LEARNING STRATEGIES: TESTING PASK'S CONVERSATION THEORY IN A COMPUTER ENVIRONMENT

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Human communication is never one way. Always, it not only calls for response but is shaped in its very form and content by anticipated response.

Ong, 1982

Most geographers still, however, subscribe to the faith-like premise that complex patterns on the surface of the earth are at least in principle explainable even if they have lost their faith in logical positivism as a way to achieve that quest for understanding.

Dear, 1989

The same thing that's wrong ... with metaphysics when it tries to devour the world intellectually. It attempts to capture the Dynamic within a static pattern.

Pirsig, 1991

ABSTRACT

Pask's "Conversation Theory", is an influential view of the nature of conversations between people, especially in learning situations. The theory provided a predictive framework within which to extend Pask's laboratory work. Existing work used participant human observers to study the learning process. This technique may be unsuited to the normal classroom context. Software extensions to a geographical image library, map and data store, the BBC Domesday System, were used to extend Pask's work. In carrying out this research, the three main principles from Conversation Theory were examined: 1) that people learn in different ways; 2) that the degree of matching between the learning strategies of teachers and learners strongly influences the rate of learning; and 3) that learning takes place as a conversation between participants whose essential features can be successfully automated.

This thesis examined and evaluated three questions derived from Pask's Conversation Theory in the light of empirical results collected in Phase 1 of a two phase research design. These questions were: 1) whether differences in learning preferences were detectable in modified versions of Ford's (1985) questionnaire; 2) whether preferences for learning strategies were reflected in individual differences in learning behaviour; 3) whether matching learning preferences with learning experiences enhanced the learning process.

Methods of investigation in Phase 1 included: a modified questionnaire; and using the BBC Domesday System to capture learning behaviour with a series of software tools. Findings show: that differences in learning preferences were detectable in questionnaire responses; that differences in learning behaviour were detected also in learning performances; that differences in preferences and behaviour were minimally correlated.

Questions emerged from the lack of expected strength of agreement between findings of Phase 1. These questions are discussed in Phase 2 in relation to recent developments in both epistemology and the theory of computer science. The two further questions guiding the research in Phase 2 were: 4) whether matching learning and teaching strategies enhances learning; 5) whether a computer can act as a conversation participant in a teaching-learning context.

Methods employed in Phase 2 include an examination of the findings of Phase 1 in the light of recent philosophical literature. Findings from Phase 2 show why matching is undecidable and why a computer cannot contribute to a conversation in the way a person does.

Results in Phase 2 uphold Pask's first principle, leave the second undecided and cast serious theoretical doubt on the third. The implications of the findings for educators, geographers and computer scientists are discussed.

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CHAPTER 1

INTRODUCTION

Outline: The opening chapter discusses the context in which the research questions were developed. Section 1 identifies the origins of the research. Section 2 deals with the purpose of this exploratory research and briefly outlines the Two Phase design used to address five research questions. Section 3 describes the organisation of the thesis.

Origins of the Research

My awareness of 'difference' began the first day I went to primary school where everyone else spoke with a slightly different accent. I was a Kiwi Scot among Kiwis from many cultures. I soon realised that few of my peers shared similar ways of looking at the world. Growing up carried with it an acute awareness of difference and I developed an empathy with other people who were seen as different by their peers.

Later, while a secondary school teacher in a small close-knit rural community, the depth and maturity of knowledge of farming practice shown by my less successful students surprised me. Informal conversations with them indicated that they had a very thorough grasp of basic geographical ideas as they applied to farming, yet they did not display similar performance in formal assessment. Their poor performance in examinations was often accompanied by lengthy answers having little academic substance. The apparently disorganised scripts of 'poorer' students hid the ideas that were so obvious in the work of better students. I learned to ignore the extraneous material in the essays of poor students and to look for the concepts and ideas that their language all but obscured. I found that what I had seen in the past was often not the ideas of poorer students, but the flaws in expression of equivalently understood work.

