يكون أهداف ومزايا اي عمل نقوم به محددة وواضحه | | | | | | يمكنني ان استنتج مزايا اي عمل أقوم به وأهدافه حتى لو لم تحدد. |
| أفهم الموضوع أفضل اذا احتوى على امثله واقعية من الحياة الاجتماعية | | | | | | يمكنني أن افهم الموضوع من خلال الرسوم البيانية. |
| أفضل الدروس التي يتم تقسيم الطلبه فيها الى مجموعات تتعاون مع بعض لحل المسائل والتدريبات | | | | | | أفضل الدروس التي يكون التعلم فيها وحل المسائل فردي. |
| يكون رد فعلي ايجابيا للتعليق الايجابي ولكن اتضايق من التعليق السلبي . | | | | | | لا اتأثر كثيرا من اي تعليق حتى لو كان سلبيا. |
| يصعب علي استخراج المعلومات المهمة من الدرس مع وجود كثير من التفاصيل في الموضوع | | | | | | استطيع تحديد النقاط المهمة في الدرس بسهولة من اي موضوع مهما احتوى على تفاصيل |
| أفضل القصص التي تكون نهايتها واضحة ومحددة | | | | | | أفضل القصص التي لا تكون لها نهاية محددة |
| أفضل دراسة مواد مثل العلوم والرياضيات واللغات | | | | | | أفضل دراسة المواد الفنيه مثل الرسم والديكور والموسيقى. |
| أفضل ان استخلص الفكر الرئيسة التي تربط عدة مواضيع بعضها ببعض. | | | | | | أفضل أن استنتج أفكار جديدة متعددة من فكرة واحده |
| أفضل المواضيع المختصره . | | | | | | أفضل المواضيع التي فيها شرح وتفاصيل اكثر . |
| استمتع بالالعاب التي تحتاج تفكير مثل الشطرنج | | | | | | استمتع بالالعاب التي تحتاج مهاره مثل العاب الفك والتركيب وبناء المجسمات. |
| أفضل المواضيع التي تحتوي على حقائق ومعلومات واضحة | | | | | | أفضل مواضيع الخيال العلمي |

شكرا لتعاونكم
مع تمنياتي لكم بالتوفيق

**Questionnaire (English Edition)**

## How do You Prefer to Learn

*This questionnaire seeks to find out how you prefer to learn*
*Your answers will not affect your school marks in any way*
*No one will see the information you provide except the researcher*

Name:........................................................
Classroom ..................................................
School .......................................................

Put a mark (✓) in the suitable square.

| N | Items | Strongly agree | Agree | Uncertain | disagree | Strongly disagree |
|---|---|---|---|---|---|---|
| 1 | I can maintain attention for a long time | | | | | |
| 2 | I have a good memory | | | | | |
| 3 | I find mathematics exercises easy | | | | | |
| 4 | I concentrate well until I finish a task | | | | | |
| 5 | I have a wide interest in many topics, whether included in the curriculum or not | | | | | |
| 6 | I like using different new vocabulary | | | | | |
| 7 | I am very sensitive about many problems around the world | | | | | |
| 8 | I can produce new ideas easily | | | | | |
| 9 | It is very important for me doing my homework really well | | | | | |
| 10 | I prefer friends who are older than myself | | | | | |
| 11 | I am good at jigsaw puzzles | | | | | |
| 12 | I have my own way to solve problems | | | | | |
| 13 | I find it easy to imagine a story | | | | | |
| 14 | I have an excellent sense of humor | | | | | |
| 15 | I like to find out how things work | | | | | |
| 16 | When I thinking about any topic I often can see an image in my mind for the topic. | | | | | |
| 17 | I am better to learn in a whole rather than taking things step by step. | | | | | |
| 18 | I can remember things in general but I often forget the details | | | | | |
| 19 | If I want to remember any word, I need to write it down | | | | | |
| 20 | I find I can put parts together without reading the instructions | | | | | |
| 21 | I prefer see a map for a place rather than describing it orally | | | | | |

(2) Here is a way to describe a racing car.

| I often resolve the issue by explaining that the teacher model for the way the solution | 5 | 4 | 3 | 4 | 5 | Waited until the teacher to completes explain issues to be learned before that start answer |
|---|---|---|---|---|---|---|
| | | | | ✓ | | |
| Choice No. (4) of the left mean that you are in the earliest your style words to the left of the phrase on the right if you say you wait until the end teacher solution examples and then resolve any issues required of you agree, but not strongly | | | | | | |

Use the same method to show your preferred way of working.
*(Place one tick on each line)*

| | | | | | | |
|---|---|---|---|---|---|---|
| With a task, I prefer to be given a structure and plan | | | | | | With a task, I prefer to develop my own structure and plan |
| I need to know explicitly the goals and objectives for an assignment | | | | | | I can deduce what to do from the task assigned. |
| I understand materials best when presented in a social context | | | | | | I prefer information, charts and graphs that stress factual details |
| I prefer to learn in a situation where guidance and examples are provided | | | | | | I prefer to learn on my own without help from others |
| I respond poorly to negative feedback | | | | | | I react favourably to feedback, even if negative |
| I find it is difficult to find the important point from the many details in the topic. | | | | | | I am able to define the important point easily from any topic no matter how much detail is there |
| I tend to read stories where the end point is the goal of the story | | | | | | I tend to read stories where there is no clear end point |
| I prefer themes related to the sciences and mathematics | | | | | | I prefer themes that involve drawing, décor, music, and design |
| I prefer seeing the main idea which binds several ideas together | | | | | | I prefer thinking about many ideas even when the links are not too clear |
| I like to summarise what I learn | | | | | | I prefer to describe and give details in my studies |
| I enjoyed playing game like chess. | | | | | | I enjoyed playing games with many parts and ideas |
| I like the topics which contain realities and clear information. | | | | | | I like topics of the scientific imagination |

Thank you

**Visual-Spatial test 3 (Arabic Edition)**

## تدريبات مصورة

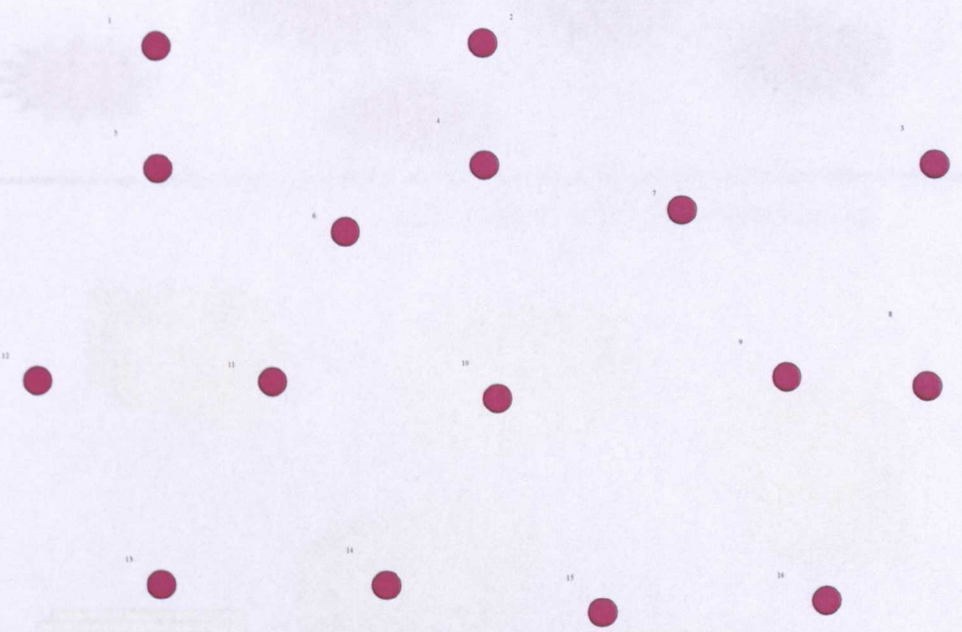
عزيزي الطالب / الطالبة

النموذج الذي بين يديك عبارة عن أداة للبحث العلمي / من المهم أن تعرف أنه ليس لها تأثير على درجاتك ، وانه لن يطلع عليه أحد سوى الباحث . لذا ارجو تعاونك في الاجابة على هذا النموذج وفقا للتعليمات التالية :

- ابدأ الاجابة عندما يخبرك الباحث
- حاول قدر الامكان الاستفادة من الوقت المسموح لك بها
- انتقل من بند لاخر عندما تواجهك صعوبة في اي من البنود
- تذكر ان الوقت المسموح لك به هو 20 دقيقه .
- اكتب بياناتك

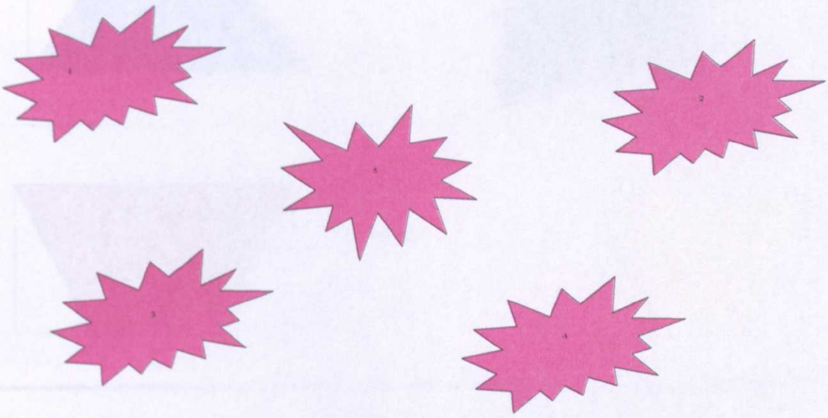
الاسم ..............................................................................
المدرسة ..........................................................................
الصف .............................................................................

الأن تابع مع الباحث كيفية حل الاسئلة عن طريق المثال التالي :

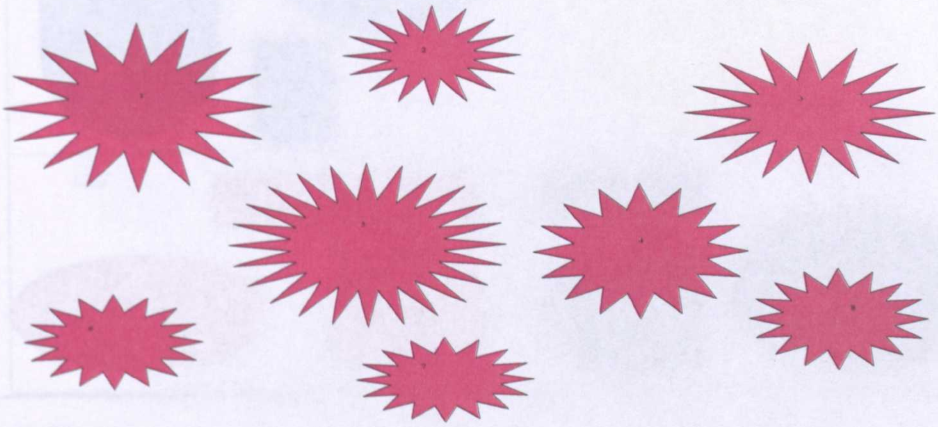


مثال : إكتشف شكل متوازي الاضلاع بوصل النقاط المرقمة المناسبة لتكوين الشكل

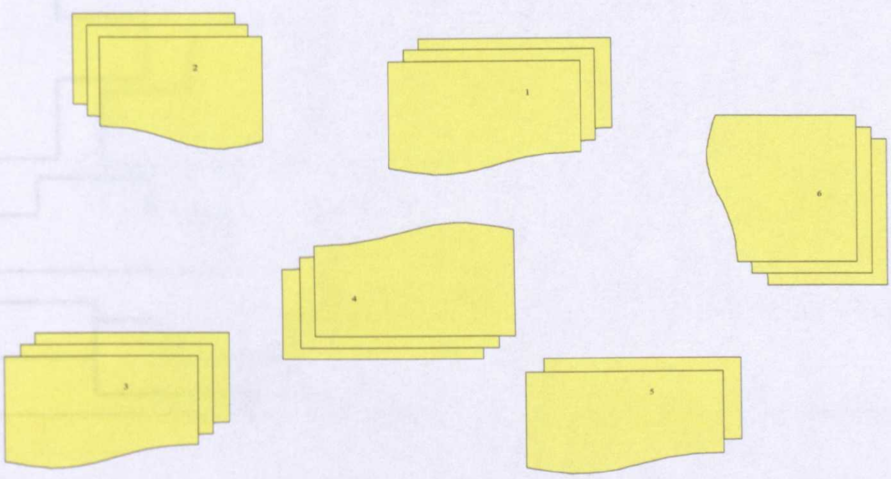
1- حدد الشكل المختلف من بين مجموعة الاشكال



