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THE ROLE OF STRATEGIES IN COGNITIVE LEARNING
UNIVERSITY OF DUBLIN
TRINITY COLLEGE

THE ROLE OF STRATEGIES IN COGNITIVE LEARNING

by

GERALDINE MOONEY

A thesis submitted to the School of Education at Trinity College Dublin, the University of Dublin, in partial fulfilment of the requirements for the award of the Degree of Master in Education

August 2002
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Dedication

I dedicate this work to my beloved husband Shay who sadly is no longer with us in this world. He gave me the confidence, support and courage to achieve. I am privileged to have shared my life with him.
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Abstract

The Role of Strategies in Cognitive Learning

An understanding of the factors that affect the academic performance of school students is of practical importance. Two of known factors are students' cognitive styles and cognitive skills. The aim of the paper was to develop an understanding of some of the factors that affect the academic performance of school students. This research will consider the nature of cognitive style, and its relationship to general ability, mode of presentation, and teaching methodologies and school performance. A total of 42 twelve to thirteen year-old students from a single sex secondary school in south Dublin were assessed for cognitive style by means of the Cognitive Styles Analysis. This is a computer presented method of determining cognitive style, which indicates the students' position on each of the two cognitive style dimensions the Wholist-Analytic, and the Verbal-Imagery. Cognitive ability was also assessed using a computer programme the Lucid Assessment for Secondary Schools (LASS).

Students were also asked to select their preferred format of a single sheet handout on mathematical instructions. On the format preference, there was a moderate effect of the Verbal-Imagery dimension (p = 0.05) with the majority of Verbalisers choosing the Structured-Verbal sheet and the Imagers opting for the Structured-Pictorial Sheet. There was a smaller effect on the Wholist-Analytic dimension, where the Wholist had a preference for the Structured-Pictorial and the Analytics for the Structured-Verbal sheet (p = 0.056). Students were also asked to complete a structured interview questionnaire to assess their learning preferences in terms of: (a) Mode of Working, (b) Social Context and (c) Task outcomes. The main findings were as follows, (a) Mode of Working: As expected there was a tendency for Imagers to use pictures and Verbalisers to prefer text and writing. This increased with ability. (b) Social Context: Overall, Group or Paired was preferred to Individual work. Group work was particularly liked by Analytics especially by lower ability Analytic-Verbalisers. Individual work ranked high with Wholists, particularly in the case of higher ability Imagers. (c) Task Outcomes: for open and closed tasks, openness was preferred by a small number of higher ability students on the Wholist-Analytic spectrum. On the Verbal-Imagery dimension the high ability Wholists preferred closed tasks, as did the lower ability Analytic Verbalisers. The findings were discussed in terms of their implications for current practice.

The results of this study would appear to indicate that it is possible to distinguish between students in terms of the way in which they represent information during learning and retention, and that cognitive style does affect learning performance on tasks typical of those used in the school situation. The implications for instruction are that teachers should be aware of individual differences in cognitive style and should attempt to accommodate these into their instructional programmes. While there is evidence to support the notion of cognitive style, a number of questions remain and further research is needed to clarify these: (a) are there Cultural differences in Cognitive Style? And (b) what is the Interaction Between other Variables and Cognitive Style?

Geraldine Mooney

August, 2002
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Finally, but not least to my two daughters Alice and Sarah without whose support, and encouragement, it would not have been possible to undertake the degree of Master in Education, to them a very special thank you.
Introduction

Literacy—real-literacy—is an essential raw material of the information age. We are entering an era of lifelong learning that merges work and education.... We need workers who can adjust to change, who can absorb new ideas and share them easily with others. In short, we need people who have learned how to learn.¹

In education a striking range of individual differences in learning performance may be observed. The past few decades have witnessed a growth in our understanding of the development of learning and of the approaches being used in its instruction. Current research and theory has augmented this growth and understanding by examining how individuals process information via their cognitive style.² In order for a teacher to increase the effectiveness of an individuals’ learning ability an enhanced understanding of the process of cognitive development therefore, would appear to be a perquisite. The aim therefore, throughout this thesis is to consider cognitive style dimensions of individual difference and how the habitual ways of representing and structuring information may affect performance in mathematics, and how the development of educational processes helps practice, and encourages reflective teaching in which practice is informed by a greater understanding of the individual.

Several writers provide an account of cognitive style in cognitive psychology. Vernon provides an early critique of cognitive style, tracing its


development from work carried out by German 'Gestalt' psychologists. She explains that subsequent work on style flowed from a:

Considerable number of experiments...devoted to studying individual differences in perception. 3

Vernon, generally, was critical of 'style' development in the psychology of perception, pointing to a serious problem with the 'style' construct, which she believed had evolved from theories on single experiments. Grigerenko and Sternberg4 agree however, that Allport in his work, developed the idea of 'lifestyle', and was probably the first researcher to deliberately use the 'style' construct in association with cognition. This thesis explores the area of categories of individual difference during thinking and decision-making and how individuals process the same information in different ways.

It is possible to process information into the memory in terms of verbal associations and mental images. While almost all individuals are able to generate both verbal and imagery representations of information if they make a deliberate effort to do so, each person has a preferred code which is habitually and involuntarily used when analysing information. There is a considerable range of habitual mode from almost entirely verbal to almost completely imaginal, and this style represents a continuum of performance with individuals positioned fairly uniformly along it. Performance is best on a task when the learning material and


mode of presentation match the learning style of the student. When there is a mismatch between style and material or mode of presentation attainment is usually relatively poor. That individuals learn and process information in different ways is well documented.

Since cognitive style is found to influence performance on a variety of tasks, it is also likely to be related to mathematics performance. That students differ in mathematics performance is well known to teachers, but the reasons for the differences are less obvious. To say that some students have 'mathematical ability' clearly does not offer any real explanation of why some students are good at mathematics while others, very often are patently not. It is possible that the verbal-imagery continuum is in fact a verbal-numerical-imagery dimension with students at the centre of the continuum being inclined to numerical coding in preference to other types. The verbal-imagery cognitive style dimension is also related to the personality dimension of extraversion-introversion.

The results from a study by Riding in 1979 showed that ambiverts (central position on the extraversion-introversion personality continuum) do best on the task...
recall of prose details about quantity, lends some support to this possibility. If this is so, students at the central position on the verbal-imagery continuum may possibly do better on mathematical tasks, particularly where computation is involved and where verbal or imagery coding is inappropriate. On other hand, mathematical tasks where spatial relationships are involved, mental imagery could facilitate performance, and on tasks where much verbal information is given verbal coding could be useful.

In view of this, individuals will develop strategies to press into service alternative methods of performing structuring tasks in cases where their own cognitive style is inappropriate. Therefore, the structure of the learning material is likely to affect the groups differently. Classroom instruction can be enhanced by knowledge of a student’s cognitive style, which could facilitate the development of individual learning strategies. Students’ performance may then be improved by the development of learning strategies, which maximise the positive aspects of each cognitive style dimension.

Therefore, in selecting readable material such as textbooks, it is important to consider who will read the material, what is the purpose of the material and whether the material fits the readers and the purpose for which it is written. As different texts serve different functions and make different demands upon readers,


it is a complex matter to define literacy in universal terms. Some texts, because of their incompleteness or inexplicatedness, can rely heavily upon prior knowledge of a reader or writer, and remain the domain of a specialised elite. With the concepts of what defines readability it is proposed in chapter one to look at these aspects with regard to mathematics. In order to develop effective learning materials data is required to see how particular aspects of learning such as learning preference and learning performance affect the academic performance of school students.

In summary, it is proposed in this thesis to briefly examine the importance of literacy and readability of material, as it is one of the cornerstones on which our education system is built and to provide a comprehensible introduction into the fields of cognitive style, and teaching methodologies. It is further proposed to put forward the supposition that an integrated teaching approach in combination with the teacher's awareness of cognitive styles could be invaluable in allowing more flexibility in the methodology of teaching, and presentation of subject material. This in turn would allow the student to develop effective learning strategies, which could possibly enhance achievement levels in this instance within the area of mathematics. One could conclude, from Kearns that

We are entering an era of lifelong learning that merges work and education.... In short, we need people who have learned how to learn.13

and teachers in the twenty-first century must be more adept than ever at enhancing students' learning ability. The following gives a brief outline of the imminent chapters:

- **Chapter I** outlines the historical background to literacy and the importance of readability with texts and within mathematics.

- **Chapter II** will outline the salient features of cognitive style, its effect on mode of presentation, appraise two models of cognitive style and distinguish between cognitive style, learning strategies and the importance of metacognition.

- **Chapter III** reviews the role of teaching, the possible need for flexibility within teaching and the theories and methodologies available for instructional purposes to enhance the learning environment.

- **Chapter IV** looks at the methodology used within the research.

- **Chapter V** presents the results of the research.

- **Chapter VI** discusses the results of the research and in the conclusion examines whether or not cognitive styles and learning strategies contribute in pedagogical practice to the enhancement of learning.
Chapter I

A Brief Historical Perspective on Literacy and Readability.

Literacy is above all a technology or set of techniques for communications and for decoding and reproducing written or printed materials.¹

1.1 LITERACY IN MEDIEVAL EUROPE

The European societies, which gave rise to the cultural regeneration and intellectual innovation, which we call the Renaissance, enjoyed only very restricted levels of literacy among their populations. Early medieval European culture had been dominated by what might be termed 'primary orality.'² Writing and reading were skills, which very few professionals possessed, while the bulk of the population relied for information on what they could see and hear. Economic interactions took place face-to-face and religious experience was mediated to ordinary men and women by the word of a priest and the impact of visual symbols.

As European societies became more literate during the Middle Ages, writing came to be used for functions that earlier had been performed by oral language and by ritual. Indenture of servants, deeding of property, evidence at trials, and accounts of the lives of saints all came to be functions of written texts. As literacy began to be required for these vital social purposes, oral language came to be seen as loose and unruly and lacking in social authority. People who could not read and write came to be regarded as rude and ignorant--in short, unlettered.


Literacy was restricted owing to a number of factors; writings in themselves were scarce, printing was still in its infancy, books and writing materials were expensive, most literature was in Latin and schooling was sparse. By 1800 however, a new industrial age had commenced. Europe was a different place in economic, religious, political, social and intellectual terms. It was these forces that in the late 18th and the 19th centuries would weaken and, in many cases, end the old aristocratic absolutism.3

The European expansion to new worlds overseas had stimulated commercial rivalry. New trade had increased national wealth and encouraged a sharp rise in the numbers and influence of the middle classes. These social and economic transformations, joined with technological changes involving the steam engine and the factory system, together produced industrialism, urbanisation, and the initial stages of mass labour. Contemporary debates raged on ways in which children should be educated, the role that the school should play in society, the importance to the individual of high-quality literacy and to society of mass literacy.4 All these trends were to influence the progress of education.

1.2 LITERACY IN EARLY MODERN EUROPE

There are certain features that must be borne in mind about European societies before the Industrial Revolution. Firstly, the progress of education and literacy was slow, education in the modern sense was relatively disorganised and


the size of schools small. In Ireland for example we had hedge schools. Secondly one has to beware of making superficial comparisons between twenty-first century experiences and historical ones.

The institutional frameworks, social norms and mental climate in which people lived between the Renaissance and the Industrial Revolution were very different from our own. The family and the local community were far more significant to everyday life; communications were basic, technology primitive, life expectancy was short (thirty-five years on average). The role of magic and religion in everyday life was all encompassing, the latter was the 'idiom in which men thought' and the concepts of 'liberty,' 'democracy,' and 'equality,' as understood in the present day, were almost unknown. The objective of education and the uses to which it could be put on this basis may appear limited to modern observers.

Historically, literacy tended to be associated with the development of abstract thought, broadening of the mind through various experiences, for example intellectual exchange, personal independence of thought and action, economic development, and democracy. Illiterates, on the other hand, were allegedly more restricted in their thought patterns, intellectually impoverished, culturally backward, isolated, inert, and almost pathological. Illiteracy, in the words of

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6 Ibid. 6.
Lenin, was ‘enemy number one’, while for Helvetius ‘l’éducation peut tout’.  

Traditional historical writing about literacy has, for its part, concentrated on schools and universities, print and publishing rather than on the extent of reading and writing.

It is important to recognise the different purposes for which literacy can be used. It can serve some practical or functional end such as economic need amongst tradesmen, in which reading and writing would be advantageous; or fulfil a simple religious need, where reading alone is all that is required. The influences, which bore upon literacy in the early modern period, are summarised by Lawrence Stone:

The structure of education in a society is determined by... social stratification, job opportunities, religion, theories of social control, demographic and family patterns, economic organisation and resources and finally political theory and institutions.  

To this list one could add the dimension of language, since it is easier to learn to read in the language of everyday communication than in an unfamiliar tongue. But how does one define literacy? Is it the ability to sign one’s name, or is it better not to think of literacy in the singular but rather of literacies, of a variety of ways in which information can be acquired and transmitted?

It is possible to postulate that the first way could entail, looking at a picture, which can be rich in visual imagery from which one can derive as much information as from a written page. This can be seen with the wood engraving

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pictures of the 1870s and 1900s in school texts. The second element could be reading itself, which can be either for private pleasure or for reading aloud, a practice used in schoolrooms to teach literacy to illiterates. Thirdly could come writing, starting with simple abilities like signing a name, and continuing upwards to the copying of set texts in prose or verse, possibly in Latin or another language. UNESCO adopted the following definition for the modern world:

A person, to be deemed literate, should be sufficiently fluent not only to make out words on a page or copy them out but also to read a newspaper or write a letter.\(^\text{10}\)

The new social and economic changes in the industrial age called upon schools, both public and private, to broaden their aims and curricula. Schools were expected not only to promote literacy, mental discipline, and good moral character but also to help prepare children for citizenship, for jobs, and for individual development and success. ‘Post-elementary’ education was very much the preserve of the middle and upper classes, and seen as a way of preserving economic and social dominance. Order, stability and conformity were the watchwords of the authorities. Teaching methods remained oriented toward textbook memorising and strict discipline, to pass on an agreed body of knowledge.

1.3 A HISTORICAL LOOK AT DEFINING READABILITY

It is common to think of literacy as the simple ability to read and write. In part such thinking is a consequence of the naive assumption that alphabetic literacy is a matter simply of decoding graphs into sounds and vice versa. In fact, literacy

involves competence in reading, writing, and interpreting texts of various sorts. It involves both skills in decoding and higher levels of comprehension and interpretation. These higher levels depend upon knowledge both of specialised uses of language and of specialised bodies of knowledge. The intimate relations among language, literacy, and specialised bodies of knowledge have contributed to the identification of literacy with schooling.

As different texts serve different functions and make different demands upon readers, it is a complex matter to define literacy in universal terms. Therefore, to judge the literacy levels of a society at different periods or to compare one society with another is extremely difficult. Some texts, because of their incompleteness or inexplicitedness, can rely heavily upon the prior knowledge of a reader or writer, and remain the domain of a specialised elite. While other texts that are relatively explicit and complete, permit a reader who is unfamiliar with a text to read it in a reliable way and hence can be used for a much broader range of functions.

The form of a text may be less crucial than the range of functions the text serves and the breadth of its readership. However, the growth of readership leads to an increase in the production of materials to be read, combined with an increase in the number of functions the text is used for, and the invention of new, more

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specialised genres of writing. The novel form, for example, originated in Europe only in the 17th century, when there was a broadly based reading public.\(^3\)

Research into readability and the effectiveness with which books convey information is not a new phenomenon. It stems from librarians and leaders in adult education in the early 1930s in America. They tried to find some means of putting the right book into the hands of the right reader. In the late 1940’s Edgar Dale and Jeanne Chall proposed the following concept of what readability is:

In the broadest sense, readability is the sum total (including interactions) of all those elements within a given piece of printed material that affect the success a group of readers have with it. The success is the extent to which they understand it, read it at an optimum speed, and find it interesting.\(^14\)

They considered that, even if it were possible to have an entirely individualised reading programme, with a wide variety of material available so that each child could select “what is readable for him”; someone would still have to select the history text, the basic reader, and the geography book.

Nevertheless, what do we understand by the term readability? Webster’s Dictionary defines readable as: “Legible,” “easy to read because it is interesting or pleasing,” “that permits or admits of reading”. One can see from this definition that there is room for confusion between readability and legibility. In order to achieve a common definition for the notion of readability Gray and Leary\(^15\)


surveyed groups of teachers, librarians and publishers as to what in their opinion made a book readable. Their findings pointed to at least three broad aspects that increased the ease of reading proficiency.

First came content or subject matter and its interest or appeal to the reader; second was style of expression, which made it interesting and comprehensible to the reader and third came format and organisation, which made it easy to follow the logic of the material with the minimum of effort. Further research analysed the type of subject matter and themes that appealed to different readers. Dunn\textsuperscript{16} and Gates\textsuperscript{17} contributed to our knowledge of what makes books interesting or uninteresting to children in primary grades, while Zeller\textsuperscript{18} did a similar analysis for junior high school level and Sterner\textsuperscript{19} for senior level. Gates, while examining the phenomenon of "difficulty" in reading discovered that, interest depended on both stylistic and expressional elements such as, "surprise" (unexpected and unforeseen events), "liveliness" (action and movement), and "animal-ness" (presentation of things animals do). These were seen as positive contributors to young children's interest whereas "moral-ness" led to decreased interest.\textsuperscript{20}

\begin{footnotesize}
\begin{itemize}
\item 16 Fannie W. Dunn, "Interest Factors in Primary Reading Material," \textit{Contributions to Education} No. 113. (New York: Bureau of Publications, Teachers College, Columbia University, 1921).
\item 18 Dale Zeller, "Relative Importance of factors of interest in Reading Materials of Junior High School Pupils," \textit{Contributions to Education} No. 841. (New York: Bureau of Publications, Teachers College, Columbia University, 1941).
\item 19 Alice P. Sterner, "Radio, Motion Picture, & Reading Interests," \textit{Contributions to Education} No. 932 (New York: Bureau of Publications, Teachers College, Columbia University, 1947).
\end{itemize}
\end{footnotesize}
In other words, a book may lose its interest for children if the presentation has complicated sentence structure, abstract concept, or too great a concentration of ideas. Waples and Tyler\textsuperscript{21} were concerned with the way topics were presented in order that they may be read with interest and understanding. They pointed out that comprehensibility influenced and often limited readers' preferences and actual choice of book. Therefore, in selecting readable material it is important to consider who will read the material, what is the purpose of the material and whether the material fits the readers and the purpose for which it is written. With these concepts of what defines readability it is proposed in the following section to look at these aspects with regard to mathematics.