In the day-to-day classroom situation my informal knowledge about students' interests meant that additional knowledge outside of the curriculum could become part of the course work (Cambell, 1978). Drawing on this knowledge sometimes resulted in students engaging in the learning process in

ways that appeared to dramatically enhance their overall learning progress. At times, examination results of Form Six geography students did not reflect my understanding of what they knew. I was unhappy with the traditional explanations for poor examination performances. I felt that if some students could succeed in their out-of-school learning, then it was up to me to help them find ways to succeed within-school learning.

The search for a starting point led me into discussions with other teachers and an examination of the literature on individual differences in student learning. As I read the educational and psychological literature, I became aware of theories and experiments that tried to account for differences in learning. Teacher training had not provided me with the skills for dealing with students who thought in different ways. Rather, teacher trainees in the late sixties used set strategies, applying Bloom's Taxonomy of Educational Objectives (1956), to the organisation of their lesson plans. The acceptance of Bloom's taxonomy meant educators assumed that there was a single best way to learn. Teachers accepted that the strategies implied in his taxonomy were appropriate for all students.

Perusal of educational literature revealed a variety of theories and ideas to account for differences in learning. Given my experiences and knowledge of the classroom setting, one explanation that appealed to me was in Gordon Pask's book on *Conversation and Cognition: Explorations in Epistemology and Education* (1975). First, he presented evidence that differences in performance were attributable to fundamental differences in the way students learned. Second, he proposed two explanations for these differences: a holist-serialist dichotomy of learning strategies accounting for differences in learning; and a performance difference accounted for by a mismatching of learning experiences with learning strategies. Third, he showed that different ways of learning could be equally successful. This was in contrast to other theorists who tended to advance one preferred way of learning ahead of alternatives. Fourth, he predicted that students would find difficulty in changing from one strategy to another. His ideas were encapsulated in his Conversation Theory.

Purpose of the Study

Pask's ideas about differences in learning strategies seemed to provide an explanation for some of my classroom observations. For example, the

relatively rich essays that I received from some geography students indicated a sound intellect, but the poor organisation resulted in poor examination performance. This contradiction made me wonder if these students were using holist-like learning strategies in situations that required a serialist-like response. What is more, my empirical research showed that most media used in geography teaching were serialist (or analytic) in nature (Barbour, et al., 1982). This realisation led me to formulate the following research question: **Would matching a teaching strategy (which includes media) and a pupil's learning strategy enhance learning?**

Pask derived his ideas about differences in learning strategies from laboratory observations. Unlike other researchers, he used a computer, as well as face-to-face interviews, to record data about the learning strategies of his subjects. Extending Pask's ideas about capturing learning strategies by using a computer, instead of through interviews or direct observation, appealed to me. It would make research possible in a busy classroom under close to natural conditions, and would reduce the bias inherent in interviews. I therefore decided that my research would: 1) use a computer to capture the interaction between geography students and learning materials; and 2) use a computer to match the identified learning strategies with appropriate teaching strategies. The learning environment would be the available BBC Domesday Advanced Interactive Video System because it contained substantial curriculum material suitable for Form Six geography students. In this way, I hoped to examine techniques for improving learning in the naturalistic setting of the secondary school geography classroom.

The research context was confined to a rural school population of about 300 people. A classroom group of 12 Form Six geography students responded to a questionnaire and subsequently most of the staff and students in the school responded to appropriate versions of the questionnaire. A classroom group was then investigated as its members carried out activities using the BBC Advanced Interactive Video System. The computer system was also known as the 'BBC AIV'. It will be referred to as **BBC AIV** in the remainder of the thesis. Results from this research indicated that matching teaching and learning strategies would be difficult to achieve. To appreciate better why this was so, I carried out a further review of the literature on the problems of 'matching': that is, of establishing the equivalence in meaning of two sets of ideas.

These ideas were:

1) the contribution of one person to a learning situation and,

2) the matching of that contribution with the contribution of a second person in the form of appropriate materials and teaching strategies.