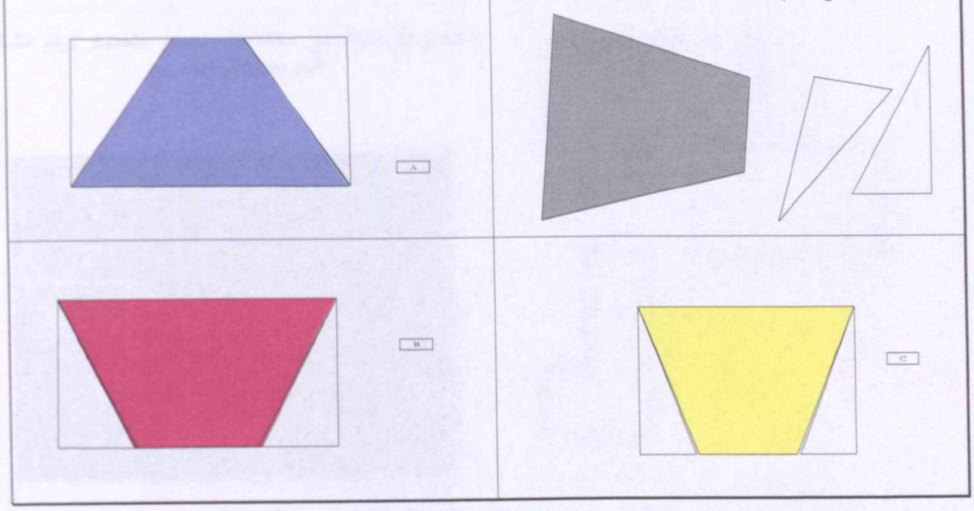
2- حدد الشكل المختلف من بين مجموعة الاشكال



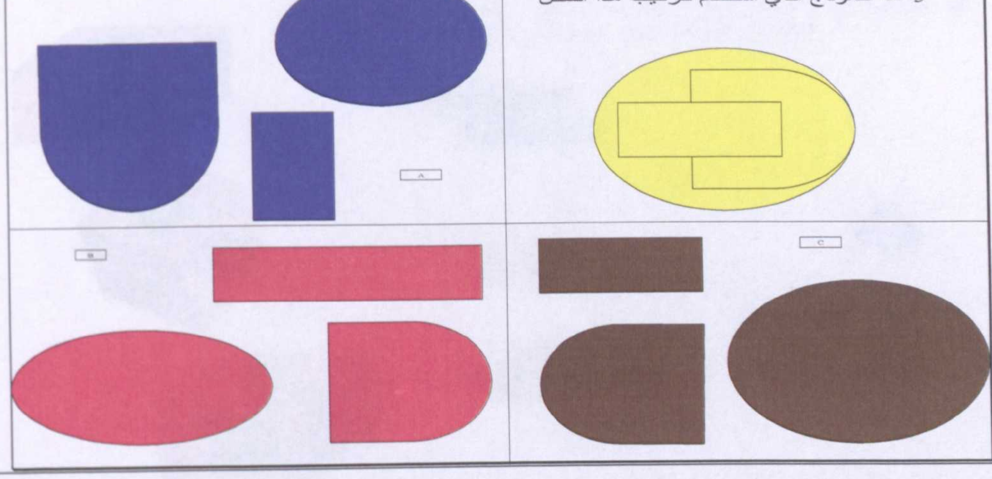
3- حدد الشكل المختلف من بين مجموعة الاشكال



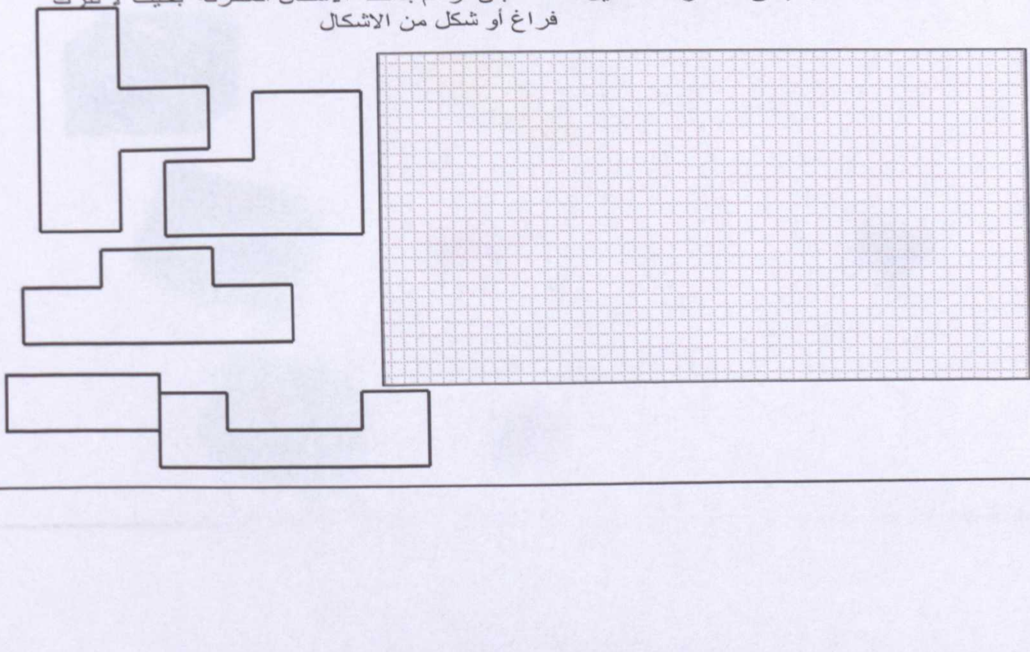
4-ما النموذج الذي يمكن أن يركب من هذه الاشكال



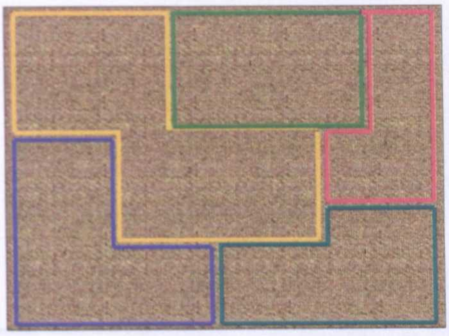

5-ما النموذج الذي استخدم لتركيب هذا الشكل

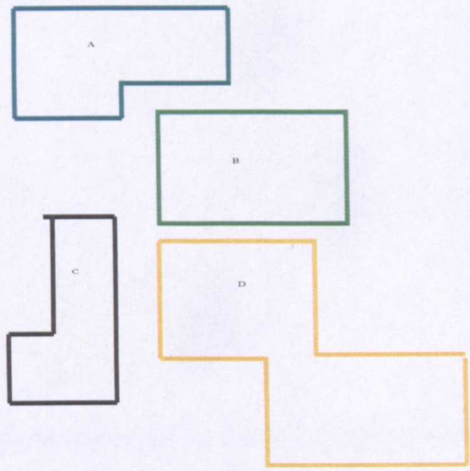



6-إملئ الاطار المستطيل أمامك بأن ترسم بداخله الاشكال المتفرقه بحيث لا تترك فراغ أو شكل من الاشكال

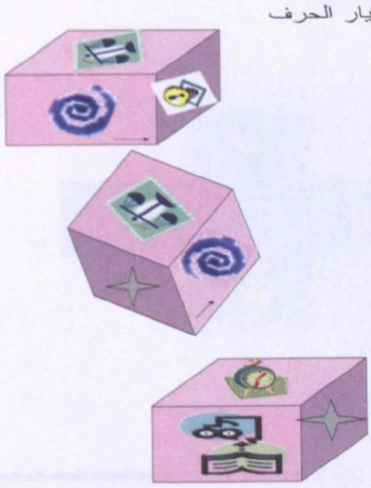


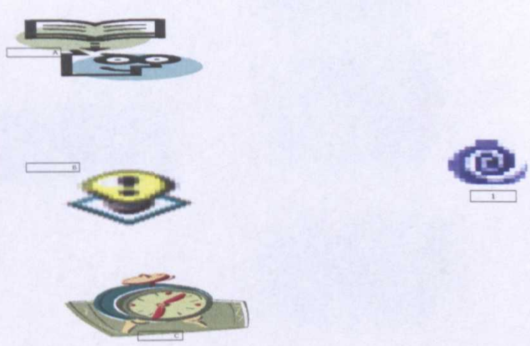
7- ضع كل شكل في مكانه الصحيح بإختيار رقم الشكل الموجود في المربع



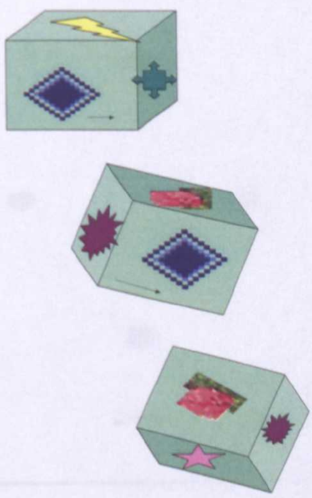


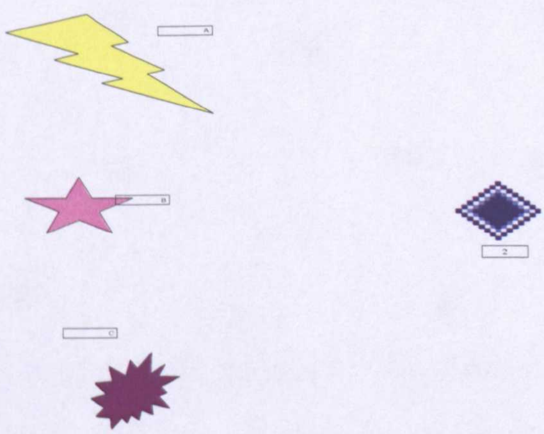
**8**- إكتشف الشكل المقابل لوجه المكعب المرقم بالرقم (1 ) بإختيار الحرف المناسب (لاحظ اتجاه السهم في المكعب)



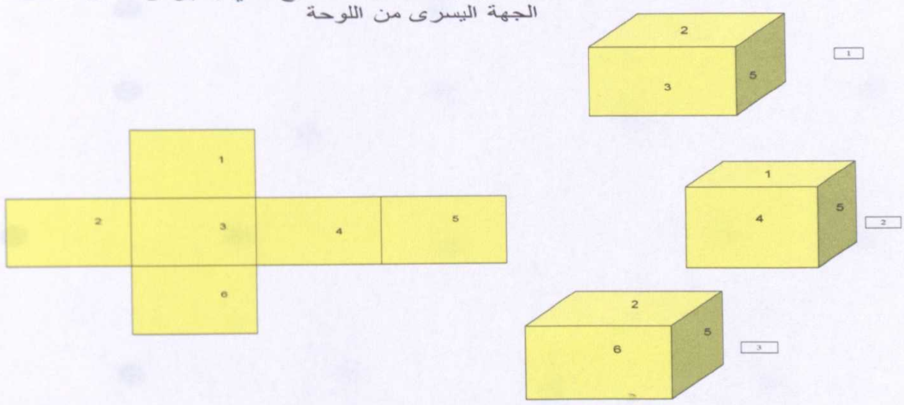


9- إكتشف الشكل المقابل لوجه المكعب المرقم بالرقم (2) بإختيار الحرف المناسب (لاحظ اتجاه السهم المكعب)