1.4 THE READABILITY OF MATHEMATICS

As discussed in previous sections the readability of text has become a major concern in education. A variety of different techniques have been established to enable teachers to carry out checks as to whether or not a particular text is appropriate. For example there is the Dale-Chall formula as discussed previously, the FOG formula, Flesch-Kinad formula and the cloze procedure, which is based on the ability of the reader to fill in the missing words in a text. However, as most of the techniques only incorporate a selection of the possible facets of readability, there is a difficulty in defining the readability of mathematical texts.

Mathematical text is peculiar in comparison with text in other subject areas. The text does not necessarily flow left to right, line after line. It is sometimes necessary to move in unusual directions and move about the page in order to refer to tables, graphs or diagrams. Kayne, Byrne and Hater\textsuperscript{22}, from the United States, devised a readability formula for use specifically with mathematical text. However, it is extremely complex and time consuming to apply, and might not give the same results outside the USA.

Any mathematical textual material, which is to be read by students, must be 'readable'. It is not easy to define readability in completely explicit terms, but there is no doubt about what is meant. It implies that students should be able to learn what one intends them to learn without the language itself getting in the way. Orton uses a good example in his book\textsuperscript{23}, the fortnightly mental arithmetic test for a particular child regularly included a question of the type:

\textbf{What is the difference between 47 and 23?}

The child thought the question rather odd, but nevertheless answered it, as follows:

\textbf{One number is bigger than the other.}

When the test papers were returned the answer was marked wrong. There was no question of going to ask the teacher why is was wrong, better to try again and see what happened. Along came the next test, and the student tried an answer as follows:

\textbf{One number contains a 4 and a 7 but the other doesn't.}


Naturally, this was also marked wrong. In a subsequent test the student in desperation tried again:

**One number is about twice the other.**

The saga continued until the student finally asked a friend what the correct answer was and why. While this story is a true one, it also begs the question why the student felt that he/she could not ask the teacher for an explanation.

Anecdotes about children experiencing difficulties because they do not understand the words are not hard to find, but they do introduce the issue of mathematical vocabulary. Even if the vocabulary is appropriate there still might be problems because the students do not always interpret statements literally, but on occasion appear to change the meaning into what they think the teacher intended to say.

It is essential that teachers of mathematics should assess, critically, the appropriateness of text for their students, but the general recommendations at the moment is that this should be achieved by means of 'informed judgements'. Therefore, it is important to have the information on which to base such a judgement. How can one make an informed judgement on a text in order to find out what format and mode of presentation the students would prefer in order for them to achieve maximum learning potential? Is it possible to postulate therefore, that in order to make an informed judgement on text for one's students, it would be necessary to assess the cognitive style of each student? It was with this hypothesis in mind that the author decided to research the area of cognitive style, and its possibilities in teaching methodology.
Chapter II

Cognitive Style and Learning Strategy

[Teachers should] Encourages pupils to engage in a long-term process of building a style of learning, which is meaningful and productive. To try to impose a cognitive learning style is the pedagogic equivalent of imposing a false self upon someone – an act, which is inevitably destructive in the long run.¹

2.1 Defining Cognitive Styles and Learning Strategy

Personal style as applied to learning describes the way in which a person habitually approaches or responds to a learning task. It consists of two essential characteristics: first, cognitive style, which reflects the way in which the individual person thinks; second, learning strategy, which reflects those processes which are used by the learner to respond to the demands of a learning activity.

Cognitive style could probably be viewed as either an innate and automatic way of responding to information and situations or as permanently fixed early on in life and thought to be deeply enveloping, affecting a wide range of individual functioning.² A person’s cognitive style, therefore, could be said to be a relatively unchanging aspect of learning performance, which influences a person’s general attainment or achievement in learning situations. By contrast, strategies are methods that may be learned and developed to cope with situations and tasks, (particularly utilising styles to make the best of situations) which present great

difficulties for the student. Within literature, the term ‘learning style’ is sometimes used to refer to as a learning strategy.

2.2 The Origins of the Construct of Cognitive Style

Early in the scientific study of psychology, Galton in 1883 and James in 1890 gave attention to the notion that some people have a predominantly verbal way of representing information in thought, while others are more visual or imaginal. Various traditions of psychology over the last one hundred years have continued this research into the emerging field of cognitive style. One of the first proponents to deliberately use the ‘style’ construct in association with cognition was Gordon Allport in his work in developing the idea of ‘life-styles’.3

More recently, research by Jonassen, Grabowski4 and Messick5 and others have approached cognitive style from an organising perspective of ‘differential psychology’ while researchers like Grigerenko, Sternberg,6 and Riding7 have been interested in the processes and abilities in cognition. Vernon and Messick have suggested that the primary antecedents of cognitive style, for example, the idea that

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4 David H. Jonassen and Bernard L. Grabowski, Handbook of Individual Differences, Learning and Instruction (Hillsdale, NJ: Lawrence Erlbaum, 1993).
Different individuals have contrasting personalities that differentially influence their modes of cognition and behavioural expression,\(^8\)
could be traced back to a description of personality in classical Greek literature. The ideology to which they referred was the early model of human personality created by Hippocrates. It consisted of four personality types: the melancholic, the sanguine, the phlegmatic and the choleric. However, as a working definition in the present context, Tennant has succinctly defined cognitive style as “an individual’s characteristic and consistent approach to organising and processing information”.\(^9\)

Researchers into cognitive style have generally worked in their own contexts, in isolation from one another, developed their own instruments for assessment and gave their own labels to the style they were studying with little reference to the work of others. Not surprisingly, this led to the development of a large variety of style labels. A number of researchers for example, Fowler\(^10\), Brumby\(^11\) and Miller\(^12\) have suggested that many of these were but different conceptions of the same dimensions. Riding and Cheema,\(^13\) found over thirty different labels and, after reviewing the descriptions, correlations, methods of assessment and effect on behaviour, concluded that they could be grouped into two

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principle cognitive style dimensions: the Wholist-Analytic and the Verbal-Imagery. These two basic dimensions of cognitive style may be summarised as follows:

1. The Wholist - Analytic Style dimension of whether an individual tends to process information in wholes or parts. This dimension describes the habitual way in which an individual organises and structures information. Some individuals will deconstruct information into component parts (described as Analytics), others will retain a global or overall view of information (described as Wholists).

2. The Verbal – Imagery Style dimension of whether an individual is inclined to represent information during thinking either verbally or in mental pictures. Basically, individuals who are verbalisers read, listen to or consider information in words. By contrast, when people who are imagers read, listen to or consider information, they experience fluent, spontaneous and frequent mental pictures. See example in Figure 2.2 on page twenty-two.

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2.3 Cognitive Styles and Mode of Presentation

The Wholist – Analytic dimension derives from the work of Witkin and others on field dependence/independence and describes how an individual habitually organises information. Analytics, as defined by Riding and Buckle, are equivalent to field-independents and Wholists to field-dependents. Wholists are able to organise information into loosely clustered wholes and tend to see information from an overall perspective and to appreciate its total context. By contrast, Analytics tend to organise information into clear-cut conceptual groupings and will see information as a collection of parts. Analytics will often focus on one or two of these at a time to the exclusion of the others. Figure 2.3

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shows in a schematic way, how information or subject matter might be perceived by Wholists and Analytics.

**Figure 2.3 Wholist-Analytic Style Dimension**

For Wholists, not only are the parts not separated, but there is also the possibility that the distinction between them is blurred so that it can be difficult to distinguish the issues that make up the whole of a piece of information. Therefore, the positive strength of the Wholist is that when considering information they can see the whole ‘picture’. This in turn makes it less likely that they will have extreme views or attitudes. The negative attribute of the style is that they find difficulty in separating out a situation into parts see Figure 2.4 page twenty-four.

By contrast, the Analytic will tend to focus on just one aspect of the whole at a time and this may have the effect of distorting or exaggerating it, or making it more prominent, with respect to the rest. This leads to the possibility of Analytics getting information out of proportion to the overall opinion. Their positive attribute is that Analytics have the ability to analyse information into parts, which allows them to get quickly to the heart of a problem. They are good at seeing similarities and detecting differences. However, their negative attribute is that they are not able to get a balanced view of the whole and they may focus on one aspect of a situation to the exclusion of the others and enlarge it out of proportion.

Verbal –Imagery Style with respect to the mode of presentation indicates that Imagers learn best from pictorial presentation, while Verbalisers are superior.

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with text. In terms of content, Imagers find concrete and readily visualised information easier than semantically and acoustically complex details, with the reverse applying to Verbalisers. In terms of thinking, Verbal-Imagery style affects the characteristic mode in which people represent information during thinking, verbally or in images. If a person reads a novel, they can represent the actions, happenings and scenes in terms of word associations or by constructing a mental picture of what they read. See Figure 2.5.

Figure 2.5 **Verbal-Imagery Style dimension**

![Verbal-Imagery Style dimension](image)

Source: R.J. Riding, A. Glass and G. Douglas, 1993

Style therefore, affects the processing of information and the mode of presentation individuals prefer and the types of tasks they will find easy or difficult. All groups can use either mode of presentation if they make a conscious

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choice i.e. Verbalisers can form images if they try, but it is not their normal, habitual mode. Imagers who are also Analytics can also use the imagery mode as a strategy in order to provide a way of obtaining a Wholist view. Similarly, Verbalisers who are Wholists can use the verbal mode to give a means of providing an analytic view. Cognitive styles in interaction with one another have been shown to affect a wide range of behaviours, including learning performance, and performance in public examinations.

An important aspect of the validity of any construct (in this case cognitive style) is that it should be related to observed behaviours and that the relationship should be large enough for practical significance. For example, if one looks at the areas of learning performance and learning preferences:

- **Learning performance**: Imagers almost double their learning performance if they are presented with the same information as text-plus-illustration compared to just text, while verbalisers are not affected.

- **Learning preferences**: Given a choice of learning material, verbalisers will choose the textual version, and imagers will choose a version with illustrations.

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In the area of education and training cognitive style would appear to have potential practical applications.

2.4 Towards a Model of Style

As discussed in the previous sections it is useful to distinguish between cognitive style and learning strategy. While cognitive style has a physiological basis and is fairly fixed for individuals, strategies are ways that may be learnt and developed to cope with situations and tasks. A useful distinction has been made by Curry who proposed that all cognitive and learning style measures may be grouped into three main types or “strata resembling layers of an onion” it is known as Curry’s ‘Onion Model’.28 By organising learning style measures like this:

Learning behaviour is fundamentally controlled by the central personality dimension, translated through middle strata information processing dimensions and given a final twist by interaction with environmental factors encountered in the outer strata.29

According to Curry, the outermost layer of the onion and the most observable style is what she labels as ‘instructional preference’. Examples of measures that assess this level of cognitive style are the Learning Preference Inventory30 and the Grasha Reichmann Students Learning Styles Scales31. Instructional preference refers to the individual’s choice of environment in which to learn. As this is the layer that

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is most exposed to the learner’s environment, learner expectations, teacher expectations and other external features, Curry believes instructional preference to be the least stable, and the most easily influenced level of measurement in the cognitive style area.

The second layer of the ‘Onion Model’ is referred to as the ‘information processing style’. This is considered as the individual’s intellectual approach to assimilating information, and because this processing does not directly involve the environment, Curry believes that measures, which assess this style level are more stable than instructional preference, but can still be modified by learning strategies. Measures such as the Learning Style Inventory\textsuperscript{32} and the Inventory of Learning Processes\textsuperscript{33} are all thought to be dealing with information processing style concepts applicable at the juncture between basic personality levels, individual differences, and environmentally offered learning format choices.

The third and the innermost layer of the hypothetical cognitive style onion is the ‘cognitive personality style’. The cognitive personality style is defined as the individual’s approach to adapting and assimilating information in which the individual does not interact directly with the environment. However, this is an underlying and relatively permanent personality dimension that is expressed indirectly and is apparent only when an individual’s behaviour is observed across many learning instances. Examples of measures, which Curry suggests assesses


this third level of cognition, are the Embedded Figures Test\textsuperscript{34}, Myers Briggs Type Indicator\textsuperscript{35} and the Matching Familiar Figures Test\textsuperscript{36}. On the basis of the onion model, the Cognitive Style Analysis, which will be used to assess the students in authors' research study, would be placed at the innermost level.

The Cognitive Control Model, which is an elaboration of that of Curry's Onion Model and of Riding and Rayner\textsuperscript{37} and bears some similarities to that of Furnham,\textsuperscript{38} will be outlined and a graphical description can be seen in Figure 2.6 on page thirty. In order to make the model more concrete, some of the personality sources were given tentative names, although physiological mechanisms for them have yet to be clearly defined.

At the innermost level there are a number of underlying primary sources comprising the memory of the individual's past experiences and knowledge, their underlying personality and their gender. The next level is that of cognitive control. This comprises the two dimensions of style, the Wholist – Analytic and the Verbal Imagery. It combines the internal state with information from the external world and imposes on the response and view, its own structure and form.


At input level there is the perceptual working memory processing system, which analyses incoming information. The performance of this is often considered to be the main determiner of ‘intelligence’ that is assessed by intelligence tests.

Many tests seem to concentrate on this area. At the output level, there are the learning strategies. These will have developed by, for instance, the individual sensing that certain modes are easier to use, and then recognising a learning preference, and deciding to translate new incoming information into that image. Learning strategies in this model are at a different level from that of Curry’s Onion Model.

Cognitive style would appear to be independent of intelligence. Riding and Pearson\(^{40}\) with a sample of 12 – 13 year old pupils found that intelligence as measured by the sub-tests of the British Abilities Scale were not related to cognitive style\(^{41}\). Both style and intelligence will affect performance on a given task. The basic distinction between them is that performance on all tasks will improve as intelligence increases, whereas the effect of cognitive style on performance for an individual will either be positive or negative depending on the nature of the task.

It follows from this, that for an individual at one end of the style dimension, a task of a type they find difficult will be found easier by someone at the other end of the dimension and vice versa. For instance, if the dimension were the Verbal – Imagery style, then Verbalisers would find pictorial tasks more difficult than would imagers, but would find highly verbal tasks easier than imagers. In other words, in terms of cognitive style a student is both good and


poor at tasks depending on the nature of the task, while for intelligence, they are either good or poor.

2.5 Learning Strategy Development

The first step to learning strategy development is awareness by a student that a subject presents difficulty. The next is a self-understanding of his/her cognitive style and of the styles appropriateness for the subject area, whether it is in terms of structure and meaning or mode of representation and consequently, information processing load. Learning strategies can then be considered which may mitigate any mismatch between subject and cognitive style. An example of a simple learning strategy could be changing the mode of presentation to match the position on the verbal – imagery dimension. For instance, a verbaliser could change the pictorial information presented by a book or lecturer into words, and the imagers could change words to illustrations or diagrams.

Cantwell and Moore\textsuperscript{42} have drawn attention to individual differences in students towards learning strategy development, and this raised the additional question of whether certain cognitive styles are more willing to develop learning strategies than others. Individuals therefore, develop learning strategies to deal with learning material, which may not initially be compatible with their cognitive style. This disparity will in turn lead to the development of a learning strategy to translate material into a preferred mode where possible. Learning strategies as

discussed earlier can be learnt and modified while cognitive style remains a relatively fixed core characteristic of an individual.\textsuperscript{43} In the long term a repertoire of learning strategies or cognitive tool-kit develops to help the individual successfully complete a specific task. These strategies are formed as part of a response within the individual to meet the demands of the learning environment.

The cognitive-centred approach emphasises the consistent and habitual nature of cognitive style in affecting the organisation and representation of information during learning and thinking. This has implications for learning within the education system. Where a cognitive style matches the content and presentation of material to be learnt, the individual is likely to find the task easier than when there is a mismatch between cognitive style and learning design.

A study by Riding and Watts\textsuperscript{44} revealed that students were attracted to, and preferred to select, materials that appeared to them to suit their own cognitive style. Further research by Riding and Staley showed that where cognitive styles of students and the structural requirements of the subject matter matched, the students did better than when there was a mismatch.\textsuperscript{45} Students were sensitive to how easy it was to understand a subject, and were consciously aware of the design of structure they preferred.


Weinstein and Van Mater Stone\textsuperscript{46} argue that to be aware of one's own thinking (metacognition) is a critical step in the acquisition and improvement of a learning strategy repertoire. Metacognition refers to the knowledge one has about how one learns. It is a key component of one's ability to regulate one's learning processes. Metacognition was first proposed by developmental psychologist John Flavell to explain why children of different ages deal with learning tasks in different ways.

One way to grasp the essence of metacognition is to contrast it with cognition. The term cognition is used to describe ways in which information is processed, that is, the way information is recognised, encoded, stored in one's memory, retrieved from storage and used for some purpose or another. Metacognition refers to knowledge about those operations and how they might be used to achieve a learning goal. As Flavell, put it:

I am engaging in metacognition...if I notice that I am having more trouble learning A than B, if it strikes me that I should double-check C before accepting it as a fact...if I sense that I had better make a note of D because I may forget it...\textsuperscript{47}

Lev Vygotsky believed that children acquire metacognitive knowledge and skills most effectively through direct instruction, imitation, and social collaboration.\textsuperscript{48}

Vygotsky's analysis also suggested, that providing children with opportunities to regulate their own and other's behaviour, as in peer tutoring, (working in pairs)


was an excellent way to help them increase their metacognitive skills and improve their quality of learning.

Self-awareness of metacognition forms a major part of personal development and utilisation of cognitive style. Riding and Rayner believe that the benefits of building a specific self-awareness of cognitive style and the development of learning strategy into pedagogical practice would contribute directly to the enhancement of learning.⁴⁹ Programs like reciprocal teaching have produced high levels of learning, motivation, and transfer of knowledge.⁵⁰

However, planning and organising relevant lessons is only half the battle, students must attend to the information, encode it into long term memory, and retrieve it when needed. Getting students to use this process can be difficult, and will be discussed in more detail in chapter three: the role of teaching methodologies. Evidence suggests however, that students and adults are inefficient learners and that their attempts at encoding rarely go beyond rote rehearsal (reading a textbook chapter), simple organisational schemes (outlining), and various cueing devices (underlining and highlighting).⁵¹,⁵²

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One possible explanation for this state is that students are rarely taught how to make the most of their cognitive abilities. When the nature of the learning task changes, few students think about changing their encoding techniques to correspond with the new task. When one considers that the amount of independent learning expected of students increases consistently from primary through secondary and into university it is even more surprising to find that the older the students are the less likely they are to receive learning strategy instruction.53

Self-understanding and learning strategy development are important for students since they have potential to enhance motivation and to make it more intrinsic, and to improve performance. When students receive the results of their assessment, they may have more realism about their level of performance, but they will not understand why there may be a difference between how they performed and how they thought they were doing. An important consideration with respect to cognitive style mismatch with a subject's content or mode of presentation is that it should not be a passive acceptance of the difficulty, but a challenge to find a learning strategy by which an inappropriate cognitive style may be used to its best advantage in order to facilitate learning performance.