Matching is a philosophical problem encountered in various guises in all disciplines including geography, education, and computer science. Work extending from my empirical research in the geography classroom to philosophical research was guided by a further research question: Can a computer act as a human conversant in a teaching-learning context?

There were, therefore, two phases to this research. Phase 1 involved empirical research that tested the experimental findings of Pask concerning learning strategies of Sixth Form Geography students. Phase 2 involved theoretical research and examined the philosophical and computer science literature for work on 'undecidability', which emerged as the crux of the matching problem. Phase 2 was thus a reflective assessment of problems that emerged from Phase 1 of the research.

Five basic issues were examined in the thesis:

- Whether the range of differences in subjects' learning preferences was detectable in questionnaire responses.
- Whether variations in learning behaviour were detectable in a computer record of a learning situation extending over several weeks.
- Whether learning preferences were reflected in different observed learning behaviours.
- Whether matching learning and teaching strategies enhances learning.
- Whether a computer can act as a human conversant, in a teaching-learning interaction with a person.

Organisation of the Thesis

The thesis is presented in two parts. Phase 1 of the research -identifying the learning strategies of students- commences in Chapter 2 with a review of the literature on differences in learning styles and strategies in education and psychology. The work of both theoretical and empirical

researchers was surveyed to help legitimise the research problems and the use of Pask's Conversation Theory.

The research methods used for investigating the research problem of Phase 1 are explained in Chapter 3. These methods include employing a modified version of a preference questionnaire, and adding extensions to the software of the BBC AIV so that it would capture what students did when using the system. The results from the empirical research in Phase 1 are presented and discussed in Chapter 4.

Phase 2 extends the research from a specific classroom teaching problem examined in Phase 1 to the wider issue of whether conversation with a machine is possible in the same way as we take for granted with people. It focused on aspects of the problems encountered in Phase 1, especially the 'undecidability' aspect of matching of teaching and learning strategies. The finding are presented in Chapters 5 to 6. The thesis concludes in Chapter 7 with a discussion of the research aims and outcomes, the implications of the findings for teaching in classrooms and other settings, and suggestions for further research.

CHAPTER 2

LITERATURE REVIEW.

Outline: This chapter contains six sections. The origins of studies in human learning are identified and the main methods used in these studies are described in Section 1. In Section 2, the research paradigms and main themes of the behaviourist, cognitivist and humanist traditions are described, with key researchers being placed in their respective paradigmatic areas, and learning theories in education and psychology described with reference to two examples. Studies reporting individual differences in ways of learning are outlined in Section 3. Interests in individual difference studies and computer applications in empirical research are linked together as a basis for introducing Pask's work. Section 4 contains an outline of key concepts in Pask's research. Section 5 discusses and critically analyses Pask's Conversation Theory. The chapter concludes in Section 6 with a range of possible research questions, among which are those central to this thesis.

Views of Thinkers from the Greeks to the Present Day

The earliest recorded attempts to understand learning in a rigorous way are found in the speculations of the Greeks, Plato and Aristotle. For Plato, as Socrates' pupil, every object had an abstract idea or 'form' which caused it (Nettleship, 1935). For example, while an actual chair has some flaws, for Plato, the 'form' of a chair is always perfect. People learned about things because they 'remembered' the 'form' of them and associated this with the less than perfect existing chair. Plato held a 'nativist' position because he believed that knowledge was inborn. Plato's views have little to offer on the question of individual difference except to say that people who do not know are not remembering, or never knew. This view is not conducive to promoting individual learning because it implies an elitist position about who can benefit from being helped to remember. Because there is no way to know what the person already knows it is difficult to decide how to identify Plato's philosopher kings. These are the people who are born knowing. Teachers working with students in every day teaching are not likely to find Plato's work

of very much value because it is too far away from the every day realities of culture in the 20th century.