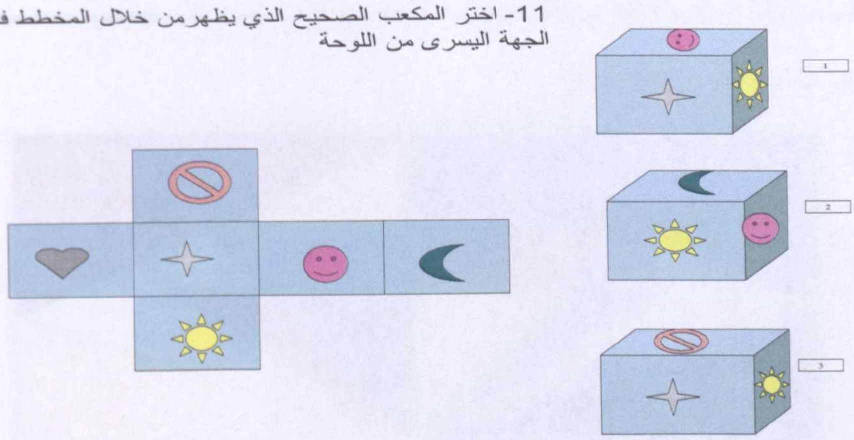


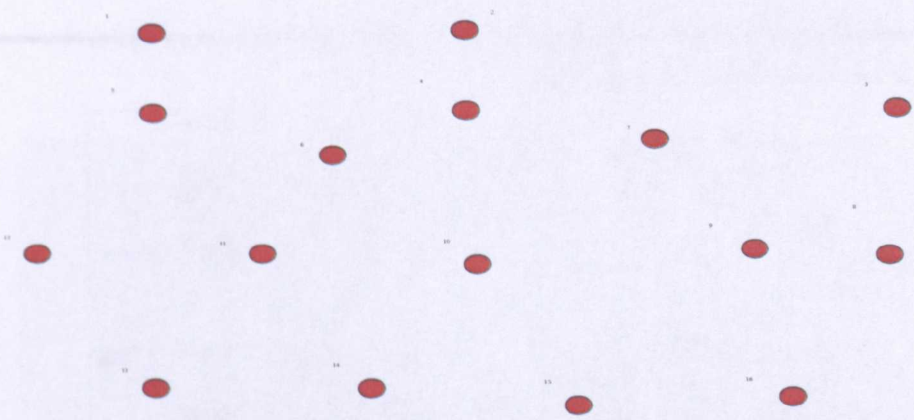


10- إختر المكعب الصحيح الذي يظهرمن خلال المخطط في الجهة اليسرى من اللوحة

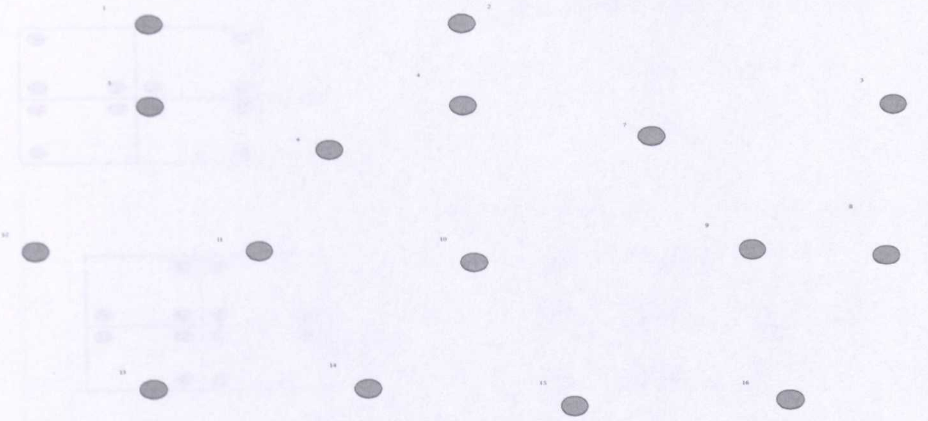


11- اختر المكعب الصحيح الذي يظهرمن خلال المخطط في الجهة اليسرى من اللوحة



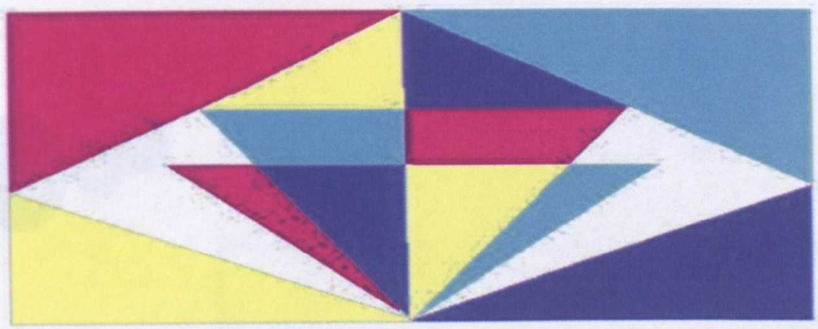


12- إكتشف الشكل المستطيل بوصل النقاط المرقمة المناسبة لتكوين الشكل ببعض

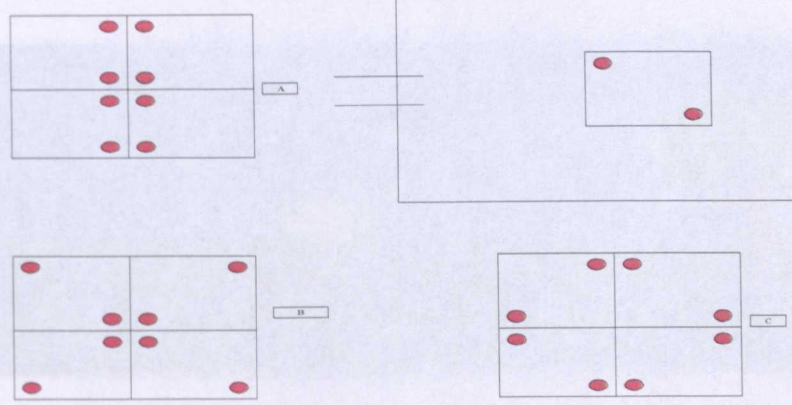


13- إكتشف شكل الدائره بوصل النقاط المرقمة المناسبة لتكوين الشكل

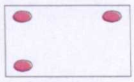
14- كم عدد المثلثات في الشكل التالي :

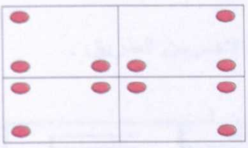


15- ما شكل الورقه قبل طيها إلى أربع اجزاء

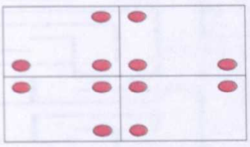


16- ما شكل الورقه قبل طيها إلى أربع أجزاء

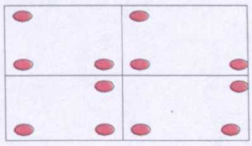




A

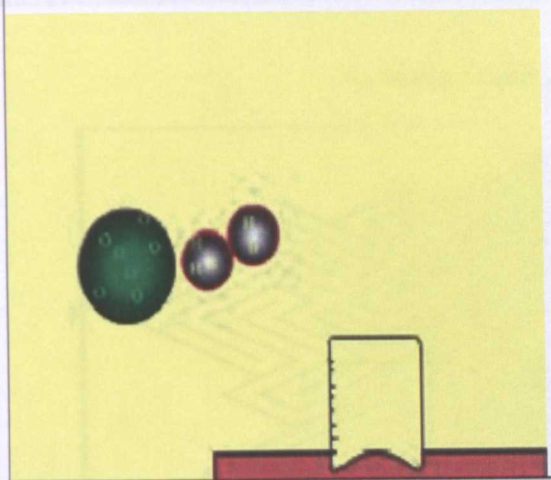


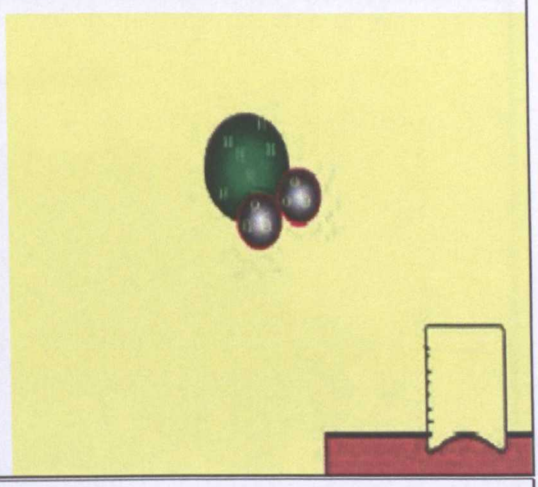
B



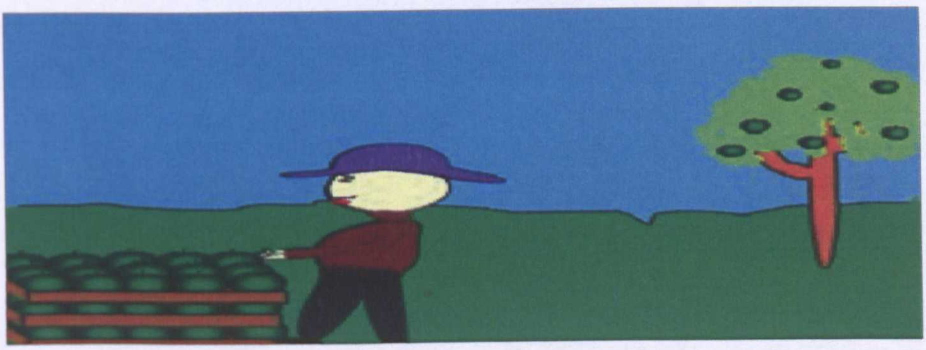
C

17- يتكون الماء من ثلاث ذرات اثنتان منها هيدروجين وواحدة أوكسجين أي الصورتين تعبر عن مركب الماء .

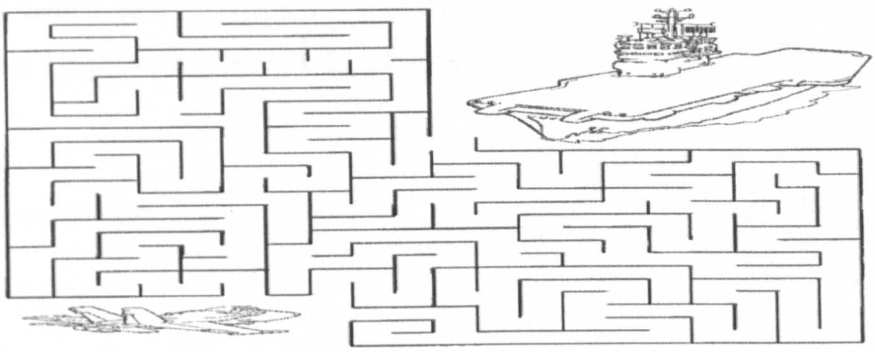




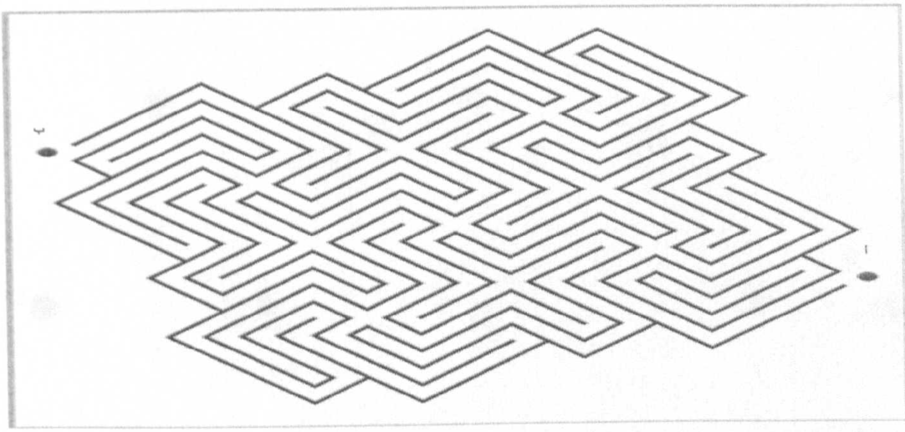
18-كم عدد التفاحات التي جمعها المزارع ووضعها في ثلاث صناديق متساوية



19-حاول الوصول بالطائرة إلى حاملة الطائرات في الجانب الاخرمن الطريق .



20-صل بين النقطة أ والنقطة ب



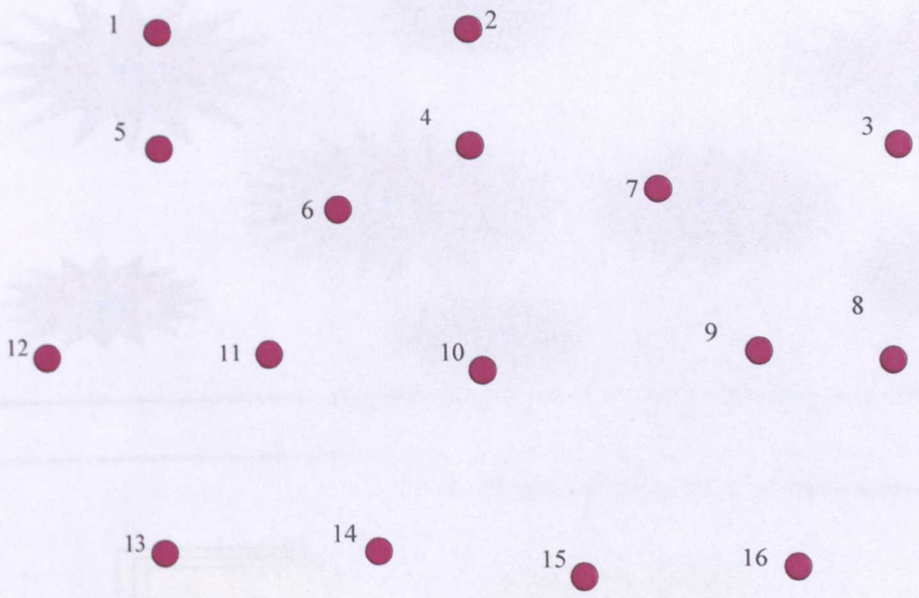
## Visual -spatial cognitive style

**This test measures your visual -spatial cognitive style.**

**There are 20 questions you must answer it.**

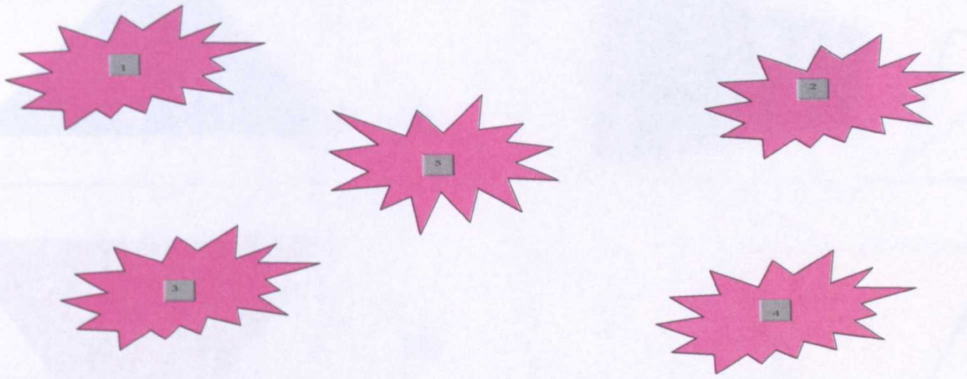
**Name:……………………………………………..**
**school:……………………………………………..**
**Class:……………………………………………**