A learning strategy therefore, is a general plan for achieving a distant academic goal. A learning tactic is a specific technique like a memory aid or a form of note taking that a learner uses to understand the concepts in a textbook and how they relate to one another. A learning tactic therefore, has an integral connection to learning strategies: it is a learning tool that moves one closer to its

objective. For example, rote rehearsal is one of the earliest tactics to be used during childhood. It is not a very effective memory tactic because it does not produce distinct encoding or good retrieval cues. Mnemonic devices are memory directed tactics that help a learner organise information to enhance its retrieval.

Two examples of mnemonics are

- **Rhyme**

  Fiddlededum, fiddlededum, a ring around the moon is \( \pi \times d \).
  If a hole in your sock you want fixed, use the formula \( \pi \times r \) squared. (To recall formulas for circumference and area).

- **Acrostic** (the first letter from each word in the sentence indicates what is to be remembered)

  Please Excuse My Dear Aunt Sally (order of operations in maths)
  Parentheses, Exponents, Multiplication, Division, Addition and Subtraction.\(^\text{54}\)

No one expects students to teach themselves reading, writing and arithmetic so why should students be expected to teach themselves how to use a variety of learning tactics? If learning tactics are taught, as isolated techniques students may not use them for very long, because as discussed earlier they may not recognise that as the situation changes, so should the tactic. Therefore, students should be taught how to use learning tactics as a part of a broader learning strategy.

Learning strategies consist of six components, metacognition, analysis, planning, implementation of the plan, monitoring of progress, and modification. Students can formulate strategic learning plans that identify and analyse the important aspects of a task. They can then tailor these plans to their own strengths

and weaknesses as learners. The true strategist is mentally active, and realises that different subjects have different types of information and structures, and that exams differ in the kind of demands they make. Therefore, strategies must be constructed anew as a student moves from task to task. This would imply that the concept of a learning strategy is complex and requires a certain level of intellectual maturity. Therefore, it might be concluded that this level of intellectual maturity would be beyond primary and secondary students.

Research evidence by Selmes in Scotland however, would suggest otherwise.\(^5^5\) He found that some students were sensitive to contextual differences among tasks and varied their approach accordingly. Hattie, Biggs and Purdie\(^5^6\) also found that students who were trained to use a single mnemonic technique out performed non-trained students by a wide margin on tests of memory 86\(^{th}\) percentile versus 50\(^{th}\) percentile respectively. The effect was particularly noticeable among low achieving students and low-level comprehension. Annemarie Palincsar and Ann Brown devised a particularly effective learning strategy-training programme known as reciprocal teaching\(^5^7\) where students learn certain comprehension skills by demonstrating them to each other. This approach to strategy instruction is based on Vygotsky’s zone of proximal development concept, which will be discussed in more depth in chapter three: The role of teaching methodologies.


Research on the effectiveness of reciprocal teaching under both controlled and realistic conditions has produced positive findings across a broad spectrum of students from primary to university.\(^{58}\) It would appear that the knowledge of the learning process and the conditions that affect it should be as much a part of the curriculum as learning to read, write and compute. One could argue that students should be gradually made aware of the relationship between cognitive style and learning strategies and how to determine if learning is proceeding as planned and what to do if it is not.

Teachers need, therefore, to avoid the notion of ‘this is the way’ to learn. On balance, it is plausible to suggest that the natural teaching style of an individual teacher will be a reflection of his or her own cognitive style and not necessarily match that of the student. Students need to be encouraged, to use whatever learning strategies, seem right for them as individuals. As discussed earlier, Riding and Watts indicated that where cognitive style matches the content and presentation of material to be learnt, the individual is likely to find the task easier than when there is a mismatch between cognitive style and learning design.\(^{59}\)

It does seem plausible therefore to suggest that the learning strategy of individuals are likely to be affected by an interaction between their cognitive style, the way the instructional material is structured, its mode of presentation, and its type of content. If readability of material as discussed in chapter one, is


manipulated by changing its structure or presentation, it poses the question as to whether this manipulation of material increases comprehension and facilitates a higher incidence of matching with individual cognitive styles? To address this question it is necessary to examine different theories and approaches to instruction.
Chapter III

The Role of Methodology in Teaching

Getting the student interested in what he is doing, in the capabilities he is going to acquire, is a task that takes great skill and persuasiveness by a person, usually a teacher, who represents the adult world. ¹

3.1 The Complexity of Teaching

Teaching is not the simple, straightforward activity people imagine it to be. In fact, it ranks in the top quartile on complexity for all occupations. ² There are many reasons for this complexity. In increasing ways teachers have daily responsibility for diverse populations of students with varied and sometimes contradictory needs. But perhaps most fundamentally, the complexity of teaching derives from its decision-making nature. Teachers are constantly, making decisions before and after instruction as well as on the spot. To be informed and effective, these decisions should be based on a deep reservoir of knowledge and a wide range of skills. As discussed in chapter two, data about cognitive style would lead to a deeper reservoir of knowledge about individual students.

Therefore, one could postulate that knowledge about psychological concepts and their application to educational settings has the potential to help one become a better teacher. Whether or not, the potential is fulfilled depends on how willing one is to maintain an open mind and a positive attitude. Not all practicing

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teachers have a positive attitude when it comes to using psychological knowledge in the classroom. Burch for example, quotes one teacher as saying that 'educational psychology and research are relatively useless because they rarely examine learning in authentic classroom contexts.'³ As discussed earlier, it is proposed to show that research in educational psychology offers many useful ideas for improving classroom instruction⁴ and that criticisms like this can be rebutted.

Many factors affect the transfer of knowledge and the form that an idea takes or whether or not it comes into existence at all. Some of these factors include age, gender, race, ethnic background, prior knowledge, problem-solving skills, and motivation (will be discussed at various stages within this paper). As different factors come into play for different students and the same factors affect students differently, two people can read the same passage or instruction and construct entirely different interpretations of its meaning. This concept, known as 'Constructivism', is so fundamental to human behaviour and learning that it will be necessary to return to it at a later stage.

It is not surprising then, that some educators argue that teaching is an art that cannot be practiced or even studied in an objective or scientific manner.⁵ For example, Gilbert Highet argues in “The Art of Teaching” that successful teaching must be considered an art because it involves two things that cannot be objectively


and systematically manipulated. These are emotions and values. In Hight's view:

Teaching is not like inducing a chemical reaction: it is more like painting a picture or making a piece of music... You must throw your heart into it, you must realise that it cannot all be done by formulas, or you will spoil your work, and your pupils, and yourself.⁶

Hight also believed that teaching is one of society's most valuable and rewarding activities, and that teaching must be done as well as possible every day, that it is important to get the students excited about learning, and that there is no such thing as an unteachable student. This belief is not only shared by the author but is the pivot on which this research is based. Therefore, the 'art of teaching' according to Hight involves values, emotions, and flexible-characteristics, which are intangible qualities that teachers must find within.

Hight when he states that teaching cannot all be done by formulas would appear to suggest, that teachers should be flexible. However, flexibility involves the willingness and resourcefulness to work around impediments. Teaching does not always occur under ideal circumstances; teachers must sometimes cope with inadequate facilities, insufficient materials, interruptions and other difficulties. If as Hight suggests the qualities of emotions and values are difficult if not impossible to educate in others (teachers) does this then imply that unless one has the natural 'art of teaching' one cannot teach? David Berliner⁷ and Lee Shulman⁸

would argue from another perspective that ‘teaching can be based on learned techniques,’ they contend that it is possible to have a technical basis for the ‘art of teaching’ by drawing on established educational research findings.

They argue that both practising and prospective teachers can be taught the prerequisites that make ‘imaginative teaching’ possible. Slavin, in addition argued that working from a technical basis helps teachers avoid the pitfall of subscribing to the latest fad. The basic tenant of this argument rests on the existence of a usable body of research findings, which educational psychologists believe exist.

Wang, Haertel and Walberg identify research, which validates instruction practices that have been shown to improve achievement. Is it possible therefore, at this point to postulate that good teachers combine both ‘imaginative’ and ‘technical’ characteristics? Hatton and Smith would suggest that it is possible and that this combination of ‘imaginative’ and ‘technical’ elements is known as reflective teaching. They identify three important qualities necessary to become a reflective teacher: introspection orientation, an open mind but questioning attitude about educational theories and practices, and the willingness to take responsibility for your decisions and actions.

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These attributes then need to be combined with the ability to see a situation from another point of view. Reflective teachers therefore, are constantly engaged in monitoring and analysing their actions before, during and after exchanges with their students in the classroom. This reflection process is likely to work well when teachers have a command of a wide range of knowledge about the nature of their students, the learning process and the instructional process, which will be discussed later in the chapter.

In recent times the scope of the teachers’ role has been vastly expanded beyond its original instructional core to include such functions as: parent surrogate, friend and confidante, counsellor, adviser, representative of adult culture and approved cultural values, and facilitator of personality development. It is not within the scope of this paper to elaborate more fully on the above-mentioned variables except for one personality development. This is for two reasons. Firstly the research for this paper was carried out on forty-three first year students entering the early stages of adolescence. Secondly, a teacher needs to be equally aware of the emotions and values that adolescence students bring with them into the classroom, teachers have to be prepared to make a special effort to allow this development to influence their teaching style.

In our complex, industrialised society we keep the young in a subservient role (i.e. still at school) long after they have reached physical maturity. The reason would appear to be that there is just so much to learn, but this places heavy potential strains upon the young themselves and upon teachers too. In less

complex communities than ours children learn by working alongside their parents, and grow up with the knowledge of what it is like to be an adult and of the rights and responsibilities that go with adult status. At some point in puberty adult status is conferred upon them and from then on they are recognised as full members of the community. In advanced industrialised societies one recognises adolescence, with all the storms and stresses that often accompany this period, as essentially a cultural phenomenon, caused by society itself with its artificial methods of relating to its young people.

The search for self-identity in adolescence is often accompanied by a great deal of experimentation. Adolescents will often adopt role models of older people, pop stars, teachers, and sports people whose life styles and values are deemed worthy of imitation. Growth, change and development remain possible (and desirable) throughout life, but adolescence marks the transition from the fluid personality of the child to the more constant one of the adult. This developmental stage is particularly associated with adolescence, which the author feels, is of sufficient importance to warrant discussion in the following section.

3.2 The Characteristics of Early Adolescence

The transition from primary to secondary school can be a source of stress during early adolescence. This is partly because of changes in their physical development, social roles, cognitive development and sexuality. Owing to these personal and environmental stresses, the self-concept, academic motivation and

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achievement levels often decline. These negative changes are due in part, to the fact that the typical school environment does not meet the needs of developing adolescents.¹⁵

Early adolescent development is characterised by an increased need for autonomy, a focus on oneself, the importance of peer acceptance, concerns about identity and the capacity for abstract thought. Therefore the typical secondary school environment is largely incompatible with the needs of the young adolescent. Instead of providing students with opportunities to make decisions regarding classroom rules and seating arrangements teachers limit the choices students can make about what, where, and how to do things. Competition and social comparisons among students are increased as a result of such practices as whole-class instruction, ability grouping, and public evaluation of one’s work. Small group instruction is infrequent, and individualised instruction is extremely difficult in classes of 15 and over. The combination of these factors can affect some students by the end of first year and can lead to lower expectations for academic success.

As mentioned previously, adolescents become capable of analysing both their own view of an interpersonal relationship and that of the other person. This new analytic ability is also turned inward, resulting in evaluations of their own intellectual and social capabilities. A learning theorist called Bandura, created the phrase ‘self-efficacy’. It referred, to how capable people believed they were at

dealing with one type of task or another. A student therefore, may have a strong sense of self-efficacy for interpersonal relationships (“I am good at making friends.”) but a low self-efficacy for mathematics (“I know I just can’t do these algebraic equations.”). These self-evaluative beliefs can influence what activities students choose and for how long they will persist at a given task, particularly when progress becomes difficult. Students with a low sense of self-efficacy, tend to abandon tasks at the first sign of difficulty, thereby establishing a pattern of failure, low expectations of future success, and task avoidance. This phenomenon has been observed within the author’s own classroom setting.

Teachers in Junior Cycle in secondary schools are faced with several developmental challenges. Consequently, in order to establish a supportive classroom atmosphere in which students can meet their social, emotional and cognitive needs, teachers have to be prepared to make a special effort to allow this development to influence their teaching style. Richard Snow, who has written extensively about individual differences in education and how to deal with them, has summarised this challenge as follows:

Individual differences among students present a pervasive and profound problem to educators. At the outset of instruction in any topic, students of any age and of any culture will differ from one another in various intellectual and psychomotor abilities and skills, in both general and specialised prior knowledge, in interests and motives, and in personal styles of thought and work during learning. These differences, in turn, appear directly related to differences in the students’ learning progress.17


The significance of these observations on variability is that although teachers usually plan lessons, assignments and teaching techniques by taking into account typical characteristics, they would also have to expect, and make allowances for the cognitive differences among students. This variability among students is one reason why teaching is both interesting and challenging. In the next section it is proposed to look at some of the broad based characteristics that distinguish one group of students from another for example, mental ability, and learning/cognitive styles.

3.3 The Differences between Students

The origin of testing mental ability owes much to the work of Alfred Binet. In 1904, the French Minister for Education commissioned Binet to develop an accurate and objective way of distinguishing between children who could benefit from normal classroom instruction and those who had special educational needs. The point of the project was to predict the degree of academic success for the student. Binet’s first scale measured such processes as memory, attention, comprehension, discrimination and reasoning. A revision of Binet’s model by Lewis Terman of Stanford University in 1916 became known as the Stanford-Binet model, which became very popular. Its success was partly due to Terman following the suggestion of a German psychologist William Stern, and expressing a child’s level of performance as a global figure called an intelligence quotient (I.Q).18

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The reason for providing this brief history was to illustrate two points. Firstly, the task that Binet was set nearly one hundred years ago, still influences the form and function of contemporary intelligence tests. Intelligence test items are still selected on the basis of their relationship to school success. Therefore, one must be very careful about using them in order to predict job success, marital bliss, or happiness in life. IQ tests were not designed for this purpose and on reflection it may be better to consider calling them tests of school ability rather than IQ tests.

Secondly, Terman used IQ scores as a quantitative summary of a child’s performance. Binet, worried that educators would use a summary score as an excuse either to ignore or get rid of troublesome or uninterested students, never endorsed this application. His intent was “to identify in order to help and improve, not to label in order to limit”. Current research indicates that cognitive abilities measured by intelligence tests can be improved with systematic instruction; therefore, intelligence test scores should not be viewed as absolute measures of ability. Many individuals, parents in particular, fail to grasp this fact.

An IQ score therefore, is not permanent; it is merely an estimate of how successful a child is in handling certain kinds of problems at a particular time on a particular test as compared with other children of a similar age. While IQ tests are designed to predict academic success, anything that enhances classroom performance (such as a wider range of factual information, or more effective learning strategies) is likely to have a positive effect on intelligence test

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performance. Research on the stability of IQ scores shows that, although they do not change significantly for most people, they can change for certain individuals and they most dramatic changes occur in individuals who were first tested in preschool.21

Traditional theories of intelligence, view intelligence as being composed of a relatively small set of cognitive skill, their associated IQ tests relate best to academic success that is used primarily to place children in special programmes. Contemporary theorists such as Sternberg’s Triarchic Theory22 and Howard Gardner’s Multiple Theory23 propose broader perspectives of intelligence that would appear to have more useful applications for classroom instruction. It is proposed to examine briefly both theories.

Sternberg believes, that research evidence supports the view that intelligence has many facets, or dimensions, and that traditional mental ability tests measure just a few of these facets.24 Sternberg’s Triarchic Theory of Intelligence has, as its name suggests, three main parts: practical ability, creative ability, and analytical ability (see Figure 3.1 page fifty-two). Sternberg’s work is a break with tradition in two respects. Firstly, it includes an aspect of intelligence that has been largely overlooked, how students/people use practical intelligence to adapt to their


environment. Secondly, Sternberg believes that each of these abilities can be improved through instruction and that students learn best when all three are called into play.25

Figure 3.1 Sternberg's Triarchic Theory of Intelligence

Where a mismatch occurs and the student cannot adapt to the standards of the majority, the intelligent student will explore ways to make the standards of others more consistent with his own standards and skills. An enterprising student may try to convince the teacher, for example that short questions are better measures of achievement than long ones and that class work should count as much


towards a grade as test scores. Sternberg’s basic point is that intelligence should be viewed as a broad characteristic of individuals not only by how well they answer a certain set of test questions, but also how well they function in different settings.

In an evaluation of the Triarchic Model in 1996 with 225 high school students, there were two very interesting findings. The first finding showed, that students who were taught and tested in a way that matched their abilities performed significantly better than the students who were mismatched. The second showed that most of the high analytic students were from white middle to upper class families, whereas most of the high – creative and high – practical groups were more racially, ethnically and socio-economically diverse. A similar study in 1998, with third and eight graders showed on average that the third and eight graders who had received triarchically based instruction outscored the two control groups.

Gardner’s Multiple Intelligence Theory like Sternberg’s is broader than the traditional conceptions and is often referred to as MI theory. It is different from Sternberg’s, however, in that it describes at least seven separate types of intelligence. Gardner describes the intelligences as logical-mathematical, linguistic, musical, spatial, bodily kinaesthetic, interpersonal (understanding of


others) and intrapersonal (understanding of self) see Figure 3.2 for a more detailed explanation.