Plato's pupil Aristotle proposed, in contrast to nativist thinking, that the brain worked to create knowledge by basing this knowledge on sensory experience. Aristotle's speculations were supported by empirical observation. Aristotle's three Laws of Association have very much influenced current behaviourist thought about learning. The first, The Law of Similarity, describes how recall of one item will elicit recall of similar items. The second, The Law of Contrast, deals with opposite things while the third, The Law of Contiguity, predicts that different items learned at the same time will be recalled together (Weimer, 1973). Subsequent thinkers adopted some Greek thought in their speculations about learning.

In the many different approaches to learning, a number of ideas stand out for Hergenhahn (1982) as exemplifying particular themes:

- Structuralism, the earliest explanations of learning, based largely on introspection;
- Functionalism, a reaction against using introspection as evidence, insisted that behaviour was evidence of learning;
- Cognitivism, a view held by a number of psychologists that assigned great importance to mental events;
- Associationism followed the ideas of Aristotle's Laws of Association;
- Neurophysiologism, followed by Hebb (1972) argues that learning involves the build up of cell-assemblies. These are coded with specific sets of experiences which are associated with others to give rise to patterns of thought called stage sequences. Learning is viewed by Hebb as cumulative and dependent on earlier learning.

Across these broad categories of research run a number of interwoven streams of thought and various points of focus. Each tends to be associated with a particular paradigm and a number of key workers. The behaviourists -Thorndike, Skinner and Hull- developed a theoretical framework from observation and interpretation of mental activity seen as the organism's behavioural adaptation to the environment (in Hergenhahn, 1982). Cognitive research, in contrast, includes a large body of empirical and theoretical work initiated by Piaget (1968), Ausubel (1968) and Bandura (1977). These theorists argue that learning must take place within the framework of the

learner's cognitive structures, otherwise it is not meaningful. Gestalt Theorists -Wertheimer, Koffka, and Kohler- argue that the structured wholeness of what we perceive about the world around us is of paramount importance to learning (in Hergenhahn, 1982) . Each part is important in relation to the whole and can also be seen as a whole. Meaningfulness and understanding arise out of the relationships of parts to whole and the recognition of wholes brings satisfaction to the learning.

While Skinner, Piaget and the Gestalt theorists draw empirical support from the idiographic techniques of studying single subjects, other behaviourist and cognitive theorists use data from nomothetic techniques in which the focus is on the average or typical performance of groups of people (Hergenhahn, 1982). Experiments and observations aimed at detecting the learning activities of individuals tend to focus on processes over weeks or months as well as outcomes on particular sessions lasting up to an hour. Both behaviourists and cognitivists argue that learning must take into account the individuals involved in the learning process. However, in contrast to behaviourists, who argue that behavioural habits are learned, cognitive theorists argue that what is learned produces changes in cognitive structures. The main difference between the two views is that the behaviourist argues that only overt actions provide evidence of learning whereas the cognitivist argues that internal activity of thought also results in learning.

More recently, other variants of the behaviourist/cognitivist views have appeared which depend on particular philosophical views for their coherence. Among these newer views are Generative Learning Theory and Constructivist Theory. Generative Learning Theory is in the cognitivist tradition and applies Piagetian 'interviews about instances' to examining scientific learning among children (Osborne and Gilbert, 1980 and 1984). Here the researcher attempts to elicit from the learner a clear statement of the views they hold. Using this data, the researcher is in a better position to appreciate the nature of what the learner knows (Driver, 1982). A main point to come out of this research is that when learners take responsibility for their learning, progress is improved (Gilbert et al., 1981 and Watts and Gilbert, 1989).