**An Example:**

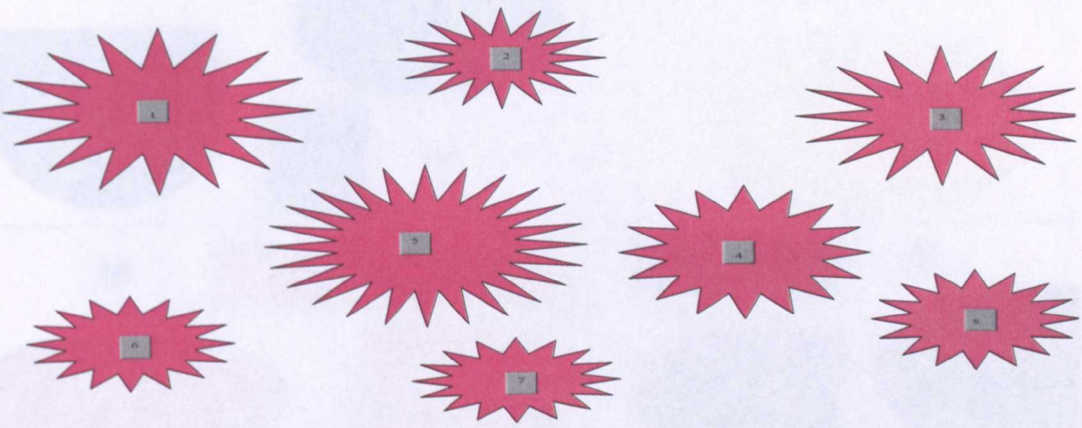



Find a parallelogram is hidden in the dots

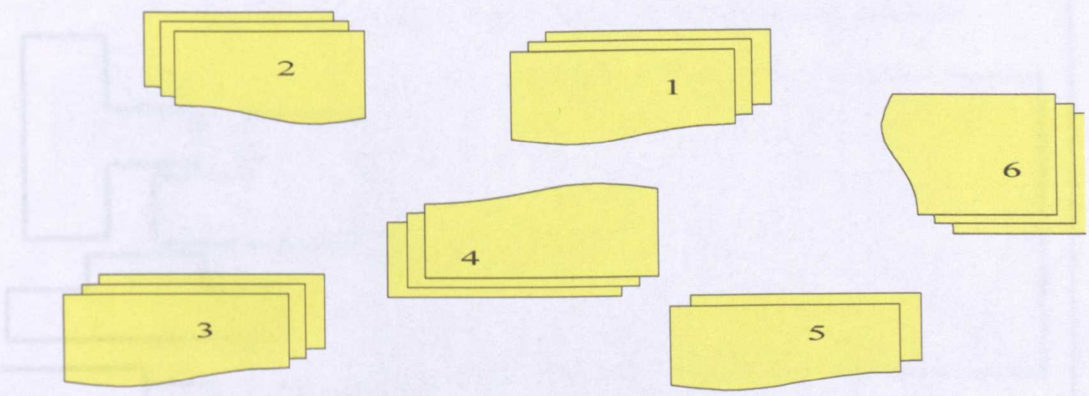
**1- Which one is a different sha**



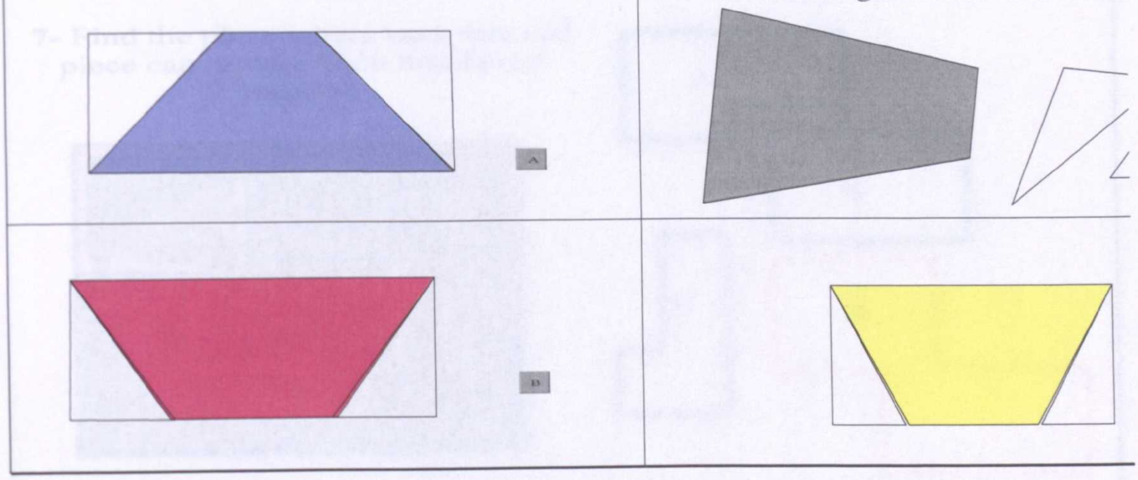
**2-Which one is a different shape?**



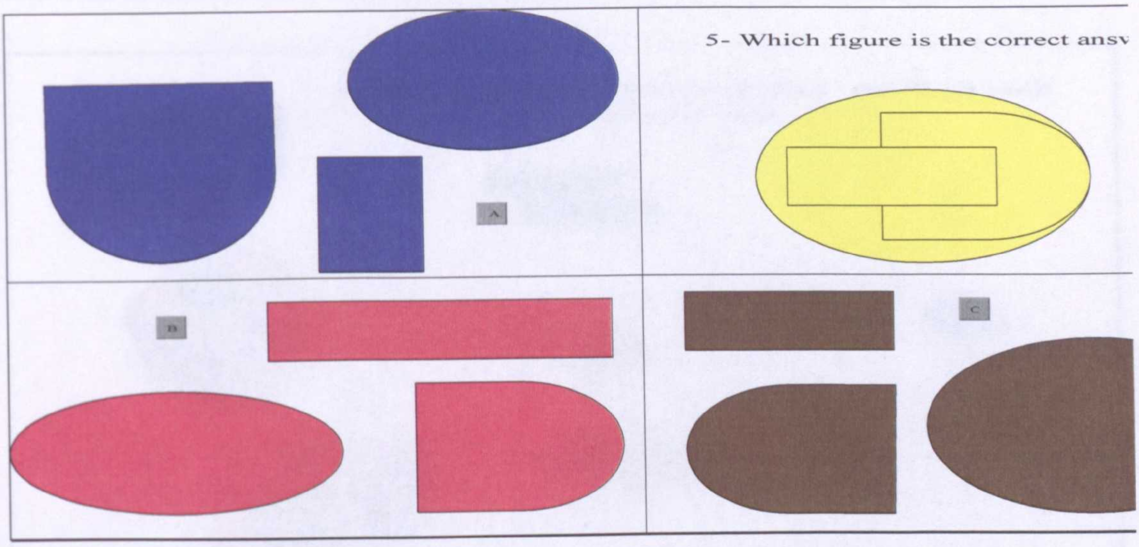
**3- Which one is a different shape?**



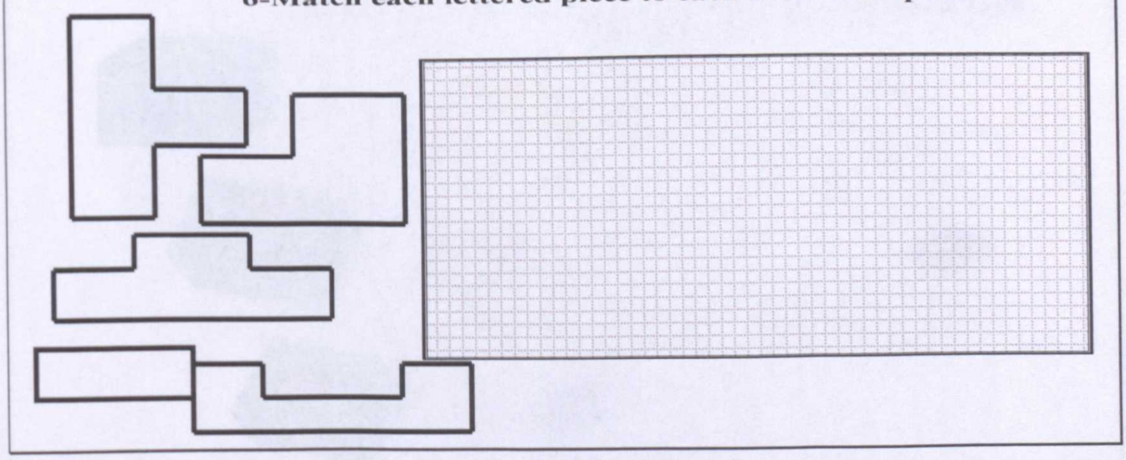
4- Which figure is the correct ans



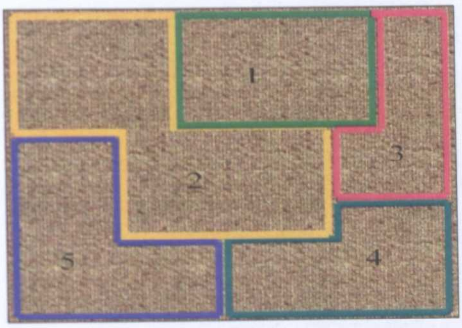

5- Which figure is the correct ansv

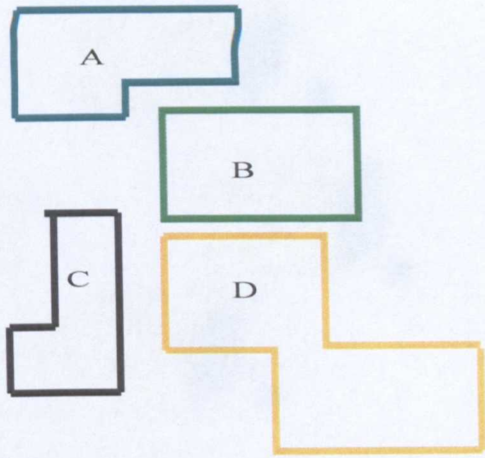



**6-Match each lettered piece to each numbered position**

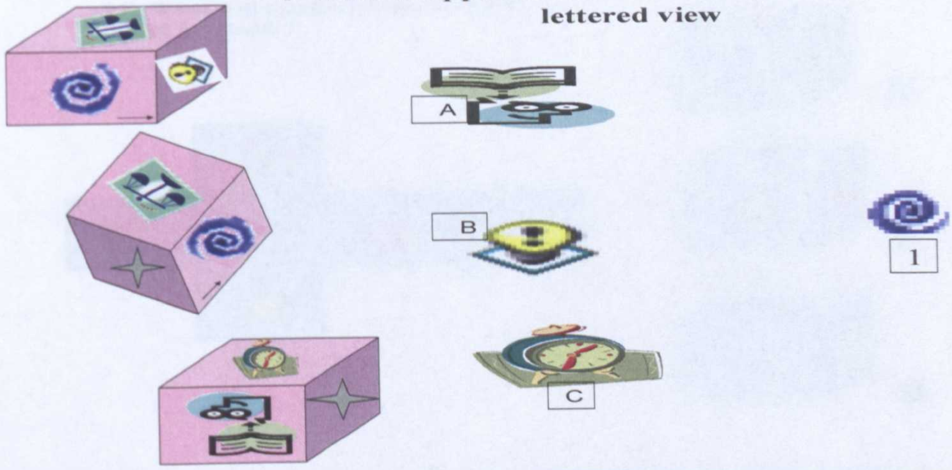


7- Find the place where each *lettered* piece can replace each numbered position

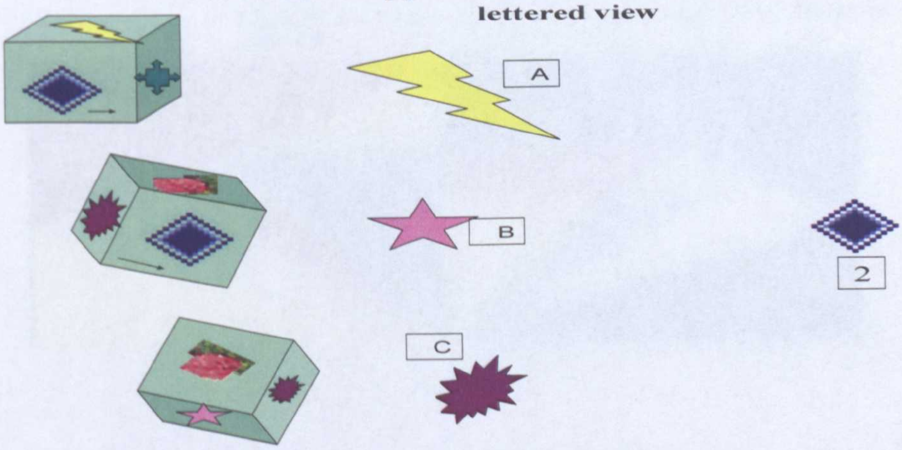


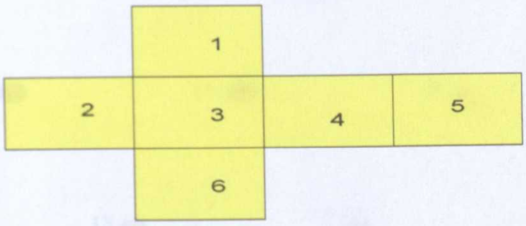

**8-What is opposite each numbered view from each lettered view**

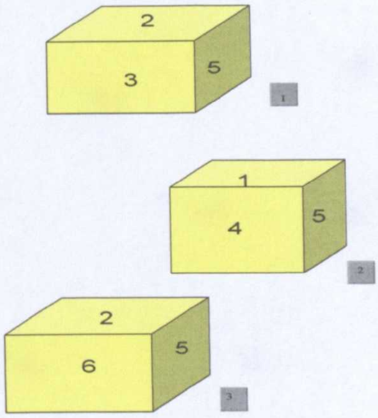



**9- What is opposite each numbered view from each lettered view**

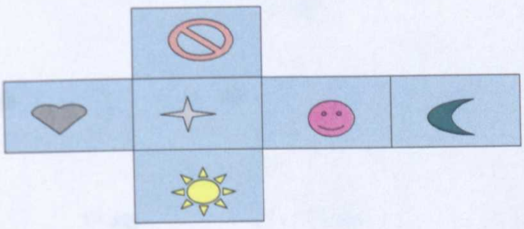


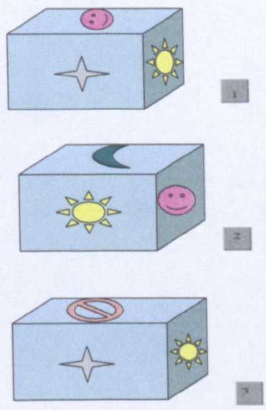
10 -What will a pattern look like when it is folded into cube ?