**Figure 3.2**

<table>
<thead>
<tr>
<th>Intelligence</th>
<th>Core Components</th>
<th>End-States</th>
</tr>
</thead>
<tbody>
<tr>
<td>Logical Mathematical</td>
<td>Sensitivity to, and capacity to discern logical or numerical patterns; ability to handle long chains of reasoning</td>
<td>Scientist Mathematician</td>
</tr>
<tr>
<td>Linguistic</td>
<td>Sensitivity to sounds, rhythms, and meaning of words; sensitivity to the different functions of language</td>
<td>Poet Journalist</td>
</tr>
<tr>
<td>Musical</td>
<td>Abilities to produce and appreciate rhythm, pitch, and timbre; appreciation of the forms of musical expressiveness</td>
<td>Violinist Composer</td>
</tr>
<tr>
<td>Spatial</td>
<td>Capacities to perceive the visual-spatial world accurately and to perform transformations on one's initial perceptions.</td>
<td>Sculptor Navigator</td>
</tr>
<tr>
<td>Bodily-Kinesthetic</td>
<td>Abilities to control one's body movements and to handle objects skilfully.</td>
<td>Dancer Athlete</td>
</tr>
<tr>
<td>Interpersonal</td>
<td>Capacities to discern and respond appropriately to the moods, temperaments, motivations and desires of other people</td>
<td>Therapist Salesman</td>
</tr>
<tr>
<td>Intrapersonal</td>
<td>Access to one's own feelings and the ability to discriminate among them and draw upon them to guide behaviour, knowledge of one's own strengths, weaknesses, desires and intelligences.</td>
<td>Person with detailed, accurate self-knowledge</td>
</tr>
</tbody>
</table>

Source: H. Gardner and T. Hatch 1989. 29

Gardner’s MI theory, while it is extremely popular is often misinterpreted. Many people believe for example, that if a student has a strength in a particular intelligence, he or she will excel at all tasks within that domain. This however, need not necessarily be the case. For example, a student with a high level of linguistic intelligence may be quite good at writing essays on various topics but be

unable to produce a good poem. Thomas Hatch\textsuperscript{30} described how three children all with a high level of interpersonal intelligence, used that ability in different ways within the classroom. The first child was good at organising classroom activities, the second was able to solve conflicts among his classmates better than anyone else, and the third child was good at making friends with his peers but shied away from leadership roles.

Gardner's general recommendation for applying MI theory in the classroom is essentially the same as Sternberg's. He believes that teachers should use MI theory as a framework for devising alternative ways to teach subject matter. Checkley, believes that some children learn a subject best when it is presented in a particular format or when it emphasises a particular type of ability or when it is taught under different conditions.\textsuperscript{31} This would concur with the findings of Riding and Rayner, which was discussed in chapter II.

Lessons can be designed to include two or three intelligences. For example; a high school algebra teacher combined kinesthetic and logical mathematical abilities to teach a lesson on graphing. Instead of using in class paper and pencil exercises, the teacher took the students outside to the school's courtyard. Using the large cement pavement squares as a grid and the grooves between the squares as X and Y co-ordinates, she had the students stand at various junctures and plot their own location.


Since, contemporary theories view intelligence as being made up of modifiable cognitive skills, it poses a question as a new millennium begins, of the use of technology to develop intelligence. Robert Sternberg states that, 'Technology can enable people to better develop their intelligence - no question about it.' But, what kind of technology? There are a few possibilities Multimedia, Hypertext, and Hypermedia such as a computerised encyclopaedia for example, the Encyclopaedia Britannica. Hypermedia combines multimedia and hypertext and allows the learner to explore facts, concepts or knowledge domains and move around to different links or more appealing presentation formats.

According to Hilary McLellan, technology holds great promise in addressing the multiple intelligences theory promoted by Gardner. For instance, electronic role-play and Web based conferencing might promote students' intrapersonal intelligence by computer prompts, style checkers and journal aids. It would appear that psychologists conceive intelligence as 'ability' and that it is better to have more of this ability than less of it. As discussed in chapter II this characteristic is often referred to as cognitive style or learning style.

During the primary school years it becomes apparent that students approach tasks in different ways. Some for example, are impulsive thinkers who tend to react quickly when asked a question; other students are reflective thinkers who prefer to mull over things before answering. Jerome Kagan, in the early sixties

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was one of the first to investigate the cognitive style dimensions of reflectivity and impulsivity.\textsuperscript{34} How could one use the awareness of cognitive styles to guide instruction? This paper proposes to research not only, how one can use the awareness of cognitive styles for instruction but also, if one can improve achievement by manipulating instruction to suit cognitive styles. This will be dealt with in more detail in chapter IV Methodology.

Technology can be used to strengthen different forms of intelligence. Dickson\textsuperscript{35} points out how visualising mathematical equations and statistics allows visual learners to better understand the material and facilitates learners mobility between different ways of representing information. Students are not left with masses of data in written form; but rather they can see it displayed visually and hear it. When this occurs, students are freer to process information in a way that is consistent with their learning style.

Roy Clariana found that computer-assisted learning environments shifted both early adolescent and adult learners toward preferring more active and concrete learning experiences.\textsuperscript{36} The author proposes to introduce computer assisted mathematical programs to help students consolidate mathematical sections next year in her own classroom. Gender is another characteristic that influences academic performance. As Myra and David Sadker point out:

\textsuperscript{34} H. Morgan, \textit{Cognitive Styles and classroom Learning} (Westport, CT: Praeger, 1997).


Sitting in the same classroom, reading the same textbook, listening to the same teacher, boys and girls receive very different educations. Why do these differences exist? No one knows for sure although hormonal differences and socialisation differences are all thought to play a role. Despite, increased awareness of how society reinforces gender role stereotyping and measures taken to ensure greater gender equity, girls and boys continue to receive from a variety of sources different messages and incentives about what is appropriate behaviour. Some gender differences are first noticeable at certain grade levels. However, there are no gender differences in mathematical problem solving ability among primary school and early secondary school students but this would appear to change as the student’s progress towards the senior cycle.

In a recent study, the Programme for International Student Assessment (PISA), developed by the Organisation for Economic Co-operation and Development (OECD), Ireland ranked 15th out of twenty-seven OECD countries on the mathematical literacy assessment. The study involving fifteen year olds showed that the score of Irish students at the national 10th percentile were significantly higher than the OECD country average score at that marker, Ireland ranked 14th. However, Ireland ranked 20th, indicating a poor performance by higher-achieving students at the 90th percentile which was below the corresponding OECD country average. The study also showed that male students performed significantly better than female students (by about one-sixth of a


standard deviation) on assessment of mathematical literacy. Are gender differences the result of social pressures to participate in some activities and not in others, or are socialisation patterns the result of biological differences, or do both factors play a role? There is no definitive answer; one simply does not know as yet. However, what is true in general is not true of all individuals and as Sternberg and Gardner have argued, virtually all-cognitive skills can be improved to some degree with the aid of well-designed instruction. Therefore, if the goal of teaching is to help students acquire and use a variety of knowledge and skills, what better way to achieve this than to examine the techniques and approaches already established. The following section will briefly explore The Behavioural, Cognitive and Social instructional approaches and techniques to teaching.

3.4 The Theory of Instructional Approaches.

Instructional planning should always begin with a description of what the teacher desires the student to know and be able to do after the instructional unit is completed. Mager emphasised the importance of objectives by pointing out that

If you don’t know where you’re going, the best maps won’t help you get there. Without a way to communicate your instructional objectives to others:

- You wouldn’t be able to decide which instructional content and procedures would help you to accomplish your objectives.
- You wouldn’t be able to create measuring instruments (tests) that tell you whether your students had become competent enough to move on.
- And your students wouldn’t be able to decide for themselves when to stop practicing.

39 Ibid. viii.


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Mager's proposals for specific objectives were widely accepted at first, but in time it became apparent that the very specific kinds of objectives Mager recommended were most useful in situations where students were asked to acquire knowledge of factual information or to learn simple skills.

For some objectives and students a teacher may wish to use a highly structured approach, which would be consistent with the principles of behavioural and social learning theories. For other objectives the focus may be on helping the students to develop more effective learning and problem solving skills, which would be consistent with the principles of the cognitive approach to teaching. Norman Gronlund concluded that a general type of objective was more appropriate for complex and advanced learning. 41

The behavioural approach to teaching views learning as a means to acquiring new behaviours, and new behaviours are learned because of the role played by external stimuli. In other words, the behavioural approach involves arranging and implementing conditions, which will make it highly likely that a certain response will occur when presented with a certain stimulus; for example, a student will accurately use the correct mathematical formula when faced with an algebraic problem. This form of teaching is often referred to as direct instruction or explicit teaching.

The underlying philosophy of direct instruction is that if the student has not learned, the teacher has not effectively taught. This approach keeps students

consistently engaged in learning basic skills and knowledge through the design of effective lessons, corrective feedback, and opportunities for practice. It is frequently used in the teaching of basic skills for example, in reading, mathematical computations, science, and foreign language vocabulary at primary school level. The goal of direct instruction is to have students master basic skills because students who have learned the wrong information require more time and effort to relearn new concepts.

How effective is direct instruction? Adams and Engelmann conducted a review of thirty-seven studies of direct instruction and reported strong effects. On average, direct instruction students scored at the 81st percentile on an end of unit exam whereas conventionally taught peers scored at the 50th percentile. Positive effects have also been found for teaching reading comprehension and writing strategies to students with learning disabilities and phonemic awareness skills to young children.

The focus of cognitive learning theories is the mind and how it works. Therefore, the cognitive approach concentrates on the mental processes that increase our knowledge and allow us to understand and respond to a question or problem. It is proposed to look at two approaches that are based on different aspects of cognitive theory: information processing and constructivism. The

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information processing approach to teaching looks at conditions that help students transfer information from, for example, a text or lecture to the mind. Constructivism focuses on providing students with opportunities to create their own meaningful view of reality.

Information processing therefore, focuses on how individuals change the form and organisational properties of information and integrate that information into an existing body of knowledge. It also examines how information is stored, retrieved and used to solve problems. Research into this field supports the view that learning occurs:

- As information passes through a series of mental storehouses that vary in the way information is stored and for how long.
- That learning occurs slowly but surely because there is a limit to how much information can be processed at any one time.
- Prior knowledge has a strong influence over what we learn.
- That it is possible for the individual to have control over the cognitive processes that result in learning.\(^{45}\)

This approach has two main parts. The first part of the information processing approach has much in common with the behavioural approach, in that the design of lessons and teaching behaviours make the most of what is known about the learning process. Both the behavioural and cognitive approaches therefore, manipulate the structure of the classroom environment to improve the effectiveness and efficiency of learning. The second part makes students aware of

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how they learn and how they can use those processes to improve classroom performance. The latter is what makes the information processing exceptional.

One of the implications of the information processing approach to instruction is to use attention getting devices since information not attended to will not be learned. Research in cognitive style has found that students learn and recall more information when it is presented in an organised format and meaningful context.46 These findings would concur with those of Riding and Rayner in chapter II. Teachers have to beware of assigning too much information for students to learn. The new ideas students can learn (as discussed earlier) in any one time is limited, and students need time and repeated exposure to new ideas in order to analyse, understand, and integrate them into existing knowledge schemes. Information therefore, should be presented in small chunks. This is the same as one of the recommendations for direct instruction. By monitoring the accuracy of the students' responses the teacher would be able to gauge the time to introduce new ideas and concepts.

The basic tenet therefore, of the information processing approach is that if a teacher believes that how students process information plays a major role in how well they learn information, then the teacher should demonstrate how to analyse a task, formulate a learning plan, and use a variety of learning tactics (such as mnemonics, summarising, note taking), monitor these tactics and make changes when the results are unsatisfactory. In order to be able to do this, a teacher must foster metacognitive skills as discussed in chapter II.

In a constructivist approach to learning the teacher provides a set of conditions that will lead the students to construct a view of reality that will make sense to them. Constructivist explanations of learning are not new: notable psychologist such as; John Dewey, Jean Piaget, Lev Vygotsky and Jerome Bruner have promoted them. Jerome Bruner in the 1960s proposed the concept of discovery learning.\textsuperscript{47} Constructivism emphasised an alternative approach to classroom instruction particularly in the areas of mathematics and science. Bruner believed that teachers should confront children with problems and help them seek solutions either independently or by engaging in-group discussion. Bruner believed that true learning involved 'figuring out how to use what you already know to go beyond what you already think.'\textsuperscript{48}

Like Piaget, Bruner argued that conceptions that students arrive at on their own are usually more meaningful than those proposed by others and that students do not need to be rewarded when they seek to make sense of things that puzzle them. Bruner also maintained, that when students are given sufficient amount of practice in finding solutions to problems, they not only develop problem solving skills but also acquire confidence in their own learning abilities. In other words they learn how to learn. Bruner does not suggest that students should discover every fact or principle or formula they need to know through discovery learning, as it would be too inefficient a process. Learning from others can be as meaningful as personal discovery.


Contemporary constructivism has several variations but two of the main approaches are cognitive constructivism and social constructivism. The basic characteristics of cognitive constructivism are that the existing knowledge schemes are modified by the addition (assimilation) of new ideas that are judged to be linked. New knowledge schemes and operations are created (accommodation) to adapt to ideas and procedures that are inconsistent with existing schemes. Assimilation and accommodation are assumed to be innate and the instructional implication is that the teacher can challenge the students’ current conceptions by presenting new ideas that do not quite fit. The emphasis is on constructing personal meaning; students can work individually or together to create new and more effective schemes. Cognitive constructivism therefore, is an outgrowth of Piaget’s ideas because it focuses on the cognitive processes that take place within the individuals.

Social Constructivism has its roots in the writings of such individuals as psychologist Lev Vygotsky and educational philosopher John Dewey. It holds that meaningful learning occurs when students are explicitly taught how to use the psychological tools of their culture. These tools would include for example, language, mathematics, diagrams, and approaches to problem solving. Learning initially occurs in the presence of and is influenced by more knowledgeable others, for example the teacher. The teacher helps the student through scaffold instruction to construct ideas using realistic open-ended tasks. The knowledge and skill

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acquired are connected to existing schemes and are internalised, allowing the student to become more self-regulated and independent.

The purpose of scaffolding is to help students acquire knowledge and skills that they would not have learnt on their own. As the student demonstrates that they can solve a question, the learning aids (prompts, suggestions, rewards, feedback, and rules for helping students organise and understand their ideas) are faded and removed. Scaffolding techniques are likely to help students traverse what Vygotsky referred to as their zone of proximal development (the difference between what a student can do on his own versus what can be accomplished with some assistance). As students approach the upper limit of their zone of proximal development their behaviour becomes smoother, more internalised and more automatic. Any assistance offered at this level is likely to be perceived as disruptive and irritating.

Unlike Piaget, who believed that student's schemes developed more quickly when they interacted with one another than when they interacted with adults, Vygotsky believed that students gain significantly from knowledge and conceptual tools handed down to them by those who are more intellectually advanced, by peers, older children or adults. It is important at this stage to put all of the approaches discussed into perspective and to realise that no one theory

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53 Ibid. 97 – 99.
will provide the right way to learn. Students will construct their own interpretations of things regardless of whether or not you teach from a behavioural or constructivist perspective. You can provide students with a clear description of what you want them to learn, provide expert scaffolding instruction, and provide realistic tasks to which students can relate, and still find some students who have developed a very different idea of the purpose of the lesson.

The teacher therefore, needs to know which theory or approach best fits which purposes and circumstances. Sometimes memorisation of factual information is essential, and sometimes an instructional objective can be accomplished more efficiently with a clear and well-organised lecture. Knowledge of cognitive style therefore, should be of value to a teacher in helping them assess which theories are best used in particular circumstances. The following methodology chapter examines the methods used in assessing cognitive style, memory and reasoning and the approaches chosen for research purposes.

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Chapter IV

Methodology

The great danger today is of slogans, collective opinions, and ready made trends of thought. We have to be able to resist individually, to criticise, and to distinguish between what is proven and what is not. So we need pupils who are active, who learn early to find out by themselves, partly by their own spontaneous activity and partly through material we set up for them; who learn early to tell what is verifiable and what is simply the first idea to come to them.¹

4.1 Approaches to Educational Research

While it is possible to carry out a worthwhile investigation without having a detailed knowledge of the various approaches to or styles of educational research, a study of different approaches will give insight into the different ways of planning an investigation and enhance one's understanding of the literature. Different styles, traditions or approaches use different methods of collecting data, but no approach prescribes nor automatically rejects any particular method. Quantitative researchers collect facts, which they measure, using scientific techniques that are likely to produce quantified and if possible, generalised conclusions.

Researchers adopting a qualitative perspective are more concerned to understand individual's perceptions of the world. They seek insight rather than statistical analysis. They doubt whether or not social facts exist and question whether or not a scientific approach can be used when dealing with human beings.

However, there are occasions when qualitative researchers draw on quantitative techniques and vice versa. Classifying an approach as quantitative or qualitative, ethnographic, survey, action research or whatever, does not mean that once an approach has been selected, the researcher may not move from the methods normally associated with that style. Each approach has its strengths and weaknesses and each is particularly suitable for a particular context. The approach adopted and the methods of data collected will depend on the nature of the inquiry and the type of information required. The aim of this research paper was to develop an understanding of some of the factors that affect the academic performance of school students. This paper will consider the nature of cognitive style, and its relationship to general ability, mode of presentation, and teaching methodologies and school performance.

The action research method with the 'Teacher as Researcher' was the method chosen for this research paper. The essentially practical, problem-solving nature of action research made this approach attractive to the researcher who having identified a problem of under achievement during the course of her work, saw the merit in investigating it and if possible, of improving practice. There are many definitions of action research however; Cohen and Manion describe it as:

Essentially an on-the-spot procedure designed to deal with a concrete problem located in an immediate situation. This means that the step-by-step process is constantly monitored (ideally, that is) over varying periods of time and by a variety of mechanisms so that the ensuing feedback may be translated into modifications, adjustments, directional changes, redefinitions, as necessary, so as to bring about lasting benefit to the ongoing process itself.2

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An important feature of action research is that the task is not finished when the project ends. The researcher can continue to review, evaluate and improve practice.

Brown and McIntrye, who described an action research model for curriculum innovation in Scottish schools, emphasised the on-going nature of the method. They wrote:

The research questions arise from analysis of the problems of the practitioners in the situation and the immediate aim then becomes that of understanding those problems. The researcher, at an early stage, formulates speculative, tentative, general principles in relation to the problems that have been identified, from these principles; hypotheses may then be generated about what action is likely to lead to the desired improvements in practice. Such action will then be tried out and data on its effects collected, these data are used to revise earlier hypotheses and identify more appropriate action that reflects a modification of the general principles. .... and so on as we move towards a greater understanding and improvement of practice. This implies a continuous process of research and the worth of the work is judged by the understanding of, and desirable change in, the practice that is achieved. ³

There is nothing new about teachers operating as researchers, and Cope and Gray,⁴ and Raven and Parker⁵ in 1981 extensively discuss the ‘teacher as researcher’ model. Action research is not, of course, limited to projects carried out by teachers in an educational setting. It is appropriate in any context when ‘specific knowledge is required for a specific problem in a specific situation, or when a new approach is to be grafted on to an existing system’.⁶

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Action research needs to be planned in the same systematic way as any other type of research, and the methods selected for gathering information will depend on the nature of the information required. Action research is not a method or technique but rather an approach, which has proved to be particularly attractive to educators because of its practical, problem-solving emphasis, because practitioners carry out the research and because the research is directed towards greater understanding and improvement of practice over a period of time.

4.2 The Assessment of Cognitive Style

In teaching students there is often the assumption that all pupils learn in a similar manner. This approach ignores the effect of cognitive style difference. In practice there is a considerable range of cognitive styles, which affects the ways in which a student finds it easiest to learn. In this research paper the nature of two fundamental cognitive styles and their relationship to aspects of school learning will be examined. As discussed in chapter II an individual's cognitive style affects the manner in which information is habitually processed during learning and thinking. Individuals vary along a continuum from one extreme to the other. A cognitive style is different from intelligence in that an individual at one end of the continuum will be good at some tasks and poor at others, while for an individual at the other extreme the situation will be the reverse.7

Two fundamental dimensions of cognitive style will be examined that of the verbal-imagery style of the representation of information during thinking and

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the Wholist-analytic mode of processing information. It should be noted that the position of an individual on one dimension of cognitive style does not effect their position on the other. For example, a person may be an imager and a wholist, and another an imager and an analytic, or another may be a verbaliser and a wholist, while someone else may be a verbaliser and analytic. The two dimensions will briefly be described in turn.

The first dimension of verbal-imagery cognitive style consists of people who are imagers and verbalisers. Basically, when people who are imagers read, listen to or consider information, they experience fluent, spontaneous and frequent mental pictures. By contrast, individuals who are verbalisers read, listen to or consider information in words. The verbal-imagery mode of representation is a continuum with individuals placed along it; individuals in the middle tend to use either mode of representation. The assessment of an individuals' verbal-imagery cognitive style poses the problem that it is not usually externally obvious (it cannot be seen by looking at them). Furthermore, since the only style that the individual is familiar with is their own, it is not easy for them to discover their style by introspection. It is, therefore, necessary to devise an indirect method.

Riding and Taylor first proposed the elements of the method of determining verbal-imagery cognitive style in 1976. These were incorporated into a computer

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presented assessment by Riding et al in 1989, and were further refined into Cognitive Styles Analysis by Riding in 1991, to provide an easily administered and short test of verbal-imagery style for use in education and training. This computer-presented test assesses both the verbal-imagery and the wholist-analytic dimensions of cognitive style. It contains three sub-sets.

The first assesses the verbal-imagery dimension by presenting statements one at a time to be judged true or false. Half of the statements contained information about conceptual categories while the rest described the appearance of items. Half of the statements of each type were true and the rest false. It was assumed that imagers would respond more quickly to the appearance statements, because the objects could be easily represented as mental pictures and the information for the comparison could be obtained directly and rapidly from these images. In the case of conceptual category items, it was assumed that verbalisers would have a shorter response time because the semantic conceptual category membership is verbally abstract in nature and cannot be represented in visual form. The computer records the response time to each statement and calculates the verbal-imagery ratio. A ratio of less than one corresponds to a verbaliser and a ration of more than one to an imager. It should be noted that in this approach individuals have to read both verbal and the imagery items so that it is not a test of reading ability or of reading speed.

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The second dimension of wholist-analytic cognitive style is often referred to as field dependence-independence, and it can be known by a variety of other names. Knowledge of this style has its origins in wartime research on the performance of aircraft pilots. In the 1940s Witkin, and his co-workers studied the perception of the vertical in connection with the flying of aircraft. They observed that some individuals were more affected by the surrounding cues than others, in that when objects around them were tilted some found it more difficult to decide which direction was vertical. Witkin, labelled those who were influenced by a tilted surrounding field as ‘field dependent’ and those who were less so as ‘field independent’. Subsequent work showed that this style was also linked to cognitive performance, and it is felt that for education and training it is more meaningful to use the term ‘wholist’ rather than ‘field-dependent’ since the individual views the learning material in wholes, and ‘analytic’ rather than ‘field-independent’ because for the individual parts of the information are separated out.

The assessment of the wholist-analytic style known as field dependence-independence in the past has been assessed by means of an Embedded Figures Test, in pencil and paper format, in which a simple geometrical shape, which is embedded in a more complex pattern, had to be located. The score is the number correct within a given time. This approach however, has limitations, particularly


13 Ibid. 47 – 59.

in that it only positively assesses field-independence. Furthermore, it does not allow the timing of individual items so that, if a subject spends an atypical amount of time on certain items either through being distracted or finding it unusually difficult, that time is added to the total, so that the final score may be reduced by a relatively large amount due to slowness on one or two items. The Cognitive Styles Analysis developed by Riding overcame these problems in its wholist-analytic section.

The second two subtests in the Cognitive Style Analysis suite assess the wholist-analytic dimension. The first of these presents items containing pairs of complex geometrical figures which the subject is required to judge either the same or different. Since the task involves judgements about the overall similarity of the two figures, it was assumed by Riding\textsuperscript{15} that a relatively fast response to this task would be possible by wholists. The second presents items comprising a single geometrical shape (e.g. a square \( \square \) or a triangle \( \Delta \)) and a complex geometrical figure, the subject is then asked to indicate whether or not the simple shape is contained within the complex one by pressing one of the two response keys.

This task requires a degree of disembedding of the simple shape within the complex geometrical figure in order to establish that it is the same as the stimulus simple shape displayed. It was assumed that analytics would be relatively quicker at this. The computer records the latency of the responses and from this calculates the wholist-analytic ratio. A ratio of less than one corresponds to a wholist and a

ratio of more than one to analytic. The cognitive style analysis test differs from the traditional method of assessing field dependence – independence (e.g. by using the embedded figures test) in three distinctive ways. Firstly, by using a computer presentation, it allows a more sensitive timing of the task at hand.

Secondly, it compares a person’s relative performance on the two halves of the continuum (Verbal-Imagery and Wholist-Analytic cognitive style). Thirdly, it positively measures the wholist tendency and does not simply assume that if a person does poorly on a disembedding task that they are field-dependent. This third point was seen to overcome a major objection to the notion of field-independence being a learning style raised by those who have argued that since generally field-independents are superior to field-dependants, it was simply a correlate of intelligence or general ability.

In considering psychological assessments the most important feature of a test is its construct validity and reliability. If there is no evidence that it assesses what it purports to measure then it is of no use. There is now considerable evidence for the validity of the cognitive styles analysis (CSA) programme and Riding and Rayner have reviewed this in 1998.¹⁶ The CSA programme was used to assess the students in this research as it provided a simple, quick and convenient means of assessing an individual’s position on the two fundamental cognitive style dimensions.

4.3 The Assessment of General Ability

The LASS (Lucid Assessment System for Schools) Secondary is a fully computerised multifunctional assessment system that can be used with students in the age range from eleven years to fifteen years and eleven months. The full suite of eight computerised modules is delivered to the student in the form of games, without the need for individual supervision, and scores the results immediately. The tasks are challenging and enjoyable and are presented with colourful cartoon-style graphics and high quality digitised sound.\(^7\) Most of the modules are adaptive tests, which means that the computer automatically adjusts the difficulty of the items to suite the ability level of the student. This prevents the students becoming bored by items, which are too easy or frustrated by items that are too difficult. It enables teachers to obtain:

- A reasonable assessment of a student’s general ability/intelligence.
- Measure discrepancies between actual literacy attainment and expected literacy attainment based on intelligence.
- Identify underlying problems in memory or phonological processing skills that could be the cause of under performance
- Identification of special learning difficulties and dyslexia
- Assess improvements in memory, phonological and phonic decoding skills brought about by appropriate training or intervention.

The eight tests in the LASS Secondary have been standardised so that teachers using the system can establish where any given student falls on any one of the components of the suite, in relation to the population norms. This means that

direct and meaningful comparisons can be made between the individual tests that a student takes. The initial standardisation of LASS Secondary was carried out in 1998, using a representative sample of 505 students (300 boys and 205 girls) attending 14 schools in different parts of the United Kingdom. The age range was eleven years to fifteen years eleven months. The mean age was thirteen years two months (standard deviation was 14.3 months).

Figure 4.1 Composition of the LASS Secondary Suite of Tests.\(^{18}\)

<table>
<thead>
<tr>
<th>TEST</th>
<th>CATEGORY</th>
<th>TYPE</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sentence Reading</td>
<td>Attainment</td>
<td>Adaptive</td>
<td>Cloze Reading – completing sentences by identifying the missing word from a choice of five alternatives. No spoken assistance is given.</td>
</tr>
<tr>
<td>Single Word Reading</td>
<td>Attainment</td>
<td>Progressive</td>
<td>Reading individual words out of context – identifying from a choice of five alternatives the printed word that corresponds to a spoken word.</td>
</tr>
<tr>
<td>Spelling</td>
<td>Attainment</td>
<td>Adaptive</td>
<td>Spelling individual real words that are spoken by the computer.</td>
</tr>
<tr>
<td>Reasoning</td>
<td>Ability</td>
<td>Adaptive</td>
<td>Non-verbal intelligence – analogical reasoning where the correct item from a choice of six alternatives has to be selected in order to complete a spatial matrix.</td>
</tr>
<tr>
<td>Mobile</td>
<td>Diagnostic</td>
<td>Progressive</td>
<td>Auditory sequential memory (digit span) – recall of between two and nine digits in correct (forwards) sequential order.</td>
</tr>
<tr>
<td>Cave</td>
<td>Diagnostic</td>
<td>Progressive</td>
<td>Visual memory – immediate recall of objects and their spatial positions, beginning with two items and progressing to seven items.</td>
</tr>
<tr>
<td>Nonwords</td>
<td>Diagnostic</td>
<td>Progressive</td>
<td>Reading individual non-words – a pure measure of phonic decoding skills. For each non-word there is a choice of four spoken alternatives.</td>
</tr>
<tr>
<td>Segments</td>
<td>Diagnostic</td>
<td>Progressive</td>
<td>Phonological processing ability – segmentation and deletion of syllables and phonemes in real words. For each item there is a choice from four spoken alternatives.</td>
</tr>
</tbody>
</table>

The LASS Secondary software conforms to the British Psychological Society’s guidelines for the development and use of computer-based assessments. The LASS secondary suite is comprised of three attainment tests (single word reading, sentence reading and spelling), one ability test (reasoning) and four diagnostic tests (auditory memory, visual memory, phonic skills and phonological processing). An outline of each test is given on page seventy-eight Figure 4.1. The term ‘adaptive testing’ refers to any technique that modifies the nature of the test in response to the performance of the test taker. Paper based tests are static instruments, fixed in their item content, item order, and duration. By contrast, computer based assessment can be dynamic. Since the computer can score performance at the same time as item presentation, it can modify the test accordingly, tailoring it to the capabilities of the individual taking the test much more effectively than has ever been possible before.

Conventional tests can be crude instruments in which, much of the time, the individual’s abilities are not being assessed with great precision because items are either too difficult or too easy. In an adaptive test the individual can be moved swiftly to that zone of the test that will most efficiently discriminate his or her capabilities, thereby making the assessment shorter, more reliable, more efficient and often more acceptable to the person being tested. For example, Olsen compared paper-based and computer administered school achievement and assessment tests with computerised adaptive tests. The computer based non-

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adaptive version took 50 – 75% of the time taken to administer the conventional version, while the adaptive version was only 25% of the time taken for the paper-based version.

Many students tend to have a greater strength in visual, auditory or tactile cognitive areas and this influences their preferred way of learning. The student who has dyslexic problems will tend to have a very uneven profile, with some cognitive areas in the low centiles and others high. Looking at the whole profile will provide evidence of the areas that need attention and at the same time indicate where the strengths are, so that one can use those strengths to mitigate or remediate the problem learning areas.

Although, the full suite of tests were given to each student, for the purpose of this study the researcher was mainly concerned with three of the tests reasoning (ability), Auditory Memory (Mobile, diagnostic), and Visual Memory (Cave, diagnostic). The purpose of the reasoning module is to give the assessor a reasonable estimate of the student’s general intellectual ability or intelligence. This is a matrix test, in which both visual and verbal reasoning strategies may be employed. There is good evidence that such matrix reasoning tests correlates well with more extensive measures of intelligence and therefore provides a good overall indicator of general intellectual ability.21

The ‘cave’ is a test of visual memory, involving spatial and temporal sequences. However, since the stimulus items for the ‘cave’ can be encoded by

use of verbal labels, the part played by verbal memory skills in this task is potentially as great as that played by visual memory. Although auditory-verbal memory is usually regarded as being the greatest significance where literacy skills are concerned, there is good evidence that visual memory tasks can also give good indications of dyslexia and literacy difficulties.\textsuperscript{22} Visual memory also comes into play when retrieving visual sequences of letters in the correct order, hence, its importance in mathematics especially when dealing with algebraic sequences. Therefore, it is important for the teacher to know whether or not student's visual memory skills are weak or strong, as it will have implications for teaching recommendations.

The 'mobile is a test of auditory-verbal sequential short-term memory, based on the recall of digits. Students with dyslexia and specific learning difficulties experience problems with the recall of digits, and digit span is a feature of the majority of assessment batteries used for the diagnosis of dyslexia.\textsuperscript{23} LASS Secondary correlates highly with traditional forms (digit span is normally a spoken test), such as those used in the Wechsler Intelligence Tests and the British Ability Scales, and is therefore considered a valid measure of auditory-memory.

Short-term auditory-verbal memory is sometimes called 'working memory' because it is the system, which is used when information needs to be held for a brief period of time, while it is being processed. Working memory however, has a

\textsuperscript{22} J. R. Beech, Assessment of Memory and Reading, in \emph{The Psychological Assessment of Reading}, eds. J. Beech and C. H. Singleton (London: Routledge, 1997), 143 – 159.

limited capacity system, and unless information is rehearsed and transferred to longer-term storage, it is lost (information in one’s working memory is retained for only a few seconds). The relevance of auditory-verbal working memory to mathematical skills is equally important, in the same way that it is necessary to hold spoken words in memory in conversation, the student must hold letters and mathematical symbols in memory when processing information to long-term memory.

Poor working memory will affect recall and comprehension, visual memory skills are also involved in this cognitive activity. Students with weaknesses in auditory-verbal working memory also tend to have difficulty in monitoring their written output, and are inclined to leave letters, syllables and words out when they are writing. This phenomenon also manifests itself within mathematics especially when developing the abstract concepts of algebra and in other areas of mathematics where you have mathematical progressions. The following section examines how these concepts were assessed.

4.4 Methodology of Assessment

The sample comprised of forty-three 12 – 13 year old boys in an urban single-sex South Dublin secondary school. The sample included all first year students including those needing remedial classes. The materials comprised an

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assessment of Cognitive Style, an assessment of general ability using the Lucid Assessment System for Secondary Schools (LASS), Mathematical Instructional Sheets to assess instructional material preference, a Structured Questionnaire to assess pupil preferences over a range of learning contexts and Measures of School Achievement using class tests.

1. The Cognitive Styles Analysis\textsuperscript{26} as described in 4.2 was used. This computer presented test gave measures of an individual’s position on both the Wholist-Analytic and Verbal-Imagery cognitive style dimensions.

2. The Lucid Assessment Systems for Schools\textsuperscript{27} as described in 4.3 is a full suite of eight computerised modules for use with students in the age range of eleven years zero months to fifteen years eleven months. It allowed the teacher (author) to obtain a reasonable estimate of the student’s intelligence and to highlight low ability and dyslexic students.

3. Mathematical Instructional Sheets to assess Instructional Material Preference. Three versions of an A4 sized Mathematical Instructional sheet was produced in different formats: Unstructured-Verbal (paragraphs without headings), Structured-Verbal (paragraphs, each with a clear heading) and Structured-Pictorial (paragraphs, each with a clear heading and a pictorial icon as an aid to explaining the information (see Appendix I)

4. A Structured Interview Questionnaire to assess pupil preferences over a range of learning contexts. One of the aims of this study was to investigate the relationship between students’ cognitive style and their


preferred mode of learning. The learning strategies\textsuperscript{28} that were investigated were selected in order to cover a balanced range of the strategies and methodologies that are characteristic of classroom practice. Although not exhaustive, the areas covered were, mode of working, social context and task outcomes, these were used in order to recognise the complex range of variables that create the learning context within classrooms. This part of study used the structured questionnaire developed by Riding and Read who investigated the relationship of cognitive style and pupil learning preference of seventy eight twelve year old students in English and Science in 1997.\textsuperscript{29} A copy of the questionnaire can be seen in Appendix II. The areas covered were as follows

(a) Mode of working

(1) Mode of Preference for Using Materials
(2) Completing Tasks Mode Preference

(b) Social Context

(1) Group, Pair and Individual Preference.
(2) Leading Groups.
(3) Asking and Answering Questions.
(4) Confidence

(c) Task Outcomes

(1) Task Type.
(2) Open or Closed.
(3) Knowledge versus Skill


5. Measures of School Achievement. The measure of achievement was assessed in Mid-March and Mid-May of the school academic year by means of class tests in mathematics. The examination papers were compiled of Junior Certificate Ordinary Level Questions in topics of Area, Volume, Sets and Statistics examination papers can be seen in Appendix III.

4. 5 Procedures

Testing for the Cognitive Style Analysis assessment took place in the computer laboratory, a maximum of fifteen students were tested in a single session, using the fifteen IBM computers available. The room was quiet, with minimal distractions. Participants were given individual instructions before commencing the test once the test had begun no further communication was given be the assessor. The test took approximately fifteen minutes from start to finish.

Testing for the LASS Secondary assessment took place in a small quiet room with no distractions. A maximum of two students were tested on two Hewlard Packard Pavilion N5461 compatible laptop computers. To minimise auditory distractions, inexpensive lightweight headphones of the type used for audio portable equipment was used. The computers were positioned in such a way that neither student could directly see the monitor screen of the other. The assessor checked for reflections on the monitor from windows and lights that could impair the student's perception and lead to failure to see everything that was happening on the monitor. The testing on average took approximately 50 minutes. A brief written record was kept of the student's behaviour at each time of the LASS secondary testing, particularly noting such factors as health, tiredness, attention,
concentration, distractions, and general motivation. A template comments sheet is provided in Appendix IV.

In a classroom setting, the Mathematical Instructional Sheets and the Structured Questionnaire were given to participants in the form of a booklet. The participants were told to write their name on each booklet and only look at each section when instructed. Students were instructed that the booklet had been prepared which contained three formats/layouts for instructional material and that each layout contained the same information, and that they were to examine each version and place a tick in the box provided of the one they preferred. When this was completed they were told to work through the structured interview questionnaire at the back of the booklet. When this was completed the assessor collected the booklet.