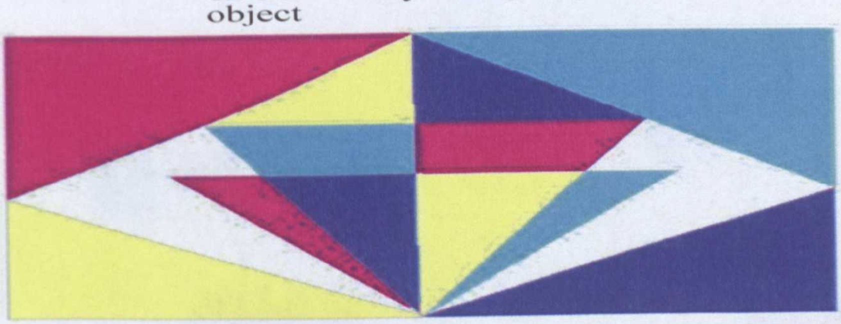



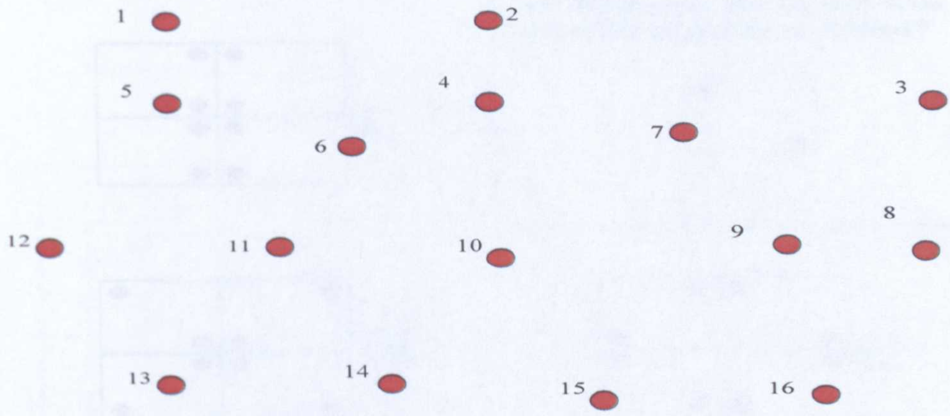

11 -What will a pattern look like when it is folded into cube ?



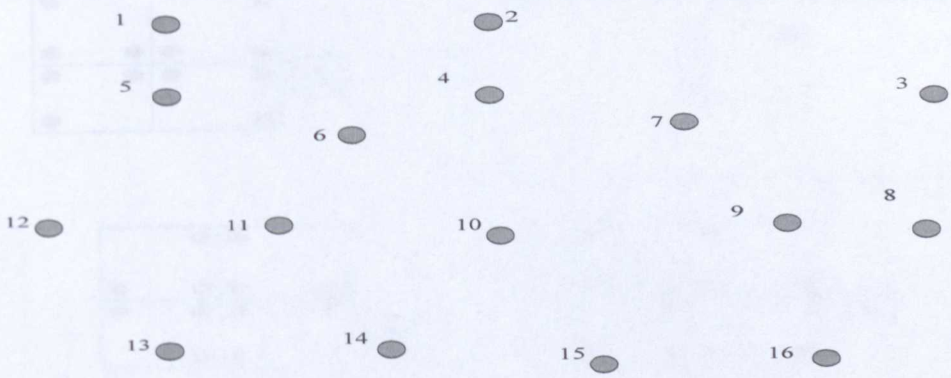



12-how many triangles you can see in this object



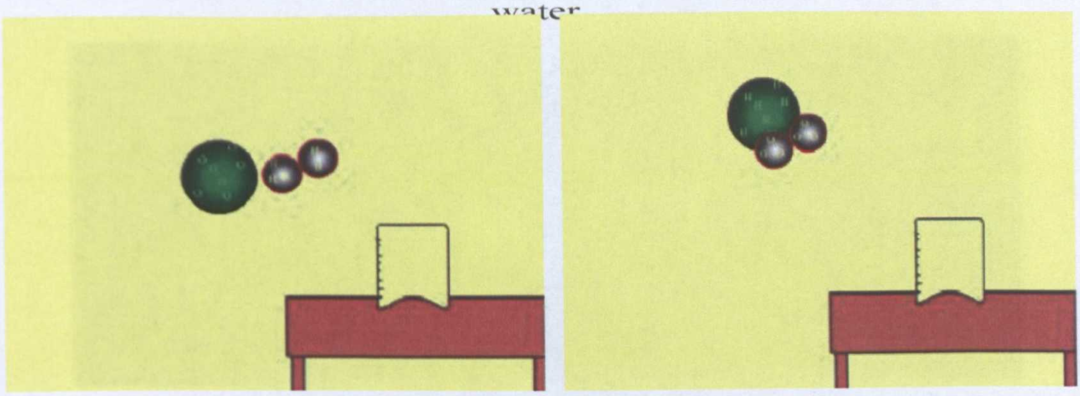



13 -Find a square is hidden in the dots

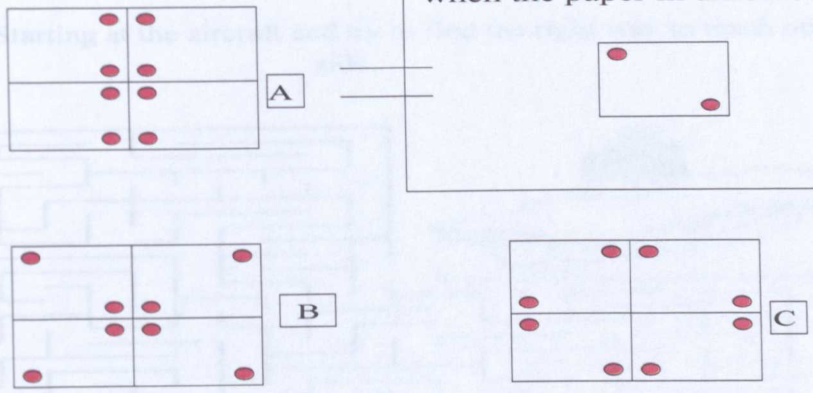



14 -Find circle is hidden in the dots .

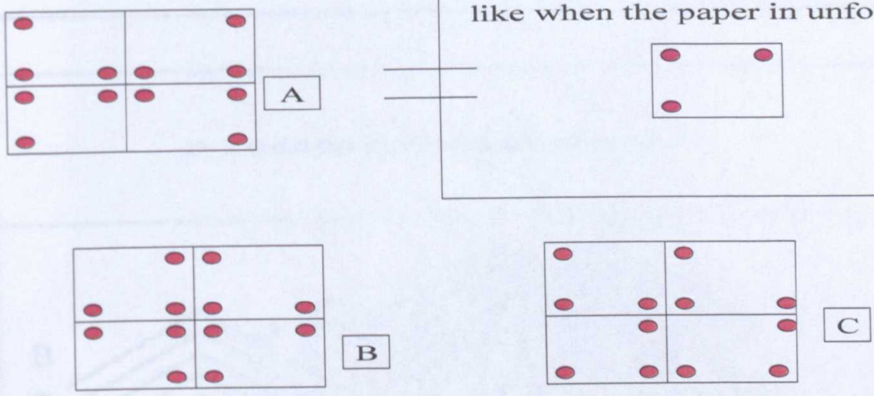
15- Water is compose of three atoms, two of hydrogen and one of oxygen, which picture shows the composite water



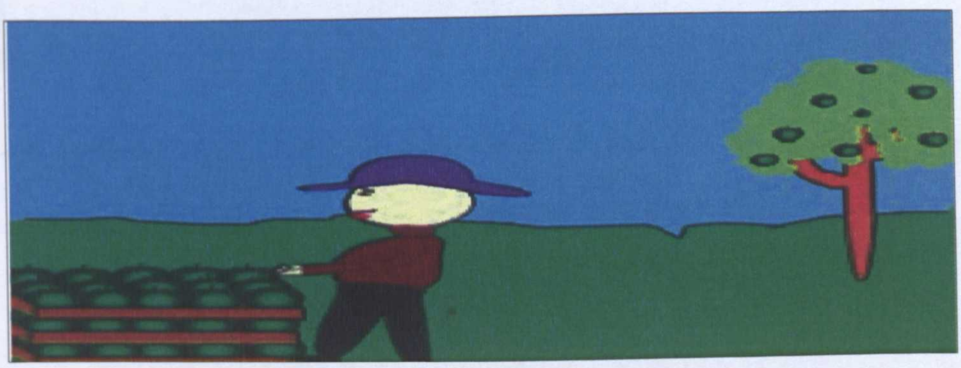
16- What will the square look like when the paper in unfolded?



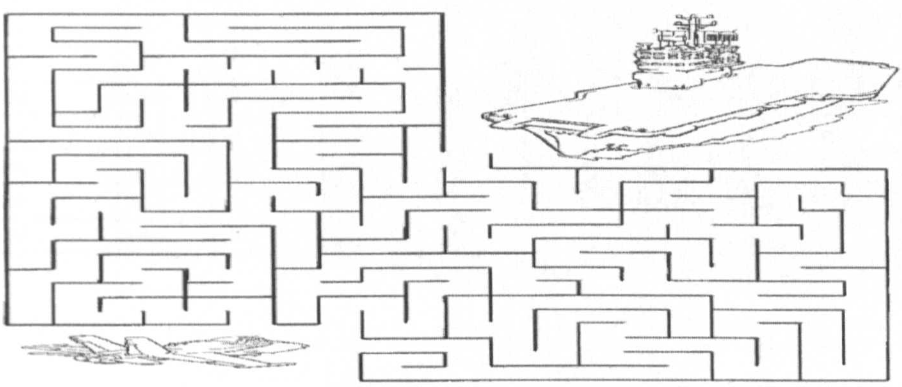

17-What will the square look like when the paper in unfolded?




18- How many apples does the farmer pick to fill three box



19- Starting at the aircraft and try to find the right way to reach other side



20- Start at A then try to find the right way to reach B

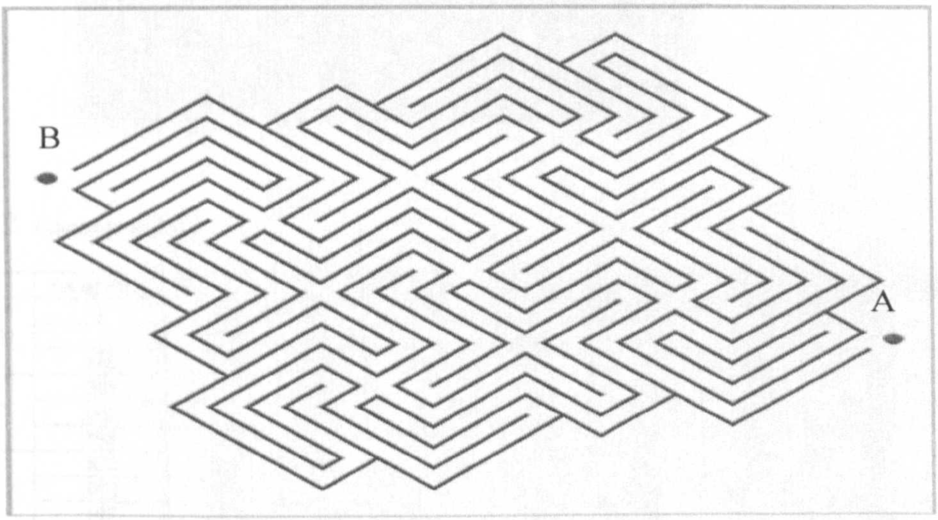


Table B.1 pilot study factor analysis convergent test

| Total Variance Explained | Initial Eigenvalues | | | Extraction Sums of Squared Loadings | | | Rotation Sums of Squared Loadings | | |
|---|---|---|---|---|---|---|---|---|---|
| Component | Total | % of Variance | Cumulative % | Total | % of Variance | Cumulative % | Total | % of Variance | Cumulative % |
| 1.00 | 3.72 | 20.66 | 20.66 | 3.72 | 20.66 | 20.66 | 2.28 | 12.64 | 12.64 |
| 2.00 | 2.00 | 11.12 | 31.79 | 2.00 | 11.12 | 31.79 | 2.22 | 12.32 | 24.96 |
| 3.00 | 1.84 | 10.24 | 42.03 | 1.84 | 10.24 | 42.03 | 2.17 | 12.06 | 37.01 |
| 4.00 | 1.74 | 9.65 | 51.67 | 1.74 | 9.65 | 51.67 | 2.02 | 11.25 | 48.26 |
| 5.00 | 1.16 | 6.44 | 58.12 | 1.16 | 6.44 | 58.12 | 1.50 | 8.31 | 56.57 |
| 6.00 | 1.13 | 6.26 | 64.38 | 1.13 | 6.26 | 64.38 | 1.34 | 7.44 | 64.01 |
| 7.00 | 1.07 | 5.96 | 70.34 | 1.07 | 5.96 | 70.34 | 1.14 | 6.33 | 70.34 |
| 8.00 | 0.93 | 5.19 | 75.54 | | | | | | |