The measure of school achievement was taken at the end of the autumn and summer terms. The scores were obtained from the school secretary's computer printout. Many types of profiles are possible, by studying assessments one to four the researcher should be able to the interpret the results and gain insights into deciding on the appropriate strategies for learning and teaching. The fifth assessment, which measured school achievement, was to provide an indicator as to the success or failure of the learning strategy and teaching methodology that was used. The results in assessments one to four were analysed firstly by using a Pearson product moment correlation for an overall affect and then be means of analysis of variance for more detailed affects. In assessment five a paired t-test was also used. The results of these assessments follow in the penultimate chapter.
Chapter V

Results

People commonly imagine that experiments in education are not necessary, and that we can judge from our reason whether anything is good or not. But this is a great mistake, and experience teaches that the results of our experiments are often entirely different from what we expected.... Thus we see that, since we must be guided by experiments, no one generation can set forth a complete scheme of education.¹

The main findings of the study will be presented in terms of the four aspects of assessment (1) Cognitive Style and Cognitive Ability, (2) Cognitive Style and Instructional Preferences, (3) Cognitive Style and the Structured Interview Questionnaire and (4) Cognitive Style and Academic Achievement.

5.1 Characteristics of the Sample

The characteristics of the sample were as follows the mean, with the standard deviation in brackets, for each of the cognitive style measures were Wholist-Analytic Ratio 1.14 (SD. 0.42), Verbaliser-Imager Ratio 1.11 (SD. 0.42). In the present sample, the correlation between the Wholist-Analytic ratio and Verbal-Imager ratio (r = -0.2451) was low. This would concur with findings in other studies where measures for Wholist-Analytic and Verbal-Imagers cognitive style dimensions had low correlations, supporting the view that they are independent dimensions.². The students were divided by the computer according to their ratios into three groups on each of the cognitive style dimensions. The two


style dimensions are continua, but may be divided into groupings and given descriptive labels.

Figure 5.1  
**Cognitive Style Distribution**

![Bar chart showing cognitive style distribution](image)

**The Ratios of Cognitive Style Analysis**

<table>
<thead>
<tr>
<th>Dimension</th>
<th>Wholist</th>
<th>Analytic</th>
<th>Bimodal</th>
<th>Imager</th>
</tr>
</thead>
<tbody>
<tr>
<td>VERBAL-IMAGERY</td>
<td>&lt;=0.98</td>
<td>&gt;0.98 and &lt;=1.09</td>
<td>&gt;1.09</td>
<td></td>
</tr>
</tbody>
</table>

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Figure 5.1, shows a graphical account of the forty-two student positions on the Cognitive Style Analysis (CSA) scale. Figure 5.2, shows the break-up of the ratios used by the (CSA) and the CSA Results Screen describes a person’s style in terms of one of the nine positions, these diagrams can be seen on page eighty-eight. The ratios typically range from 0.4 through to 4.0 with a central value around 1.0.4 Riding and Sadler-Smith 5 have argued that the mechanisms underlying the two cognitive style dimensions are independent of one another and they can be employed separately.

**Figure 5.3**

<table>
<thead>
<tr>
<th>WHOLIST</th>
<th>The Four Cognitive Style Groups</th>
<th>(Number of students in brackets)</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;=1.08</td>
<td>[<strong>Wholist Verbaliser</strong>]</td>
<td>[<strong>Wholist Imager</strong>]</td>
</tr>
<tr>
<td></td>
<td>(12)</td>
<td>(12)</td>
</tr>
<tr>
<td>&gt;1.09</td>
<td><strong>Analytic Verbaliser</strong></td>
<td><strong>Analytic Imager</strong></td>
</tr>
<tr>
<td></td>
<td>(9)</td>
<td>(9)</td>
</tr>
<tr>
<td>&lt;=1.05</td>
<td></td>
<td>&gt; 1.06</td>
</tr>
</tbody>
</table>

**VERBAL-IMAGERY DIMENSION**

However, the size of the sample did not permit a three-way split of the Wholist-Analytic or the Verbal-Imagery dimension. A two-way split gave a reasonably balanced distribution across the cells. It was decided therefore, for the purposes of analysis that the sample would be divided in terms of their cognitive

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style ratios into two categories to give four cognitive style groups of similar sizes see Figure 5.3, page eighty-nine, Riding used this method in previous studies.⁶

Figure 5.4  
A Two-Way Split of Cognitive Style Ratios

Figure 5.4 shows the class distribution transformed under the two-way split of the cognitive style ratios.

5.2 Cognitive Styles and Cognitive Ability

The relationship between cognitive style and cognitive ability was considered in two ways: correlation and, in order to look for possible interactive effects of cognitive style on cognitive ability, by means of analysis of variance. Figure 5.5(a) on page ninety-one shows the interaction of the cognitive ability (assessed by the LASS secondary school programme) and cognitive style on the Wholist-Analytic dimension. The results were analysed firstly by using a Pearson

product moment correlation to indicate the overall effect of how cognitive style interacts with cognitive ability.

**Figure 5.5 (a) The Wholist-Analytic Dimension with Cognitive Ability**

Low correlations were found between the Wholist-Analytic dimension and cognitive ability assessed by the LASS programmes of Cave ($r = 0.10$), Mobile ($r = -0.07$), and Reasoning ($r = -0.02$).

**Figure 5.5 (b) The Verbal-Imagery Dimension with Cognitive Ability**
On the Verbal-Imagery dimension Figure 5.5(b) page ninety-one shows the interaction of the cognitive ability (assessed by the LASS secondary school programme) and the Verbal-Imagery dimension of cognitive style. The results were analysed by using a Pearson product moment correlation to indicate the overall effect. Low correlations were once again found between the Verbal-Imagery dimension and cognitive ability assessed by the LASS programme of Cave \((r = 0.02)\), Mobile \((r = 0.003)\), and Reasoning \((r = -0.25)\). A further two-way analysis of variance of the cognitive style groups (Wholist-Verbalisers, Wholist-Imagers, Analytic-Verbalisers, and Analytic-Imagers) with repeated measures on the three subtests from the LASS programme assessing cognitive ability was performed on the data. No significant interaction was found on the tests for cave and reasoning.

However on the mobile test there were minor effects (approaching significance at 0.01 level) on the Verbal-Imagery dimension for Analytics (Analytic-Verbalisers \(F=5.81;\) d.f. 2,6; \(p = 0.07\) and Analytic-Imagers \(F =3.67;\) d.f. 2,9 \(p = 0.09\)). This may indicate that a bigger cohort may show a more significant association between the Verbal-Imagery dimension and cognitive ability. The finding of no relationship between style and the overall measure of cognitive ability suggests that they are generally independent in origin, as found by Riding and Pearson\(^7\) and Riding and Agrell.\(^8\) They are nevertheless, likely to interact on other variables such as instructional preferences which will be assessed next.


5.3 Cognitive Style and Instructional Preferences

Students were offered instructional material in three formats. The material was a one-page mathematical instructional handout. The overall preference for the three versions of study sheet offered to the students was for Structured-Verbal, and Structured Pictorial. Figure 5.6 gives an overview of the preferences for each cognitive style.

**Figure 5.6 Instructional Preferences and Cognitive Style Dimensions**

A two-way analysis of variance of Verbal-Imagery, Wholist-Analytic cognitive style, and presentation condition was performed on the data. There was a two-way interaction of presentation condition on the Verbal-Imagery dimension with the Wholist-Verbalisers \( F = 6.04; \) d.f. 2,12, \( p = 0.03 \) at 0.01 level) for Version 2 and the Analytic-Imagers \( F = 6.06; \) d.f. 2,9; \( p = 0.04 \) at 0.01 level) for Version 3. The graph illustrates that, for Wholist-Verbalisers, the majority had a preference for the Structured-Verbal format Version 2, while Analytic-Verbalisers had a slight preference for the Structured-Verbal format, over twenty percent chose the Structured Pictorial format Version 3. This was probably because the
appearance of Version 2 was more ‘neat and tidy’, and would appeal to Wholists-Verbalisers, while the Structured-Pictorial Version 3 probably looked more interesting and attracted the Analytics. There was a crossover for the Wholist-Imagers between Version 2 and Version 3. Students whose ratio was high on the Verbal-Imagery Dimension tended towards Version 3, with students whose ratio was low near the borderline choosing Version 2.

On the Verbal-Imagery dimension, most Imagers preferred Version 3 (the Structured-Pictorial format) with nearly 66 percent of the Analytic-Imagers choosing this version as seen in Figure 5.5. This choice was not unexpected as the choice amounted to text versus text-plus picture. Four students selected the unstructured-verbal format Version 1. These students were mainly from two groups that of Wholist-Analytic-Verbalisers. There was no significant effect on the Wholist-Analytic cognitive style. However, the results suggest that the students are attracted to, and prefer to select, materials that appear to suit their own learning style.

5.4 Cognitive Styles and the Structured Interview Questionnaire

The structured interview questionnaire-investigated preferences in three areas (a) the modes of working, (b) the social context and (c) task outcomes. An overview of the responses to the questions by group can be seen in Figure 5.6 on page ninety-five. The relationship between cognitive style and the questions were analysed by means of analysis of variance and descriptive statistics. These will be considered in turn. Questions one and two looked at the Mode of Preference for Using Materials. Question one asked: “What type of materials do you prefer to
use: (a) written/text based or (b) diagrams/pictures/maps?" There was no significant effect on the Wholist-Analytic Dimension with \( (F = 0.02; \text{d.f.} 2,41; p = 0.88) \). On the Verbal-Imagery dimension however, the data indicated that there was almost a significant interaction between the Verbal-Imagery dimension and question one \( (F = 3.48; \text{d.f.} 2, 41; p = 0.06 \text{ at 0.01 level}) \).

**Figure 5.7  Analysis of the Structured Interview Questionnaire**

Question one in Figure 5.7 reflects the bias towards pictorial materials versus written materials for the Wholist-Analytic-Imager Groups. In mathematics there is
a more balanced choice of mode and the preference is for picture materials by the
Imagers, which is their natural mode with the lower ability Verbalisers choosing
written materials, which appears a safer choice and is their natural mode.

**Question two** looked at how the students preferred to complete their tasks;
"How do you prefer to complete tasks: (a) in writing, (b) by speaking, (c) in
diagrams/pictures/maps?" There was no significant effect on either of the two
dimensions Wholist-Analytic ($F = 0.93$; d.f.2, 41; $p = 0.34$) and Verbal-Imagery ($F$
$= 2.65$; d.f.2, 41; $p = 0.11$) for this question. On the Wholist-Analytic dimension
there was a preference for Wholists-Verbalisers to use writing and for Wholist-
Imagers to complete tasks with pictures both groups contained over sixty-five
percent of the higher ability students. Analytic-Verbalisers showed a distinct
preference for writing versus pictures/graphs. For lower ability students, the
situation was more mixed, with three different modes being chosen. This was
probably because they were more reliant on their usual mode, on the one hand, and
on the difficulty they had with the subject, on the other. The reasons for the
choices are not obvious, but are probably related to an interfering effect between
the student’s natural mode and the subject’s natural mode.

Questions three, four, five, and six looked at the social context in which
student’s preferred to work. **Question three** asked: "In what context do you prefer
to complete tasks: (a) within groups of students, (b) by yourself, (c) with a
partner?" Of the two cognitive style dimension there was no overall significant
interaction between the dimensions. However, on the Wholist-Analytic style there
was almost a significant interaction ($F = 4.57$; d.f.2, 41; $p = 0.03$). On the Verbal-
Imagery dimension the Wholists preferred to work on their own or in pairs. The Wholist-Imagers showed a marked dislike of working in groups. The Analytics on the Verbal-Imagery dimension the situation was more mixed with no distinct preference for any of the modes.

**Question four** asked the students: “Do you like leading groups: (a) yes, (b) no?” There were no significant effects here with all cognitive style groups showing a fairly balanced fifty-fifty answer. **Question five** asked the students how did they prefer to answer questions: “Do you like asking or answering questions (a) when the teacher is working with the whole class, or (b) when you are part of a smaller group within the class working with the teacher?” There was no significant effect on either of the cognitive style dimensions. However, on the Wholist-Analytic dimension Analytics showed a marked preference for asking questions in smaller groups with the Wholist-Verbal-Imagers preferring to ask and answer questions in a whole class situation. The overall preference was for more questions to be asked/answered in groups than in the whole class situation, which is expected as they are smaller and lend themselves more to discussion.

**Question six** looked at the measure of confidence the student had when given a choice between two subjects: “Do you feel confident in this subject: (a) English or (b) Mathematics?” There was no significant effect on either of the cognitive style dimensions. However, on the Verbal-Imagery dimension the Analytic-Imagers showed a marked preference for mathematics (see figure 5.6 page ninety-five). Wholist-Verbalisers also showed a preference for mathematics,
which was unexpected. However, the author thought, this reflected more the high percentage of higher ability student’s within the

Questions seven, eight and nine looked at the style of task that students preferred. In **Question seven** the students were asked: “What sort of tasks do you prefer: (a) investigative, (b) testing ideas, and (c) interpreting?” There was no significant effect on either of the cognitive style dimensions. The situation was mixed with the three different modes being chosen. The Wholist-Verbalisers showed a slight preference for answer (b) testing ideas and dislike most the concept of answer (c) interpreting. **Question eight** asked the students: “What type of task do you prefer: (a) Closed or (b) open?” Note that the terms ‘closed’ and ‘opened’ were explained and more detail was provided on the questionnaire (see Appendix II). There was no significant effect on either of the cognitive style dimensions. All of the cognitive style groups preferred the ‘closed task’ to the ‘open’ task.

**Question nine** asked the students: “What type of tasks do you prefer: (a) knowledge/information learning, where you are required to learn facts and information, or (b) skill learning, where you are required to learn how to use or do something?” The bias towards skill versus knowledge can be seen in Figure 5.6 page ninety-five. There was almost a significant interaction on the Wholist-Analytic dimension ($F = 3.33; \text{d.f.} 2, 41; p = 0.07$) with Analytics biased towards skill and Wholists biased towards knowledge.
5.5 Cognitive Styles and Academic Achievement

To facilitate a consideration of the interaction between the style dimensions and learning, their possible effects in combination will be outlined. The data was analysed in terms of a comparison of the performance of the students on traditional Junior Certificate Examination questions at ordinary level in March and a recall test eight weeks later in May. The overall mean Wholist-Analytic ratio was 1.11 (SD 0.42) and the mean Verbal-Imagery ratio was 1.10 (SD 0.42). The correlation between the ratios was non-significant ($r = -0.245$) as expected, indicating the independence of the dimensions. A Pearson product moment correlation was also performed between the individual ratios and achievement results they were non-significant on the Verbal-Imagery dimension ($r = -0.114$) and on the Wholist Analytic dimension ($r = -0.037$) neither result was significant at the five percent level. A paired t-test was performed on the mathematics results for March and May; this showed a significant interaction ($t = 5.97; d.f.41; p > 0.05$). An increase in the mean difference of 3.8 percent mean was found between March and May.

Figure 5.8 (a) Academic Results for the Wholist-Analytic-Imagers

A COMPARISON OF ACADEMIC RESULTS ALONG THE WHOLIST- ANALYTIC - IMAGER DIMENSION

<table>
<thead>
<tr>
<th></th>
<th>March</th>
<th>May</th>
<th>March</th>
<th>May</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wholist</td>
<td>65.92</td>
<td>70.15</td>
<td>69.33</td>
<td>74.11</td>
</tr>
<tr>
<td>Imager</td>
<td></td>
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<td></td>
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</tr>
</tbody>
</table>
Both Figure 5.8 (a) and (b) show the distinction between the Wholist-Analytic and the Verbal-Imagery dimensions. The best overall performance was by the Analytic-Imagers with an increase of 4.78 percent followed by the Wholist-Imagers with an increase of 4.23 percent. The Analytic-Verbalisers did least well with only an increase of 2.78 percent, however it must be noted that this particular group had five students with learning difficulties.

Figure 5.9  Mean Overall Performance in Mathematics
Taking the overall performance on mathematics, the mean pattern from March to May showed: analytics in general displaying a skewed graph with analytic imagers doing best. Similar results were found in mathematics for Analytic-Verbalisers in the data collected by Riding and Caine in 1993.\(^9\) It is also interesting to note that over the academic year the mean difference between winter (Mean 64.31, SD 22.85) and summer (Mean 74.17, SD 20.04) end of term examinations showed an increase of 9.86\%. This phenomenon may well warrant further investigation and it is the author’s intention to continue to monitor the progress of the cohort through to the completion of the Junior Certificate in mathematics. It would be interesting to investigate if variables such as age and personal development would sustain or hinder the initial academic improvement. Studies have found that academic performance decreases around sixteen years.\(^10\) It will be interesting to see if the present cohort follows the same trend.

A wider range of presentation methods would mean that there were more options for the individual learner to choose from. Consequently, a wider range of cognitive styles would be catered for, which would hopefully increase the individuals learning potential. This exploratory study tends to suggest, that the designers of learning material need to be aware of cognitive styles in order to improve the quality of the learning packages they are producing. A fuller discussion of the results will follow in the final chapter.

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\(^10\) Ibid. 67.
Chapter VI

Discussion

And this is the final and inevitable problem of the tester. There is a certain response he wants to get. How shall he ask for it? What shall he say? If he makes his question too clear, he gives his answer away with the question... If the teacher does not make the question clear enough, it may be misunderstood. What is worse, he may not recognise that it has been misunderstood and like many educators and psychologists, may be led by the wrong answers he gets to highly dubious conclusions.1

Introduction

The main findings of the study will be discussed in terms of four aspects of the research, (1) Cognitive Style and Cognitive Ability, (2) Cognitive Style and Instructional Preferences, (3) Cognitive Style and the Structured Questionnaire and (4) Examines the methodologies used in the teaching of mathematics to first year students in conjunction with the knowledge of the students cognitive style and their preferred mode of presentation and its effect on achievement results.

6.1 Cognitive Styles and Cognitive Ability

In considering results, two general points should be made. These concern what cognitive ability/intelligence tests measure and cognitive style and performance in particular subjects. Firstly, with respect to cognitive skills measures, these are likely to include more than just the processing capacity and facility, since the items commonly used in ‘intelligence’ tests also assess learned knowledge and the application of acquired skills. They therefore include within

the measure, the ability to learn and perform and, hence, explain more of the variance than cognitive style, but they are not pure measures.

Secondly, the study of educational achievement and style poses problems. These derive from the nature of the subject, the ways in which it has been taught and the methods used to assess performance. A subject usually varies considerably within itself in terms of the type of content and the range of processing required. In considering subjects they are rarely of a unitary nature. Mathematics for example, requires sequential operations for arithmetic, abstractions for algebra and spatial representations for geometry. In school mathematics these are usually interwoven in such a way that equal overall mathematics performances in two students could result from strengths in quite different areas.

Similarly, in business studies, the diverse elements that make up the subject include consumer knowledge and accounting and these are likely to require quite different abilities. Further, the form of assessment can vary between coursework; unseen examinations and its mode of presentation can be either verbal or pictorial. All of these variables will affect performance by an individual and in reality it is not easy or probably possible to control for them. A low correlation was found between cognitive ability and cognitive style suggesting their independence. This would concur with the findings of Riding and Pearson,² that no relationship between style and overall measure of cognitive ability suggests that they are generally independent in origin. In considering the relationship between cognitive

style and cognitive ability, a further check was performed, students were divided into each of the two style dimensions, on the basis of their ratios as discussed in chapter five. An analysis of variance was performed with each of four cognitive style groups (Analytic-Verbaliser group 1, Wholist-Verbaliser group 3, Analytic-Imager group 7, and Wholist-Imager group 9) on the three subtests cave, mobile, and reasoning. While the analysis of variance did not show any significant affect overall on the subtests (p>0.05) two factors were observed.

The first was the interaction along the Verbal-Imagery dimension, with the ‘Mobile’ subtest in-group 1 (Analytic Verbalisers) it was approaching significance (p=0.07 at 0.01 level). The ‘mobile’ subtest is a test of auditory-verbal sequential short-term memory, based on the recall of digits. On the Wholist-Analytic dimension the Analytics were receiving digits one at a time therefore, they could not envisage the whole sequence. On the Verbal-Imagery dimension the digits were received in word form but some students were hampered by poor auditory-verbal working memory.

Students with weaknesses in auditory-verbal working memory tend to have difficulty in monitoring their written output, and are inclined to leave letters, syllables and words out when they are writing.\(^3\) This phenomenon can manifest itself within mathematics where you have mathematical progressions. It is well established that individuals with dyslexia or specific learning difficulties\(^4\)


experience problems with the recall of digits. Digit span is a feature of the vast majority of assessment batteries used for the diagnosis of Dyslexia. The LASS secondary identified seven students with learning difficulties out of the cohort of 42 students for this research. Five of these students were placed in-group 1 Analytic-Verbalisers and showed low performance ability (less than 40%) across a wide range of academic subjects (Geography, French, English, and Science) in both winter and summer terms.

It is probable therefore, that the high percentage of lower ability students within the Analytic-Verbaliser group contributed to the interaction between the Verbal-Imagery dimension and Cognitive Ability. The second observation ascertained that there was the possibility with a small sample size that significant results would be less likely. It would be necessary to investigate both phenomena with a more evenly distributed larger sample of low, medium and high ability students in further research.

6.2 Cognitive Style and Instructional Preferences

The assessment for instructional preferences indicated that pupils have clear preferences, in terms of their cognitive style, for certain formats of instructional materials, even on brief inspection, during the assessment. The overall preferences of the three versions of the mathematical handout were for Version 2 Structured-Verbal, and Version 3 Structured Pictorial. Only four

students from the Wholist-Analytic-Verbalisers groups picked Version 1 the unstructured mathematical handout. While no statistical significant interaction was found, descriptive statistics would seem to suggest that appearance of instructional materials have important implications for the attractiveness of a subject to the student and its consequent effects on motivation.

The structure of the learning material therefore, is likely to affect the groups differently. While the Wholist-Verbalisers and Analytic-Imagers will be able to keep a balance between an entire concept and the parts, the Wholist-Imagers will understand complete concepts, and the Analytic-Verbalisers will benefit from emphasis on discrete elements. In view of this, students can be shown how to develop learning strategies that allow alternative methods of performing structuring tasks in cases where there is a mis-match with their own cognitive style. In practice, all school subjects are likely to require both the identification of individual elements and integration into, or perception of, the whole, although the balance will vary with different subjects.

In view of this, the question arises of how materials can be produced to attract most students. Two approaches are available: (a) to have different materials for each style; and (b) to design materials to be acceptable to a broad range of students. While the former is possible, it would require greater effort and knowledge of the style of each individual student. The second is more economical and seeks to offer within the given material a range of presentation formats to cater

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for all, or most students. The students would then be free to select from within the material the aspects of the format that most suits them.

The researcher chose the latter option to evaluate its practicality in a busy teaching schedule. The researcher found that whenever pictorial/graphical or concrete material was used there appeared to be a greater interest among the students and more effective learning especially for the Wholist-Analytic-Imagers group, (which was comprised of low, medium and high ability students) a gradual rise in scores on in-class assessment was taken as an indicator that effective learning was taken place. The Wholist –Verbalisers group was comprised of mainly high ability students no effect was noticed with this group.

6.3 Cognitive Styles and the Structured Interview Questionnaire

The structured questionnaire will be discussed in terms of three aspects: Mode of Preference/Working, Social Context and Task Outcomes.

(A) Mode of Preference/Working

An individual's position on the Wholist-Analytic dimension interacts with the structure of the learning material to affect performance.7 On the other hand, the Verbal-Imagery dimension has been found to be related to cognitive tasks relevant to learning. These findings fall into two categories. Firstly, the mode of presentation of learning material is either verbal or pictorial.8 Secondly, the type

of content of learning material, where Imagers recall highly visually descriptive texts better than acoustically complex and unfamiliar text, the reverse holds for Verbalisers. This aspect was examined in chapter I with respect to the factors that influenced the ease of readability.

Question one showed an almost significant interaction on the Verbal-Imagery dimension with Analytic-Imagers choosing pictures and graphs over text for learning material. This would tend to support the findings in assessment two for instructional preferences where Analytic-Imagers showed a preference for Version 3 of the mathematical handout Structured Pictorial. In question two there was the expected tendency along the Verbal -Imagery dimension for Imagers to prefer pictures, diagrams or graphs, and Verbalisers writing in completing tasks. Previous work has suggested that diagrams and pictures, which directly illustrate the content of text, facilitate its comprehension. Mayer found that learning performance increased and recall was superior when pictures and graphs were included in learning material.

(B) Social Context

As Cognitive Styles affect the ways in which an individual thinks about and represents situations in the external world, it is reasonable to expect that they might also be related to aspects of social behaviour in addition to performance on

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cognitive tasks. The Verbal-Imagery style influences the focus and type of an individual’s activities: externally in the case of Verbalisers they would be outgoing and lively whereas, Imagers would be internally more passive, polite and restrained. The Wholist-Analytic style was derived from a family of styles, which included Field-Dependence-Independence, which was investigated by Witkin and discussed in chapter two. Witkin et al. considered the effects of this dimension on aspects of personality related to the perception of self and nonself. They argued that self-nonself segregation increases with field-independence. Riding has suggested that the Wholist-Analytic style will be reflected socially in such dimensions as the Wholists being dependent, flexible, realistic, and vague. Analytics on the other hand will be: self-reliant, consistent, idealistic, and organised.

In this study the students were impartial in their preferences for either group or paired work. Group work was particularly liked by Analytics especially by the lower ability Analytic-Verbalisers. While, individual work was liked by all cognitive styles, it ranked high with Wholists, particularly in the case of higher ability Imagers. It is interesting to note that in this study the lower ability Analytic-Verbalisers selected group or paired work as their preference. The


support of others may have a significant effect on the performance of less able students.

Assuming 'mutual support' is one of the reasons why all students prefer group or paired work, is it possible to postulate that teachers may be depressing performance by favouring individual work? It would be worth investigating if performance could be improved for all students when the balance between group, pairs and or individual work was skewed towards collaborative learning tasks. However student preference and higher performance correlate is not clear and it is not therefore possible to say that an emphasis on individual work depresses performance. In asking and answering questions, in general Wholists asked more questions than Analytics. This would appear to fit the label of Wholist, which implies not being able to distinguish the parts and issues of a topic, and a desire to clarify them.

(C) Task Outcomes

Task outcomes or conclusions to problems are more likely to be influenced by the Wholist-Analytic dimension than the Verbal-Imagery dimension, which is more likely to affect the quality of learning and processing. As has been noted in the preceding section the Wholists-Analytic style affects the way in which people think about, view and are able to respond to information and situations. This could affect task outcomes. As discussed in chapter two Wholists tend to see a situation (topic) as a whole, are able to have an overall perspective and to appreciate its total context.
There is a possible danger for Wholists however, in that, not only are the parts of a situation not separated but often the distinction between them becomes blurred and they find it difficult to distinguish what makes up the whole of the situation. By contrast, Analytics will see a situation as a collection of parts and will often focus on one or two aspects of the situation at a time, to the exclusion of the others. This may have the effect of distorting or exaggerating a particular part and getting it out of proportion to the total situation.

For open and closed tasks, openness was preferred by a small number of higher ability students on the Wholist-Analytic Bimodal spectrum. On the Verbal-Imagery dimension the high ability Wholists preferred closed tasks, as did the lower ability Analytic Verbalisers. Less able students are often believed to learn more effectively when learning outcomes are clearly identifiable in advance and where tasks focus on small units of learning. This can be traced to the predominant behavioural objectives culture that existed most strongly within special needs during the 1970 and 1980s.16

Higher ability students within this study appear to prefer tasks of a more closed and product-orientated nature, in which there is a clearly identifiable 'right' answer and fixed outcome. This would appear to conflict with the view that higher ability students are more confident in their learning and are prepared to be more adventurous in exploring and extending tasks. Is it possible therefore, to postulate at this juncture that the demands of the curriculum and the drive for points towards university entrance has stifled the adventurous spirit? Students are perhaps not

prepared to gamble and closed tasks that are constantly repeated increase the likelihood of success and consequently higher grades (points).

The use of subjective ratings by students has a number of limitations in that: (a) individuals may not be able to report accurately how they would behave, (b) they may be influenced in their responses by social desirability, (c) they may opt for pleasant, or less taxing options, which may require less effort in preference to those which produce the best work (for example, mis-behave in groups). Further studies would be required of style and actual performance to see whether or not expressed preferences correlate with best attainment.

6.4 An Examination of the Methodologies used in Teaching

As a teacher, my approach to mathematics pedagogy rests on a belief, that there is an active relationship between teaching and learning. This philosophy is associated with, Backhouse et al’s view that

No learner can be expected to think in the same way as his or her teacher and that no two learners in a class can be expected to think in the same way as each other (except possibly twins).\(^{17}\)

Therefore, it is possible to postulate that one cannot begin to make sense of what is going on inside a learner’s head until one considers the feelings and attitudes that learners bring to the classroom and the conditions under which a topic is learnt. It was from this perspective that I began a search through the Theories of Knowledge and approaches to teaching.

A quote by Barbara Jaworski captivated the author as it stressed the active roles of both teacher and learner using two negative comparisons for emphasis:

In the classrooms, which I have studied, I have regarded the students as meaning makers, and teachers as supporters of the process of meaning making by their students. This does not mean that I see teaching as some wishy-washy process of ‘letting it happen’ the teacher being no more than a facilitator. This is as simplistic a view as is the image of a teacher as the expert who hands over knowledge and skills.\(^{18}\)

In the first of these comparisons, “the wishy-washy process of letting it happen”, explored a simplified version of Piaget’s constructivism, in which children learn by passing through a sequence of four stages. Orton, in his book ‘Must we wait until pupils are ready?’,\(^{19}\) provided a helpful discussion on the aspects of Piaget’s theory in relation to mathematics teaching and learning. In the second example however, the teacher is seen ‘as the expert who hands over knowledge and skills’, there is not such an active role for the learner. This image describes learners within the behaviourist model where the teacher’s role is to shape and positively to reinforce pupils’ responses until they are correct, the learners’ motivation, experiences and understandings are not taken into account. It can be very tempting for teachers to use this approach when there is an externally imposed curriculum, and where much hangs on examination performance.

While agreeing with the premise that pupils need to develop basic skills, the narrowness of ‘rote’ learning was proving to be a stumbling block. Although, ‘rote’ learning achieves good transfer of knowledge to the long-term memory it


can lead to shallow procedural knowledge of limited use especially when dealing with problem solving. Piaget’s constructivism on balance seemed a better approach but did not encompass totally, the approach that was desired. In order to achieve this, a broader educational philosophy was necessary, one that would include an approach and teaching style, which would encompass the authors’ beliefs; allow integration, discussion, and tolerance to new ideas from the pupils. Most importantly, this approach would also build up mutual respect between the pupils and the teacher (author). It was at this juncture, that an examination into the social constructivism approach began.

Leo Vygotsky, who defines intelligence “as the capacity to learn through instruction”\(^{20}\) and for whom social interaction was a necessary condition of learning, influenced Bruner a leading proponent of social constructivism. Although social constructivism has much in common with Piaget’s constructivism it differed in that, children do not invent or discover how to adapt their thinking and act intelligently in new situations by themselves. Negotiating and interacting with more mature peers and teachers develop these processes. Instruction therefore, is not the one directional process involved in behaviourism, it is a much more subtle process in which other variables are involved.

The social constructivism approach in combination with the cognitive approach offered the latitude that allowed development of the authors’ beliefs and suited the preferred teaching style. The learning objectives for the research had to

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be established. Mager, emphasised the importance of objectives by pointing out that

If you don’t know where you’re going, the best-made maps won’t help you get there. Without a way to communicate your instructional objectives to others: You wouldn’t be able to decide which instructional content and procedures would help you to accomplish your objectives.\(^\text{21}\)

This posed two questions, a] what were the objectives? (Or, What does a teacher want students to know and be able to do after a unit of instruction is complete?) And b] how can the teacher help the students achieve those objectives using the knowledge of students' individual cognitive style and cognitive ability?

In the spring and summer term the topics assigned for the first years were Area and Volume of Rectangles, Squares, Cylinders, Spheres and Algebra I, which is by nature an abstract concept and revision of the autumn terms work including Statistics, Sets, Fractions, Percentages, Ratio and Compound interest. Preparation began by examining texts and other curriculum materials in order to devise an instructional sequence. The rational being that if one decides in advance, what you want the students to achieve, lessons could be prepared that logically lead to a particular result and also use evaluation techniques efficiently designed to determine what level of achievement has occurred. Once, the structure and goals that the students were required to accomplish became clear, the variety of instructional approaches and techniques were re-examined to determine the right approaches to use. After all, if the goal of teaching is to help students acquire and use a variety of knowledge and skills, what better way to do that than to use the

approaches and techniques that are consistent with how students learn and the conditions under which they learn best.

While, the author favoured both the social constructivism and cognitive approaches, it became apparent that no one theory was sufficiently comprehensive and powerful to work with the diversity of students that would be encounter in a mixed ability class. For some objectives, a highly structured approach consistent with the principles of behavioural and social learning would be required. Computer-based technology would be integrated into some of the class units, to facilitate students with learning disabilities. For other objectives, the focus would be on helping students develop more effective learning, and problem solving skills and to develop positive feelings about themselves as students.

Having amassed a great deal of information, the teaching methodology decided on would incorporate Bruner’s ideas that were developed by Wood who described five levels of support needed by the student:


After establishing the objectives, extra handouts, revision workbooks and pictorial diagrams were prepared to facilitate both dimensions of cognitive style and in particular Imagers. Since school academic work is generally biased towards verbal presentation and content, it is likely that Imagers will find it less appropriate to

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their natural mode of representation than do Verbalisers, and will consequently find academic work more demanding. Newton et al.\textsuperscript{24} found that in subjects of English, mathematics and science, Imagers had slightly poorer General Certificate of Education performance at sixteen than Verbalisers. Newton et al. also found that, Analytics did better at English, and Wholists were superior at mathematics and science.\textsuperscript{25} The present study would concur as the majority of higher ability students came from the Wholist-Verbaliser group.

Owing to the natural progression of the student’s age and cognitive development during the academic year it was decided to administer assessments of achievement in Mid March and Mid May. The time difference between the two assessments being eight weeks, which the author felt would be more reliable in testing learning performance and recall. The measure of achievement was assessed in three topics: Area and Volume, Sets and Statistics and will be discussed with regard to cognitive style.

The lowest scoring performance due to an extreme position was that of the Analytic-Verbalisers, who lacked the facility for obtaining a whole view necessary for integrating the different aspects of mathematics. This integration may be required at a low level, as in the comprehension of a sentence, or a higher level, where the different aspects of the topic need to be viewed as a whole in order to see their relationship with one another. While overall the Analytic-Verbalisers showed an increase in level of achievement two students did not achieve the pass


\textsuperscript{25} Ibid. 21 – 25.
rate of forty percent, one showed an increase from 32% (March) to 38% (May) the other student a decrease 32% (March) to 31% (May). The mean difference (March Mean 61.88 SD 26.20, May Mean 64.66 SD 26.08) of 2.78% was the lowest for the Analytic-Verbalisers. It is also interesting to note, that this category contained five out of seven students identified with learning difficulties by the LASS programme26 during the research assessment.

The mean difference of the Analytic-Imagers as a group was higher compared to the other groups it showed an increase of 4.78% (March Mean 69.33 SD 15.75, and May Mean 74.11 SD 15.63). The Wholist-Imager group also showed a good performance with a mean difference of 4.23% (March Mean 65.92 SD 21.10 and May Mean 70.15 SD 19.15). The mean difference (March Mean 72.5 SD 22.29 and May Mean 76.08 SD 22.41) of 3.57% for the Wholist-Verbalisers group was unexpected as the group contained a large percentage of higher ability students (students whose average would be eighty percent and above across all of their school academic subjects). This would tend to support the theory that cognitive style is independent of intelligence. Riding and Pearson found with twelve to thirteen year-old students that intelligence/ability as measured by sub-tests of the British Abilities Scale was not related to cognitive style.27 Similar results were found in a Canadian Study of the relationship between cognitive style and cognitive ability with fourteen to sixteen year-old students.28


It should be noted that two variables have to be considered which could have affected academic achievement. The first was the extent to which the mathematical questions required a whole or part view and the degree to which this requirement was matched by the individual’s style. The second was the degree to which the mathematical questions had a verbal or pictorial emphasis and the extent to which this requirement was matched by the individual’s style. The mathematical questions were taken from Junior Certificate Ordinary level papers but were in line with the model proposed by Riding and Sadler-Smith\(^29\) concerning the use of imaging as a substitute for a wholist view and of verbalising as an analytic technique.