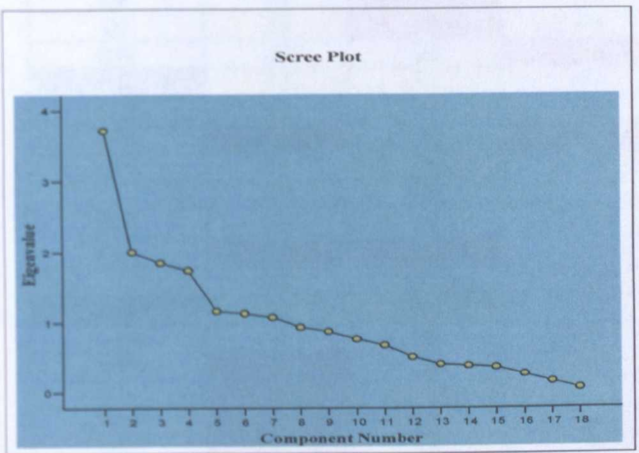



Table B.2 Pearson Correlation

| | Social study | ISLAMIC | MATH | SCINCE | ENGLISH | ARABIC | ZTOTAL | TOTALCON | TotalZ2004 |
|---|---|---|---|---|---|---|---|---|---|
| Social study | 1 | .885 | .822 | .836 | .786 | .811 | .916 | .160 | .062 |
| | . | .000 | .000 | .000 | .000 | .000 | .000 | .024 | .384 |
| | 198 | 198 | 198 | 198 | 198 | 198 | 198 | 198 | 198 |
| ISLAMIC | .885 | 1 | .895 | .855 | .853 | .872 | .955 | .183 | .067 |
| | .000 | . | .000 | .000 | .000 | .000 | .000 | .010 | .346 |
| | 198 | 198 | 198 | 198 | 198 | 198 | 198 | 198 | 198 |
| MATH | .822 | .895 | 1 | .886 | .854 | .838 | .943 | .235 | .212 |
| | .000 | .000 | . | .000 | .000 | .000 | .000 | .001 | .003 |
| | 198 | 198 | 198 | 198 | 198 | 198 | 198 | 198 | 198 |
| SCINCE | .836 | .855 | .886 | 1 | .850 | .862 | .942 | .156 | .209 |
| | .000 | .000 | .000 | . | .000 | .000 | .000 | .028 | .003 |
| | 198 | 198 | 198 | 198 | 198 | 198 | 198 | 198 | 198 |
| ENGLISH | .786 | .853 | .854 | .850 | 1 | .851 | .925 | .165 | .177 |
| | .000 | .000 | .000 | .000 | . | .000 | .000 | .021 | .013 |
| | 198 | 198 | 198 | 198 | 198 | 198 | 198 | 198 | 198 |
| ARABIC | .811 | .872 | .838 | .862 | .851 | 1 | .932 | .230 | .219 |
| | .000 | .000 | .000 | .000 | .000 | . | .000 | .001 | .002 |
| | 198 | 198 | 198 | 198 | 198 | 198 | 198 | 198 | 198 |
| ZTOTAL | .916 | .955 | .943 | .942 | .925 | .932 | 1 | .201 | .169 |
| | .000 | .000 | .000 | .000 | .000 | .000 | . | .005 | .018 |
| | 198 | 198 | 198 | 198 | 198 | 198 | 198 | 198 | 198 |
| TOTALCON | .160 | .183 | .235 | .156 | .165 | .230 | .201 | 1 | .173 |
| | .024 | .010 | .001 | .028 | .021 | .001 | .005 | . | .015 |
| | 198 | 198 | 198 | 198 | 198 | 198 | 198 | 198 | 198 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| TotalZ2004 | .062 | .067 | .212 | .209 | .177 | .219 | .169 | .173 | 1 |
| | .384 | .346 | .003 | .003 | .013 | .002 | .018 | .015 | . |
| | 198 | 198 | 198 | 198 | 198 | 198 | 198 | 198 | 198 |

** Correlation is significant at the 0.01 level (2-tailed).
* Correlation is significant at the 0.05 level (2-tailed).

**Table B.3 Correlations of Questionnaire with tests**

| | 728 | 633 | 287 | 422 |
|---|---|---|---|---|
| Kendall's tau_b | Total Marks | Convergency | Visual-spatial 3 | Divergency |
| Q1 | .05 | .06 | .03 | .02 |
| Q2 | .01 | -.03 | -.00 | .02 |
| Q3 | .07 | .04 | .06 | .04 |
| Q4 | .106 | .158 | .04 | .15 |
| Q5 | .07 | .06 | .04 | .06 |
| Q6 | .05 | .06 | .01 | .07 |
| Q7 | -.01 | -.01 | -.08 | .00 |
| Q8 | .04 | .07 | -.01 | .05 |
| Q9 | .13 | .08 | .03 | -.02 |
| Q10 | -.03 | .00 | -.10 | .06 |
| Q11 | .13 | .11 | .01 | .12 |
| Q12 | .05 | .05 | -.04 | .12 |
| Q13 | .07 | .06 | .07 | .11 |
| Q14 | .08 | .11 | -.07 | .12 |
| p | .004 | .000 | | .003 |
| Q15 | .02 | .04 | -.07 | .02 |
| Q16 | .08 | .08 | .03 | .13 |
| P | .007 | .012 | .519 | .000 |
| Q17 | .12 | .12 | .03 | .13 |
| Q18 | .04 | .03 | .02 | .04 |
| Q19 | .08 | .06 | .03 | .03 |
| P | .006 | .049 | | |
| Q20 | -.04 | .02 | -.03 | .05 |
| Q21 | -.06 | .00 | .04 | -.00 |
| P | .026 | | | |
| P2Q1 | -.02 | -.10 | -.03 | -.06 |
| P2Q2 | .06 | .10 | .03 | .04 |
| P2Q3 | .12 | .05 | .01 | .07 |
| P2Q4 | .02 | .04 | -.03 | -.02 |
| P2Q5 | .08 | .02 | .01 | .07 |
| P2Q6 | -.11 | -.09 | -.02 | -.08 |
| P2Q7 | .11 | .13 | .08 | .12 |
| P2Q8 | .05 | .02 | .03 | .03 |
| P2Q9 | -.03 | -.09 | -.10 | -.07 |
| P | | .005 | .032 | .065 |
| P2Q10 | -.02 | -.05 | .03 | -.10 |
| P2Q11 | .01 | -.01 | .02 | -.03 |
| P2Q12 | -.03 | -.06 | .00 | -.10 |
| | | .045 | | .010 |

# Appendix C

## Visual-spatial Test
## CD
## Instruction

## Use of CD

**Open CD**

- Select: Visual-Spatial E 2.pps
- This should run on most versions of Powerpoint
- The program should run without any further intervention.

**Note:**

- This is an English translation of the second version of the program.
- The first version is also on the DVD: Visual-Spatial E 1.pps
- The trial version is called: Visual-test1pilot E test.pps
- There are also versions with the same names but the prefix: .ppt
- These can be run as a slide presentation from Powerpoint.

# Appendix D

D1- Experiment 1

D2- Experiment 2

D3- Experiment 3

# Appendix D1

## Experiment 1

Working Memory Capacity

Four Methods Used

Using the traditional method
Using the traditional method with some modification
Converting scores to arbitrary working memory capacity
Combining (c) and (d)

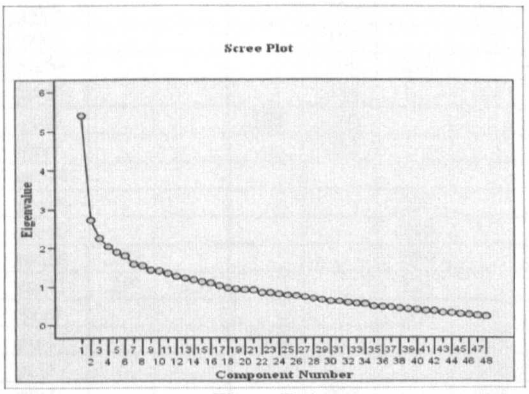
1. The way of combining approaches (c) and (d) was as follows:
2. Where the two results differed by more than 2 the lower one was raised by 1.5
3. Where the two results differed by 2 the lower one was raised by 1
4. Where the two results differed by 1.5 the lower one was raised by 0.5
5. In other cases, the lower one was left unaltered.

In practice, the proportion being changed was not large.

Visual-spatial Pilot study stage 3

Table D.1 Total Variance Explained: visual spatial 1 factor analysis

| Component | Initial Eigenvalues | | | Extraction Sums of Squared Loadings | | | Rotation Sums of Squared Loadings | | |
|---|---|---|---|---|---|---|---|---|---|
| | Total | % of Variance | Cumulative % | Total | % of Variance | Cumulative % | Total | % of Variance | Cumulative % |
| 1 | 5.410 | 11.272 | 11.272 | 5.410 | 11.272 | 11.272 | 3.196 | 6.659 | 6.659 |
| 2 | 2.722 | 5.672 | 16.944 | 2.722 | 5.672 | 16.944 | 3.193 | 6.652 | 13.311 |
| 3 | 2.2 | 4.7 | 21.6 | 2.2 | 4.7 | 21.6 | 2.2 | 4.6 | 17.9 |
| 4 | 2.0 | 4.2 | 25.9 | 2.0 | 4.2 | 25.9 | 2.1 | 4.3 | 22.3 |
| 5 | 1.8 | 3.9 | 29.8 | 1.8 | 3.9 | 29.8 | 1.8 | 3.8 | 26.1 |
| 6 | 1.7 | 3.7 | 33.5 | 1.7 | 3.7 | 33.5 | 1.7 | 3.7 | 29.8 |
| 7 | 1.5 | 3.2 | 36.8 | 1.5 | 3.2 | 36.8 | 1.6 | 3.3 | 33.2 |
| 8 | 1.5 | 3.2 | 40.1 | 1.5 | 3.2 | 40.1 | 1.6 | 3.3 | 36.6 |
| 9 | 1.4 | 2.9 | 43.0 | 1.4 | 2.9 | 43.0 | 1.5 | 3.3 | 39.9 |
| 10 | 1.4 | 2.9 | 45.9 | 1.4 | 2.9 | 45.9 | 1.4 | 3.1 | 42.9 |
| 11 | 1.3 | 2.7 | 48.7 | 1.3 | 2.2 | 48.7 | 1.4 | 2.9 | 45.9 |
| 12 | 1.2 | 2.6 | 51.3 | 1.2 | 2.6 | 51.3 | 1.4 | 2.9 | 48.8 |
| 13 | 1.2 | 2.5 | 53.9 | 1.2 | 2.5 | 53.9 | 1.3 | 2.8 | 51.7 |
| 14 | 1.1 | 2.4 | 56.3 | 1.1 | 2.4 | 56.3 | 1.3 | 2.8 | 54.6 |
| 15 | 1.1 | 2.3 | 58.7 | 1.1 | 2.3 | 58.7 | 1.3 | 2.8 | 57.4 |
| 16 | 1.0 | 2.2 | 60.9 | 1.0 | 2.2 | 60.9 | 1.3 | 2.8 | 60.3 |
| 17 | 1.0 | 2.1 | 63.1 | 1.0 | 2.1 | 63.1 | 1.3 | 2.8 | 63.1 |
| 18 | .96 | 2.01 | 65.1 | | | | | | |




**FigureD.1**

Table 0.2 Total Variance Explained

| Component | Initial Eigenvalues | | | Extraction Sums of Squared Loadings | | | Rotation Sums of Squared Loadings | | |
|---|---|---|---|---|---|---|---|---|---|
| | Total | % of Variance | Cumulative % | Total | % of Variance | Cumulative % | Total | % of Variance | Cumulative % |
| 1 | 5.3 | 11.6 | 11.6 | 5.3 | 11.6 | 11.6 | 3.4 | 7.4 | 7.4 |
| 2 | 2.7 | 5.9 | 17.6 | 2.7 | 5.9 | 17.6 | 3.3 | 7.2 | 14.6 |
| 3 | 2.2 | 4.8 | 22.4 | 2.2 | 4.8 | 22.4 | 2.6 | 5.6 | 20.3 |
| 4 | 2.0 | 4.4 | 26.8 | 2.0 | 4.4 | 26.8 | 2.5 | 5.4 | 25.7 |
| 5 | 1.8 | 4.1 | 30.9 | 1.8 | 4.1 | 30.9 | 2.2 | 4.8 | 30.5 |
| 6 | 1.7 | 3.8 | 34.8 | 1.7 | 3.8 | 34.8 | 1.9 | 4.2 | 34.8 |

Extraction Method: Principal Component Analysis.

Table D.3 Rotated Component Matrix

| | Component | | | | | |
|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 |
| pre12 | .711 | | | | | |
| pre17 | .695 | | | | | |
| pre16 | .694 | | | | | |
| pre11 | .678 | | | | | |
| pre13 | .570 | | | | | |
| pre23 | .524 | .241 | .262 | | | |
| pre19 | .395 | | .202 | | | |
| pre45 | .355 | | | | | |
| pre35 | | .765 | | | | |
| pre36 | | .755 | | | | |
| pre33 | | .729 | | .205 | | |
| pre34 | | .710 | | | | |
| pre37 | | .539 | | | | |
| pre8 | | .213 | | | | |
| pre26 | | | .652 | | | |
| pre25 | | | .635 | | | .211 |
| pre24 | | | .573 | | | |
| pre32 | | .230 | .476 | | | |
| pre30 | | .237 | .476 | | | |
| pre29 | .274 | | .368 | | | |
| pre15 | .264 | | .346 | | | |
| pre50 | | | -.220 | | | |
| pre4 | | | | .548 | | |
| pre10 | .204 | | | .531 | | |
| pre2 | | | | .477 | | |
| preVs1 | | .273 | | .441 | | |
| pre9 | | | | .390 | | .239 |
| pre5 | | | | .365 | | |
| pre54 | | | | .359 | -.249 | |
| pre55 | | | | .349 | | |
| pre6 | | | .234 | -.295 | | |
| pre7 | | | | .292 | | |
| pre44 | | | | | | |
| pre39 | | | | | .798 | |
| pre40 | | | | | .796 | |
| pre38 | .207 | | | | .599 | |
| pre41 | .249 | -.234 | | | .336 | |
| pre3 | | | | | -.314 | |
| pre21 | | | .268 | | | .618 |
| pre57 | | | | | | .548 |
| pre46 | | | | .207 | | .492 |
| pre43 | | -.279 | .270 | .296 | | -.416 |
| pre42 | | -.296 | .333 | .398 | | -.403 |
| pre52 | | | | | .255 | .356 |
| pre47 | | | .257 | | | .335 |
| pre56 | | | | .201 | | .301 |

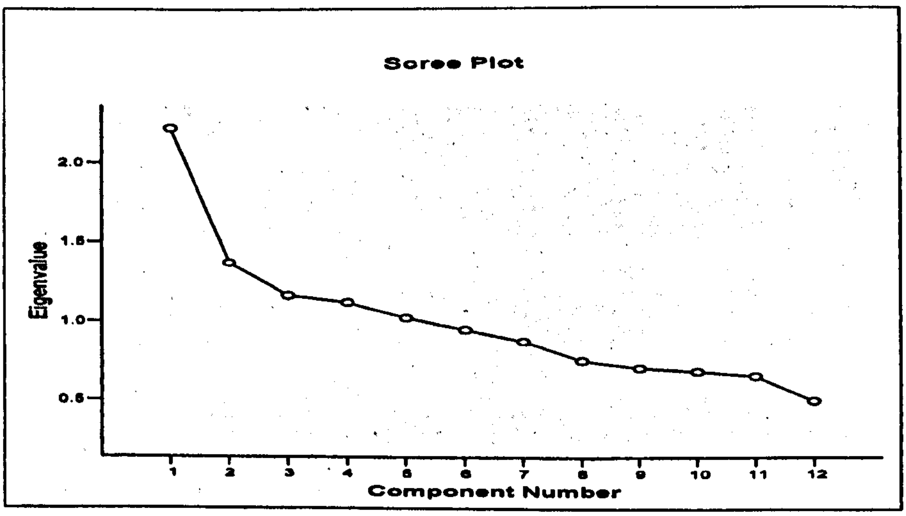
Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.
a Rotation converged in 7 iterations.

Appendix D 2

Experiment 2

| Table D4: Correlation Matrix | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | VS1 | VS2 | VS3 | VS4 | VS5 | VS6 | VS7 | VS8 | VS9 | VS10 | VS11 | VS12 |
| VS1 | 1.0 | 0.1 | 0.1 | 0.1 | 0.1 | 0.2 | 0.0 | 0.1 | 0.0 | 0.2 | 0.0 | 0.1 |
| VS2 | 0.1 | 1.0 | 0.1 | 0.0 | 0.2 | 0.1 | 0.1 | 0.2 | 0.1 | 0.2 | 0.2 | 0.1 |
| VS3 | 0.1 | 0.1 | 1.0 | 0.2 | 0.1 | 0.0 | 0.0 | 0.0 | 0.2 | -0.1 | 0.0 | 0.0 |
| VS4 | 0.1 | 0.0 | 0.2 | 1.0 | -0.1 | 0.0 | 0.1 | -0.1 | 0.1 | 0.0 | -0.1 | 0.0 |
| VS5 | 0.1 | 0.2 | 0.1 | -0.1 | 1.0 | 0.1 | 0.0 | 0.1 | 0.0 | 0.1 | 0.1 | 0.2 |
| VS6 | 0.2 | 0.1 | 0.0 | 0.0 | 0.1 | 1.0 | 0.1 | 0.0 | 0.0 | 0.4 | 0.1 | 0.3 |
| VS7 | 0.0 | 0.1 | 0.0 | 0.1 | 0.0 | 0.1 | 1.0 | 0.1 | 0.1 | 0.0 | 0.1 | 0.2 |
| VS8 | 0.1 | 0.2 | 0.0 | -0.1 | 0.1 | 0.0 | 0.1 | 1.0 | 0.1 | 0.1 | 0.1 | 0.1 |
| VS9 | 0.0 | 0.1 | 0.2 | 0.1 | 0.0 | 0.0 | 0.1 | 0.1 | 1.0 | 0.1 | 0.1 | 0.2 |
| VS10 | 0.2 | 0.2 | -0.1 | 0.0 | 0.1 | 0.4 | 0.0 | 0.1 | 0.1 | 1.0 | 0.3 | 0.2 |
| VS11 | 0.0 | 0.2 | 0.0 | -0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.3 | 1.0 | 0.2 |
| VS12 | 0.1 | 0.1 | 0.0 | 0.0 | 0.2 | 0.3 | 0.2 | 0.1 | 0.2 | 0.2 | 0.2 | 1.0 |

| Table D5: Total Variance Explained | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Compo | Initial Eigenvalues | | | Extraction Sums of S | | | Rotation Sums of Squared Loadings | | |
| | Total | % of V | Cumul | Total | % of V | Cumul | Total | % of V | Cumulative % |
| 1.0 | 2.2 | 18.5 | 18.5 | 2.2 | 18.5 | 18.5 | 1.7 | 14.3 | 14.3 |
| 2.0 | 1.4 | 11.4 | 29.9 | 1.4 | 11.4 | 29.9 | 1.4 | 11.5 | 25.9 |
| 3.0 | 1.2 | 9.7 | 39.6 | 1.2 | 9.7 | 39.6 | 1.3 | 11.1 | 36.9 |
| 4.0 | 1.1 | 9.4 | 49.0 | 1.1 | 9.4 | 49.0 | 1.3 | 11.0 | 48.0 |
| 5.0 | 1.0 | 8.5 | 57.5 | 1.0 | 8.5 | 57.5 | 1.1 | 9.6 | 57.5 |
| 6.0 | 1.0 | 7.9 | 65.4 | | | | | | |
| 7.0 | 0.9 | 7.3 | 72.7 | | | | | | |
| 8.0 | 0.8 | 6.3 | 79.0 | | | | | | |
| 9.0 | 0.7 | 5.8 | 84.8 | | | | | | |
| 10.0 | 0.7 | 5.7 | 90.5 | | | | | | |
| 11.0 | 0.6 | 5.4 | 95.9 | | | | | | |
| 12.0 | 0.5 | 4.1 | 100.0 | | | | | | |
| Extraction Method: Principal Component Analysis. | | | | | | | | | |



| Table D6: Correlation Matrix | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | FD1 | FD2 | FD3 | FD4 | FD5 | FD6 | FI1 | FI2 | FI3 | item10 | item11 | item12 |
| FD1 | 1.0 | 0.0 | 0.0 | 0.1 | 0.0 | 0.1 | -0.2 | 0.1 | 0.2 | 0.0 | 0.0 | 0.0 |
| FD2 | 0.0 | 1.0 | 0.3 | 0.3 | 0.0 | 0.1 | 0.1 | -0.2 | 0.1 | 0.0 | 0.0 | 0.0 |
| FD3 | 0.0 | 0.3 | 1.0 | 0.4 | 0.1 | 0.0 | 0.2 | -0.1 | -0.1 | 0.1 | 0.1 | 0.2 |
| FD4 | 0.1 | 0.3 | 0.4 | 1.0 | 0.0 | 0.1 | 0.2 | -0.1 | -0.1 | 0.1 | 0.1 | 0.1 |
| FD5 | 0.0 | 0.0 | 0.1 | 0.0 | 1.0 | 0.0 | 0.1 | 0.2 | 0.0 | 0.1 | -0.2 | 0.0 |
| FD6 | 0.1 | 0.1 | 0.0 | 0.1 | 0.0 | 1.0 | 0.0 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 |
| FI1 | -0.2 | 0.1 | 0.2 | 0.2 | 0.1 | 0.0 | 1.0 | -0.1 | -0.1 | 0.2 | 0.2 | 0.2 |
| FI2 | 0.1 | -0.2 | -0.1 | -0.1 | 0.2 | 0.1 | -0.1 | 1.0 | 0.1 | -0.1 | 0.0 | 0.0 |
| FI3 | 0.2 | 0.1 | -0.1 | -0.1 | 0.0 | 0.1 | -0.1 | 0.1 | 1.0 | 0.0 | 0.0 | -0.1 |
| FI4 | 0.0 | 0.0 | 0.1 | 0.1 | 0.1 | 0.1 | 0.2 | -0.1 | 0.0 | 1.0 | 0.1 | 0.3 |
| FI5 | 0.0 | 0.0 | 0.1 | 0.1 | -0.2 | 0.1 | 0.2 | 0.0 | 0.0 | 0.1 | 1.0 | 0.1 |
| FI6 | 0.0 | 0.0 | 0.2 | 0.1 | 0.0 | 0.1 | 0.2 | 0.0 | -0.1 | 0.3 | 0.1 | 1.0 |

| TableD7: Total Variance Explained | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Comp | Initial Eigenvalues | | | Extraction Sums of S | | | Rotation Sums of Squared Loadings | | |
| | Total | % of V | Cumul | Total | % of V | Cumul | Total | % of V | Cumulative % |
| 1.0 | 2.0 | 16.7 | 16.7 | 2.0 | 16.7 | 16.7 | 1.7 | 14.4 | 14.4 |
| 2.0 | 1.5 | 12.1 | 28.8 | 1.5 | 12.1 | 28.8 | 1.5 | 12.2 | 26.6 |
| 3.0 | 1.3 | 11.1 | 39.9 | 1.3 | 11.1 | 39.9 | 1.5 | 12.2 | 38.8 |
| 4.0 | 1.3 | 10.8 | 50.7 | 1.3 | 10.8 | 50.7 | 1.3 | 10.5 | 49.3 |
| 5.0 | 1.0 | 8.4 | 59.1 | 1.0 | 8.4 | 59.1 | 1.2 | 9.8 | 59.1 |
| 6.0 | 0.9 | 7.7 | 66.8 | | | | | | |
| 7.0 | 0.8 | 7.0 | 73.8 | | | | | | |
| 8.0 | 0.8 | 6.5 | 80.3 | | | | | | |
| 9.0 | 0.7 | 5.8 | 86.1 | | | | | | |
| 10.0 | 0.6 | 5.3 | 91.3 | | | | | | |
| 11.0 | 0.6 | 4.8 | 96.1 | | | | | | |
| 12.0 | 0.5 | 3.9 | 100.0 | | | | | | |
| Extraction Method: Principal Component Analysis. | | | | | | | | | |