On a personal note the author found the study interesting, challenging and rewarding. As Immanuel Kant said:

> People commonly imagine that experiments in education are not necessary, and that we can judge from our reason whether anything is good or not. But this is a great mistake, and experience teaches that the results of our experiments are often entirely different from what we expected…. Thus we see that, since we must be guided by experiments, no one generation can set forth a complete scheme of education.\(^30\)

Each new group of students presents a fresh challenge and research findings can help and assist a teacher in that challenge. Perhaps the most important element from the authors perspective were not the results but rather the concept that, each student had achieved a progression be it natural or helped (by the teacher and

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methodologies) from the weakest to the higher ability students and that mathematics was not something to be afraid of but rather to be enjoyed.

The ease with which subject matter can be learned is likely to have an effect on behaviour; since successful learning will improve a student's self-esteem and motivation, while difficulty and failure may decrease motivation and consequently may have the effect of reducing the quality of behaviour. It was interesting to note, in this study that the students self-esteem and motivation improved as their academic results increased. While it was not within the scope of this research paper to examine this phenomenon in more detail it would be an area worthwhile for further investigation. Overall, evidence would appear to suggest that cognitive style interacts with performance in particular school subjects.

6.5 Conclusion

This study has sought to explore the hypothesis that different people process the same information in different ways and identify how educational processes can help practice and encourage reflective teaching in which practice is informed by a greater understanding of the individual. It has been suggested by educational philosophers that the structure of knowledge differs within different areas of learning. Within schools, subjects take on different biases in terms of the skills they promote and the ways that knowledge seems to be offered. The 'truth criteria' by which ideas are tested is different between the knowledge for


example, within English and Mathematics, as school subjects. It may also be true that some school subjects have a bias, be it 'natural' or through 'tradition', for the representation of knowledge. English, because of the focus on language and communication, appears to have a bias towards speaking, listening and writing. Mathematics may have a greater bias towards the use of mathematical-type symbols, such as mathematical tables, charts, graphs and formulae. The extent to which these subject format dominances are 'natural' to a subject or the product of how teachers were themselves taught and prefer to offer them is unclear, but insofar as it is possible, as wide a range of mode as the subject allows should be offered to facilitate learning by pupils range of styles.

The least effective method of teaching mathematics for all cognitive style groups would appear to be that of presenting information in a highly verbal manner with abstract diagrams. This conclusion may appear self-evident, but an examination of some representative textual teaching materials in this field, suggests that this form may not be uncommon. The improvement in learning performance by the inclusion of more pictorial information diagrams confirms previous findings reported by Winn.33

The present study would appear to confirm that instructional treatment and cognitive style have important effects upon learning outcome. Instructional treatments, which use a pictorial mode of presentation, appear to be more effective for certain types of content for example, when dealing with area and volume than a

verbal mode of presentation. That individuals learn and process information in different ways is well documented.\textsuperscript{34,35} Contrast, this with the assumption, which is implicit in many instructional designs methodologies,\textsuperscript{36} namely that individuals will learn equally well from the same basic teaching materials.

The implications for instruction are that teachers should be aware of individual differences in cognitive style and should attempt to accommodate these into their instructional programmes. The identification of cognitive styles is of immediate relevance to teachers since it can be used to predict learning difficulties, make possible the design of instructional treatments which may be congruent with an individual's habitual mode of thinking, enlighten and improve the effectiveness and efficiency of instruction.

Industrial Pragmatists want pupils to be able to apply the mathematics they learn at school to the workplace, but this concept of 'transfer' may not be as straightforward as it seems. Jean Lave, concluded that all learning is closely tied to the situation in which it is found and that

People are unable to use the mathematics they learn at school because it is so closely tied to peculiar and unrealistic practices adopted there.\textsuperscript{37}

However, this need not be inevitable, transfer may be poor because the common practices of school mathematics need to be questioned, challenged and adapted. In

\textsuperscript{36} D. Rowntree, \textit{Educational Technology in Curriculum Development} (London: PCP, 1982).
turn, this may lead to developing some common ground, where not just the contexts used but also the ways of working implemented in the classroom have to change.

In Boaler's study in 1997, the concept of situated cognition was used to describe different forms of knowledge found in two schools with the same socio-economic background. Boaler concluded, that school [A] which used a traditional textbook-based approach:

Had developed a shallow and procedural knowledge that was of limited use...and their desire to interpret cues and do the 'right thing' suppressed their ability to interpret situations holistically or mathematically.38

This highlights the concept explored earlier that some teachers still use the behaviourist approach even with its limitations. In School [B] on the other hand, the teaching approach centred on open-ended projects lasting two or three weeks, with content and techniques interspersed as necessary. Despite a lack of imposed order, most of the students responded well to the amount of choice given:

They talked about the importance of thought, the adaptation of methods they had learnt and their interpretations of different situations.39

Students often fail to make sense of the mathematics they are taught at school and may learn tricks or routines that are of limited use. This points to the need for a subtle balance of support and challenge in teaching, plentiful interaction between teachers and pupils and between pupils themselves, with explicit consideration of

39 Ibid. 144.
errors and ways of thinking. There are no blueprints, and for the researcher teaching for learning is a group activity.

In order to pursue research therefore, and particularly to develop a model and evaluate a construct, the researcher needs to have sufficient evidence to sustain a belief that a construct may exist in order to maintain the energy to undertake the research. On the other hand, it is also necessary to have a degree of scepticism in order to retain the openness required to evaluate the findings. The psychological study of any construct poses difficulties.

Howe has questioned, even a generally accepted notion, such as intelligence, as to whether it really exists as a valid construct.\(^40\) He provides invaluable words of caution:

> It is particularly important not to fall into the trap of believing that by describing someone's performance we are also providing the reasons for it.\(^41\)

While there is evidence too support the notion of cognitive style, a number of questions remain and further research is needed to clarify these:

(A) Are there Cultural differences in Style? Most of the studies using Cognitive Styles Analysis approach have been in the United Kingdom. The possible effect of culture on cognitive style is of interest. If similar patterns were to be demonstrated in a wide range of cultures, it would contribute to the understanding of the cognitive nature of style.


\(^41\) Ibid. 493.
(B) What is the Interaction Between other Sources and Style? In considering the impact of styles on behaviour, such as learning performance, it is necessary to bear in mind the range of individual variables that might affect learning. For a particular task, these could include the students:

a. Level of ability/intelligence,

b. Prior knowledge which is necessary to give meaning to new information, or, on the other hand, could make the new learning redundant,

c. Degree of motivation, including the perceived relevance of the task,

d. Gender and Age,

e. Cognitive Style

Clearly cognitive style will be one of many influences, but there is a limitation in that it may not show affect when other variables are not measured and included in the analysis. A further point is that cognitive style is not likely to be critical when the task is simple. It is likely to be important however, where the learner is under pressure because, relative to their ability etc., the task is difficult. The investigations of the conditions in which cognitive style is most critical are required.

(C) What are the Mechanisms for Strategy Development? Given that a particular cognitive style may find certain tasks more difficult, how can the development of effective strategies be fostered in an individual? Various approaches could be tried:

a. Pairing students together with dissimilar cognitive styles so that they can learn from one another's approaches or

b. Deliberately present materials in mismatched mode to encourage the production of methods of recoding.

(D) The present study has indicated the need for further research into cognitive style and the observed positive effects on self-esteem and motivation when
academic improvement occurred. It has also highlighted that significant results were less likely due to the smallness of the sample size, a larger cohort might show more significant results. Further research is required into the area of cognitive style and low ability students to see if a mismatch of material is a potential cause for low achieving.

A final point, in an individual, their performance may be improved by the development of strategies, which maximise the positive aspects of each cognitive style dimension. An important consideration with respect to style mismatch with a subject’s content or presentation mode is that it should not be a passive acceptance of the difficulty, but a challenge to find strategies by which an appropriate cognitive style may be used to its best advantage in order to facilitate the learning performance. The results of this study would indicate that it is possible to distinguish between students in terms of the way in which they represent information during learning and retention, and that cognitive style does affect learning performance on tasks typical of those used in the school situation. While further research is needed to gain a clearer view of how Wholist-Analytics and Verbal-Imagers differ in the way in which they learn most effectively, it is becoming apparent that teachers may need to be more aware of these dimensions of individual differences.

If students are constantly taught by means of materials, or via modes, that are not suited to their learning style, then they will perform less well than they could and may give the impression of being less intelligent than they really are. Facilitating students to be more aware of their own learning processes will allow them the opportunity to become more effective as autonomous, self-directed, life-long learners.
Appendix I

Volume of Cylinder and Sphere Version 1

Tick √ the following box if you like this layout of this information □

Curved surface area = $2\pi rh$

Total surface area of a solid or closed cylinder

= curved surface area + 2 ends

= $2\pi rh + 2\pi r^2$

Volume = $\pi r^2h$

Calculate

(a) the curved surface area

(b) the total surface area

(c) the volume

of a cylinder of radius 7cm and height 5cm.

Use $\pi = \frac{22}{7}$

(a) Curved surface area = $2\pi rh = 2 \times \frac{22}{7} \times 7 \times 5$

= $2 \times 22 \times 5$

= 220cm$^2$

(b) Total surface area = curved surface area + 2 ends

Each end = circle $\Rightarrow$ area of each end = $\pi r^2 = \frac{22}{7} \times 7 \times 7 = 154cm^2$

$\Rightarrow$ total surface area = $220 + 2 \times 154 = 220 + 308 = 528cm^2$

(c) Volume = $\pi r^2h = \frac{22}{7} \times 7^2 \times 5 = \frac{22}{7} \times 7 \times 7 \times 5 = 22 \times 7 \times 5 = 770cm^3$

Surface area = $4\pi r$

Volume = $\frac{4}{3}\pi r^3$

Find (i) the surface area (ii) the volume of a sphere of radius 2.1 cm

(i) Surface area = $4\pi r^2 = 4 \times \frac{22}{7} \times 2.1 \times 2.1$

= $4 \times 22 \times 2.1$

= 55.44cm$^2$

(ii) Volume = $\frac{4}{3}\pi r^3 = \frac{4}{3} \times \frac{22}{7} \times 2.1 \times 2.1$

= $4 \times 22 \times 0.1 \times 2.1$

= 38.808cm$^3$
Cylinders and spheres

Here are the formulae for the volumes and surface areas of a cylinder and a sphere:

**CYLINDER of height h and radius r.**

- **Volume:** $\pi r^2 h$
- **Curved surface area:** $2\pi rh$
- **Area of base (a disc):** $\pi r^2$
- **Area of lid (a disc):** $\pi r^2$
- **Total surface area:** $2\pi rh + 2\pi r^2$

The Cylinder looks like this when it is cut open:

Example 1

A cylindrical can of soup has radius $3\sqrt{2}$ cm and height 10 cm. Using $\pi = \frac{22}{7}$, find:

(i) the volume of soup inside
(ii) the area of sheet metal used to make the can.

**Solution**

(i) Volume $= \pi r^2 h = \frac{22}{7} \times \frac{7}{2} \times \frac{7}{2} \times \frac{10}{1}$

$$= \frac{11 \times 22 \times 7 \times 5}{2 \times 1 \times 2 \times 1} = \frac{555}{1}$$

**Answer** 385 cm$^3$

The SPHERE

**The Sphere**

- Volume of a sphere = $\frac{4}{3} \pi r^3$
- Surface area of a sphere = $4\pi r^2$

A hemisphere is half a sphere. For a hemisphere of radius r,

- Volume = $\frac{2}{3} \pi r^3$
- Curved surface area = $2\pi r^2$
- Area of solid top = $\pi r^2$.

Find the volume in terms of $\pi$ of a solid metal sphere that has a radius of 6 cm. (leave $\pi$ as $\pi$) use the formula given above.
Volume of Cylinder and Sphere Version 3

Tick \( \sqrt{\text{the following box if you like this layout of information}} \)

Formulas Required:

Cylinder:

Volume, \( V = \pi r^2 h \)
Curved Surface Area, \( CSA = 2\pi rh \)
Total Surface Area, \( TSA = 2\pi rh + 2\pi r^2 \)

Sphere:

Volume, \( V = \frac{4}{3} \pi r^3 \)
Curved Surface Area, \( CSA = 4\pi r^2 \)

Hemisphere:

Volume, \( V = \frac{2}{3} \pi r^3 \)
Curved Surface Area, \( CSA = 2\pi r^2 \)
Total Surface Area, \( TSA = 2\pi r^2 + \pi r^2 = 3\pi r^2 \)

Problems:

Find the volume of a closed cylindrical can \( h = 10 \text{cm}, r = 7 \text{cm}, \pi = \frac{22}{7} \)

Solution:

(i) \( V = \pi r^2 h \)
\( V = \frac{22}{7} \times \frac{7}{1} \times \frac{10}{1} \)
\( V = 1,540 \text{ cm}^3 \)

Find the volume of a solid sphere with \( r = 6 \text{ cm}, \pi = 3.14 \)

Solution:

(i) \( V = \frac{4}{3} \pi r^3 \)
\( = \frac{4}{3} \times 3.14 \times 6 \times 6 \times 6 \)
\( = 904.32 \text{ cm}^3 \)
Appendix II
Structured Interview Questionnaire

Please answer the following questions as accurately as you can all of the responses are confidential. Answer the following questions by ticking √ one box with your answer.

(A) Mode of preference/working

Q. 1 “What type of materials do you prefer to use”:
   (a) Written or text based instructions? □
   (b) Diagrams or pictures? □

Q. 2 “How do you prefer to complete tasks:”
   (a) In writing □
   (b) By speaking □
   (c) In diagrams/pictures □

(B) Social Context

Q. 3 “In what context do you prefer to complete tasks”:
   (a) Within groups of students □
   (b) By yourself □
   (c) With a partner □

Q. 4 “Do you like leading groups”:
   (a) Yes □
   (b) No □

Q. 5 “Do you like asking/answering questions”:
   (a) When the teacher is working with the whole class? □
   (b) When you are part of a smaller group within the class working with the teacher? □
Q. 6 “Do you feel confident in this subject”:

(a) English □
(b) Mathematics □

(C) Task Outcomes

Q. 7 “What sort of tasks do you prefer”:

(a) Investigative, where you are required to identify rules and ideas □
(b) Testing ideas, where you are required to use information to test rules and ideas □
(c) Interpreting, where you are required to analyse results and information and draw conclusions? □

Q. 8 “What types of task do you prefer”:

(a) Closed task where there is one correct answer e.g. 3 X 5 = □
(b) Open task where there is a wider range of correct answers e.g. Make up some questions whose answer is 24. □

Q. 9 “What type of learning do you prefer”:

(a) Knowledge/Information learning, where You are required to learn facts and information □
(b) Skill learning, where you are required to learn how to use or do something □
Appendix III

Mathematics Paper March 2002

Form 1

Answer all questions. Questions 1, 2, and 3; carry equal marks (50).

Marks may be lost if the necessary work is not clearly shown and labelled.

Q.1

(a) In a survey of 100 teenagers,

80 like 'rock' music,
12 like both 'rock' and classical music,
7 like neither type of music.

(i) Draw a Venn diagram to represent this information.

(ii) How many teenagers like classical music only?

(b) List the elements in each of the following sets

(i) \(B\)
(ii) \(A \cap C\)
(iii) \(A \setminus (B \cup C)\)
(iv) \((A \cup B \cup C)'\).
Q.2

(a)

Find the volume of a solid cylinder of radius length 5 cm and height 14 cm.

Take \( \pi = \frac{22}{7} \).

![Diagram of a cylinder with radius 5 cm and height 14 cm]

(b)

Two of these cylinders fit exactly into a rectangular box of height 14 cm.

Find

(i) the length, \( x \) cm, of the rectangular box.

(ii) the width, \( y \) cm, of the rectangular box.

(iii) the volume of the rectangular box in cm\(^3\).

![Diagram of a rectangular box with two cylinders]
In a survey, 20 people were asked how much money each spent in a month on the National Lottery. The result, in IR£, was

<table>
<thead>
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<th>4</th>
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<td>Number of people</td>
<td>2</td>
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(i) State the amount of money which is the mode.
(ii) What percentage of the 20 people spent IR£6 or more?
(iii) Calculate the mean amount of money spent per person.
(iv) Draw a pie-chart to show the contrast between the numbers of people who spent IR£4, IR£5, IR£6 and IR£7.
Appendix III

Mathematics Paper May 2002

Form 1

Part 2

Answer all questions. Question 1, 2, and 3; carry equal marks (50).

Marks may be lost if the necessary work is not clearly shown and labelled.

Q.1

(a)

U is the set of pupils in a class.
E is the set of pupils who watch “Eastenders”.
F is the set of pupils who watch “Fair City”.

(i) How many pupils watch neither “Eastenders” nor “Fair City”?

(ii) How many pupils are in the class?

(iii) How many pupils watch “Fair City”?

(b)

Draw a Venn diagram to illustrate the following elements:

\[ U = \{1, 2, 3, 4, 5, 6, 7\} \]
\[ P = \{1, 2, 3\} \]
\[ Q = \{3, 4, 5\} \]
\[ R = \{1, 3, 5, 6\} \]

Write down the elements of

(i) \( P \cap Q \cap R \)

(ii) \( P \setminus Q \)

(iii) \( (P \cup Q) \setminus R \)

(iv) \( (P \cup Q \cup R)' \).
Q.2

(a)

The cylinder shown has radius length 4 cm and height 14 cm.

(i) Find the volume of the cylinder in cm³.

(Note: Use the formula \( \pi r^2 h \)
and take \( \pi = \frac{22}{7} \).)

(ii) The cylinder is filled from 1 litre of water. How much water is left over?

(Note: 1 litre = 1000 cm³.)

(b)

(i) Calculate, to the nearest cm³, the volume of a sphere of radius \( \frac{7}{2} \) cm.

Take \( \pi = \frac{22}{7} \).

(ii) How many of these spheres would fit exactly into a rectangular box of length 14 cm, width 7 cm and height 21 cm?

(iii) Calculate the volume of space in the box not taken up by the spheres.
4. In a survey 30 people were asked how much money they saved each week. The result, in €, was as follows:

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Copy the following frequency table into your answer book and complete it:

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<tr>
<td>Number of people</td>
<td>8</td>
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</table>

(i) State the amount of money which is the mode.

(ii) What percentage of the 30 people saved €15 per week?

(iii) Calculate the mean amount of money saved per person.

(iv) Draw a pie-chart to show the contrast between the numbers of people who saved €5, €10, €15 and €20.
Appendix IV

LASS Secondary Comments Sheet

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General comments

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This sheet may be freely photocopied for use in conjunction with LASS Secondary testing.

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Bibliography

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