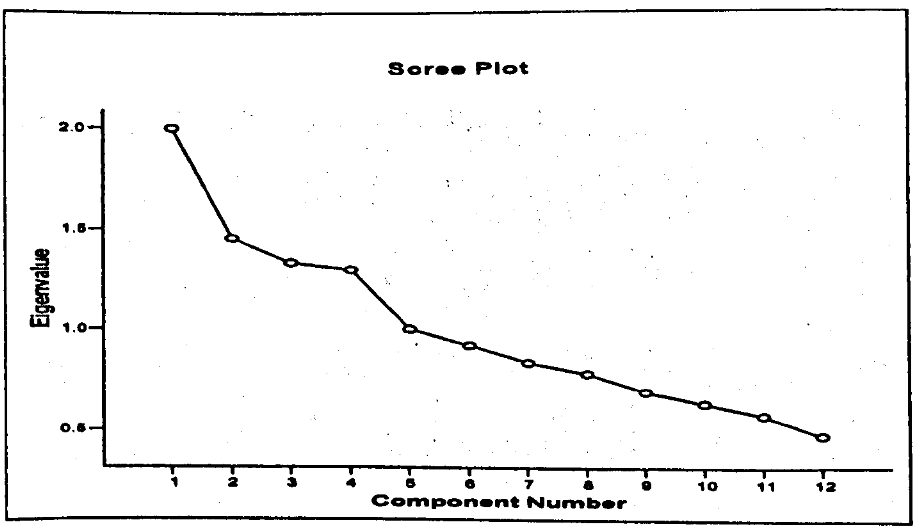


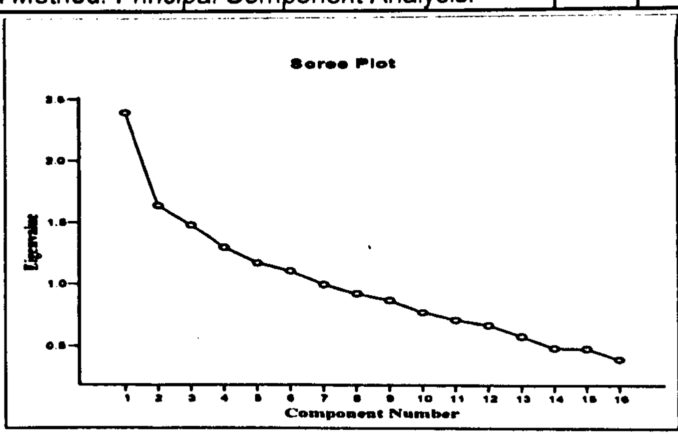
Table D8: Correlation Matrix

| CON1 | CON2 | CON3 | CON4 | CON5 | CON6 | CON7 | DIV1 | DIV2 | DIV3 | DIV4 | DIV5 | DIV6 | Div7 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1.0 | 0.0 | 0.1 | 0.0 | 0.1 | 0.3 | 0.1 | 0.1 | -0.1 | 0.0 | 0.2 | 0.0 | 0.0 | 0.2 |
| 0.0 | 1.0 | -0.2 | 0.1 | -0.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | -0.1 | 0.1 | 0.1 | 0.1 |
| 0.1 | -0.2 | 1.0 | 0.3 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.2 | 0.1 | 0.1 | 0.1 |
| 0.0 | 0.1 | 0.3 | 1.0 | 0.4 | 0.1 | 0.0 | 0.1 | 0.1 | 0.1 | 0.2 | 0.1 | 0.2 | 0.2 |
| 0.1 | -0.1 | 0.1 | 0.4 | 1.0 | 0.0 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.0 | 0.0 | 0.0 |
| 0.3 | 0.0 | 0.1 | 0.1 | 0.0 | 1.0 | 0.1 | 0.1 | 0.0 | 0.1 | 0.2 | -0.2 | 0.1 | 0.1 |
| 0.1 | 0.0 | 0.1 | 0.0 | 0.1 | 0.1 | 1.0 | 0.2 | 0.2 | 0.2 | -0.1 | 0.1 | -0.1 | -0.2 |
| 0.1 | 0.0 | 0.1 | 0.1 | 0.1 | 0.1 | 0.2 | 1.0 | 0.2 | 0.2 | 0.1 | 0.2 | 0.4 | 0.2 |
| -0.1 | 0.0 | 0.1 | 0.1 | 0.1 | 0.0 | 0.2 | 0.2 | 1.0 | 0.2 | 0.1 | 0.1 | 0.1 | 0.0 |
| 0.0 | 0.0 | 0.1 | 0.1 | 0.1 | 0.1 | 0.2 | 0.2 | 0.2 | 1.0 | 0.2 | 0.0 | 0.2 | 0.0 |
| 0.2 | -0.1 | 0.2 | 0.2 | 0.1 | 0.2 | -0.1 | 0.1 | 0.1 | 0.2 | 1.0 | -0.1 | 0.1 | 0.2 |
| 0.0 | 0.1 | 0.1 | 0.1 | 0.0 | -0.2 | 0.1 | 0.2 | 0.1 | 0.0 | -0.1 | 1.0 | 0.0 | -0.1 |
| 0.0 | 0.1 | 0.1 | 0.2 | 0.0 | 0.1 | -0.1 | 0.4 | 0.1 | 0.2 | 0.1 | 0.0 | 1.0 | 0.2 |
| 0.2 | 0.1 | 0.1 | 0.2 | 0.0 | 0.1 | -0.2 | 0.2 | 0.0 | 0.0 | 0.2 | -0.1 | 0.2 | 1.0 |
| -0.2 | 0.1 | 0.0 | 0.0 | 0.0 | -0.1 | 0.1 | 0.2 | 0.1 | -0.1 | 0.1 | 0.0 | 0.1 | 0.0 |

Table D9: Total Variance Explained

| Compo | Initial Eigenvalues | | | Extraction Sums of S | | | Rotation Sums of Squared Loadings | | |
|---|---|---|---|---|---|---|---|---|---|
| | Total | % of V | Cumul | Total | % of V | Cumul | Total | % of V | Cumulative % |
| 1.0 | 2.4 | 15.0 | 15.0 | 2.4 | 15.0 | 15.0 | 1.8 | 11.0 | 11.0 |
| 2.0 | 1.6 | 10.2 | 25.2 | 1.6 | 10.2 | 25.2 | 1.7 | 10.7 | 21.7 |
| 3.0 | 1.5 | 9.3 | 34.5 | 1.5 | 9.3 | 34.5 | 1.5 | 9.4 | 31.2 |
| 4.0 | 1.3 | 8.1 | 42.6 | 1.3 | 8.1 | 42.6 | 1.5 | 9.4 | 40.5 |
| 5.0 | 1.2 | 7.4 | 49.9 | 1.2 | 7.4 | 49.9 | 1.3 | 8.3 | 48.8 |
| 6.0 | 1.1 | 7.0 | 56.9 | 1.1 | 7.0 | 56.9 | 1.3 | 8.1 | 56.9 |
| 7.0 | 1.0 | 6.2 | 63.2 | | | | | | |
| 8.0 | 0.9 | 5.8 | 69.0 | | | | | | |
| 9.0 | 0.9 | 5.5 | 74.4 | | | | | | |
| 10.0 | 0.8 | 4.8 | 79.3 | | | | | | |
| 11.0 | 0.7 | 4.4 | 83.7 | | | | | | |
| 12.0 | 0.7 | 4.2 | 87.9 | | | | | | |
| 13.0 | 0.6 | 3.6 | 91.5 | | | | | | |
| 14.0 | 0.5 | 3.0 | 94.5 | | | | | | |
| 15.0 | 0.5 | 3.0 | 97.5 | | | | | | |
| 16.0 | 0.4 | 2.5 | 100.0 | | | | | | |

Extraction Method: Principal Component Analysis.



Appendix D3

Experiment 3

## Factor Analyziz To Convergency test

Table D1: Total Variance Explained

| Compo | Initial Eigenvalues | | | Extraction Sums of S | | | Rotation Sums of Squared L | | |
|---|---|---|---|---|---|---|---|---|---|
| | Total | % of V | Cumul | Total | % of V | Cumul | Total | % of V | Cumulative % |
| 1 | 4 | 21 | 21 | 4 | 21 | 21 | 2 | 13 | 13 |
| 2 | 2 | 11 | 32 | 2 | 11 | 32 | 2 | 12 | 25 |
| 3 | 2 | 10 | 42 | 2 | 10 | 42 | 2 | 12 | 37 |
| 4 | 2 | 10 | 52 | 2 | 10 | 52 | 2 | 11 | 48 |
| 5 | 1 | 6 | 58 | 1 | 6 | 58 | 1 | 8 | 57 |
| 6 | 1 | 6 | 64 | 1 | 6 | 64 | 1 | 7 | 64 |
| 7 | 1 | 6 | 70 | 1 | 6 | 70 | 1 | 6 | 70 |
| 8 | 1 | 5 | 76 | | | | | | |
| 9 | 1 | 5 | 80 | | | | | | |
| 10 | 1 | 4 | 85 | | | | | | |
| 11 | 1 | 4 | 88 | | | | | | |
| 12 | 1 | 3 | 91 | | | | | | |
| 13 | 0 | 2 | 93 | | | | | | |
| 14 | 0 | 2 | 95 | | | | | | |
| 15 | 0 | 2 | 97 | | | | | | |
| 16 | 0 | 1 | 99 | | | | | | |
| 17 | 0 | 1 | 100 | | | | | | |
| 18 | 0 | 0 | 100 | | | | | | |

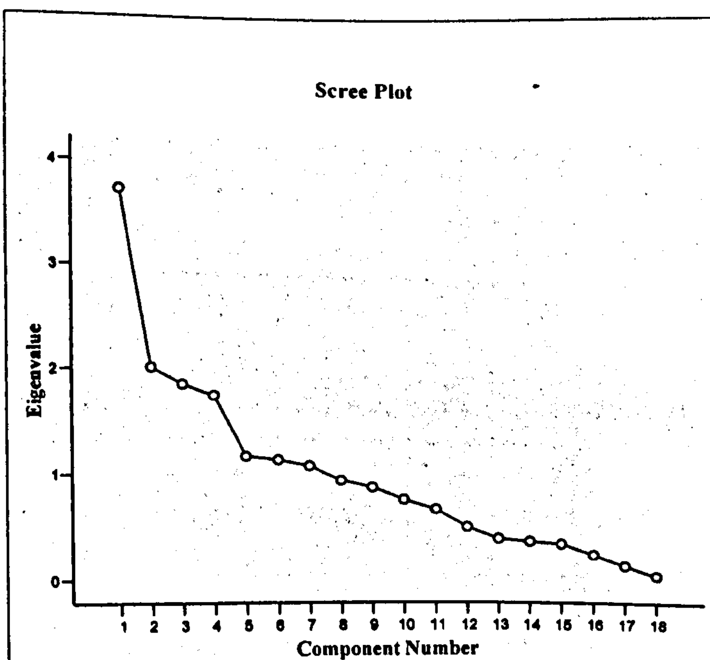


Table D2: Rotated Component Matrix

| | Component | | | |
|---|---|---|---|---|
| | 1.00 | 2.00 | 3.00 | 4.00 |
| Q3-3R | 0.73 | | | |
| Q3-3re | 0.73 | | | |
| Q1-1a | 0.66 | | | |
| Q3-4re | 0.54 | 0.35 | 0.42 | |
| Q2-m3 | 0.45 | | | |
| Q1-3a | 0.39 | | | |
| Q1-3b | 0.38 | | | |
| Q5-ma | | 0.83 | | |
| Q5-m3 | | 0.70 | | |
| Q1-2b | | 0.62 | 0.36 | |
| Q1-2c | | 0.44 | | |
| Q3-1R | | | 0.84 | |
| Q3-1re | | | 0.81 | |
| Q4-2m | 0.34 | 0.45 | -0.47 | |
| Q1-2a | | | 0.38 | |
| Q3-2R | | | | 0.90 |
| Q3-2re | | | | 0.88 |
| Q3-4R | 0.32 | | | -0.37 |

Table D3: Total Variance Explained

| Compo | Initial Eigenvalues | | | Rotation Sums of Squared Loadings | | | |
|---|---|---|---|---|---|---|---|
| | Total | % of V | Cumul | Total | % of V | Cumulative % | |
| 1.0 | 3.7 | 20.7 | 20.7 | 2.7 | 14.9 | 14.9 | |
| 2.0 | 2.0 | 11.1 | 31.8 | 2.4 | 13.6 | 28.5 | |
| 3.0 | 1.8 | 10.2 | 42.0 | 2.2 | 12.1 | 40.6 | |
| 4.0 | 1.7 | 9.6 | 51.7 | 2.0 | 11.1 | 51.7 | |
| 5.0 | 1.2 | 6.4 | 58.1 | | | | |
| 6.0 | 1.1 | 6.3 | 64.4 | | | | |
| 7.0 | 1.1 | 6.0 | 70.3 | | | | |
| 8.0 | 0.9 | 5.2 | 75.5 | | | | |
| 9.0 | 0.9 | 4.9 | 80.4 | | | | |
| 10.0 | 0.8 | 4.2 | 84.6 | | | | |
| 11.0 | 0.7 | 3.7 | 88.4 | | | | |
| 12.0 | 0.5 | 2.8 | 91.2 | | | | |
| 13.0 | 0.4 | 2.2 | 93.4 | | | | |
| 14.0 | 0.4 | 2.1 | 95.5 | | | | |
| 15.0 | 0.4 | 2.0 | 97.5 | | | | |
| 16.0 | 0.3 | 1.4 | 98.9 | | | | |
| 17.0 | 0.1 | 0.8 | 99.7 | | | | |
| 18.0 | 0.1 | 0.3 | 100.0 | | | | |

Extraction Method: Principal Component Analysis.

**Method for Scoring Questionnaires**

All the questions in the questionnaires were designed to consider different aspects of the variable being explored. A simple way to bring the results of all the questions together is to add up all the positive responses and subtract all the negative responses. This has the advantage of giving some kind of 'score' for each student - a measure of their view towards the variable under consideration. The method has some fundamental flaws associated with it. For example, it assumes that both a 'strongly agree' and an 'agree' are of equal value as positive responses; clearly they are not. It also assumes that a positive response in one question is of equal value to a positive response in another. There is no way of knowing whether this is true or not. Because of the suspect nature of this method, each question was also looked at on its own to see how it correlated with other variables. A critical consideration of scoring methods for these kinds of measurements is outlined in Reid (2006).

**Comparing Correlations (table 7.20 onwards)**

Correlations were obtained between various questions in questionnaires and total marks for two year groups. T see if the two year groups are behaving similarly, the following procedure was adopted.

With the sample sizes, significance occurs for each year group with correlation values around 0.10 and 0.15. The differences between the two correlation values for the same question with the two year groups will be likely to be significant around the same kind of values. For caution, the lower value was chosen (0.1) and it was assumed that there might be a significant difference if the two correlation coefficients varied by more than this. It has to be noted that this is a value judgement and is used merely as a very general guide. It is likely to err on the over-cautious. Nonetheless, using this value, it can be seen in tables 7.20, 7.22, 7.24.