Constructivist Theory developed from a reaction against traditional rationalistic or logical positivist views of learning, in combination with Piagetian concepts of discussing learning with the learners in interview situations. Constructivists argue that this theory is about the limits of human

knowledge (Confrey, in Davis et al., 1990, 108). These limits include the concept that knowledge is the product of our own cognitive acts and that we can get access to these cognitive acts through the process of reflection. This reflective process can be facilitated by the Piagetian interview. A significant aspect of current constructivist thought is that each person creates their own constructs and can only be interacted with, by, and through, those constructs. The focus of the theory is very much on the individual learner. There have been no attempts to find regularities in the way people go about constructing their ideas. There are unlikely to be any because constructivist thinking takes the view that each person is uniquely different. Similarly, the generative theorist's empirical interest in individuals and how they go about learning is not likely to result in research on similar patterns of learning across individuals. This is because both theoretical positions adopt the view that only by working with each student as an individual can the researcher discern what is known.

It seems that both constructivist and generative learning theories require a very intimate and detailed interaction with each student's knowledge. My response as a professional teacher is that this requirement is beyond the practical possibilities of current New Zealand class numbers of 30 or more students. In the ordinary classroom of this size and greater, the large number of students necessitates taking advantage of any strategy that will facilitate independent learning. There is simply not time to interact in the ways required by Generative and Constructivist Learning theorists with this number of people. Both theories are heavily reliant on constant and in-depth interaction of the student with the material and a teacher. Neither theory gives consideration to the possibility that differences in what is learned are other than the outcome of poor human performance. Pask's work does have this focus and it is dealt with in Sections 4 and 5 below. The language of studies into individual difference has associated with it a number of specialist terms. The next section defines these terms because they are crucial to studies on learning in general and the coherence of Pask's Conversation Theory in particular.

The review begins by examining the concepts used for describing longer term behaviours (styles) and then moves to those for short term behaviour (strategies).

Key Terms and Concepts in Learning Theory

Finding common definitions for words that are used in a variety of disciplines would be unusual. Certainly, technical terms with respect to learning are variously used in the educational and psychological literature. The key terms defined in this section are central to this review. They are: learning style and cognitive style, learning strategy and cognitive strategy. In brief, learning style and learning strategy refer to a wide variety of observable behaviours that are planned or goal directed, whereas cognitive style and cognitive strategy refer to assumed or inferred intellectual actions that are used generally (styles) or in particular circumstances (strategies). The focus of this thesis is on the learning strategies that can be seen in the every day activities of students in classrooms.

Cognition and Learning

Cognitive styles are viewed by most workers in terms of 'the consistent ways individuals organise information' (Broadbent, 1958; Messick, 1976; Squires, 1981; Dunn, 1984; Laurillard, 1984; Schmeck, 1988). However, there are variations in the detail and 'hardness' of definition and the range of behaviours to which it is ascribed. While educators in America have drawn from the work of researchers concerned with psychological preferences for learning materials and learning environments (Dunn, 1984), British and European researchers have tended to focus on studying the actual behaviours, steps, and mechanisms, displayed by the learner during the process of learning (Entwistle, 1981; Marton and Saljo, 1976). Two early studies using qualitative research in America (Heath, 1964 and Perry, 1970) are described by Entwistle (1981). These researchers recorded students responses to interview questions during their academic careers and found characteristic individual differences in how students used their intellects. This research did not develop a theoretical structure, but was a basis for the more rigorous work of the seventies and eighties described below.

Later work in Britain and Europe (Marton and Saljo, 1976; Entwistle, 1981; Pask, 1975) examined aspects of student learning in great detail. Marton (1976) was particularly interested in how students approached learning tasks involving reading academic articles. He found students employed one of four categories of approach: deep active, deep passive, surface active and

surface passive. According to Marton et al. (1984), changes in teaching strategy alter the approaches students use, but they note that a curriculum overloaded with facts reduces the number of students adopting the desired 'deep approach'. Entwistle (1978) began his research by examining the academic motivation of students. Later, he attempted to develop techniques to apply Marton's findings. His earlier data collection was questionnaire based, but his later work moved to in-depth interviews. He integrated his findings with Pask's (1975) in an attempt to identify more effective learning and teaching strategies. His recent work has moved to helping students identify their own strategies. He has also applied his work to the problem of having academics consider the implications for student learning when adopting various approaches to their teaching (Entwistle, 1988, in Schmeck, 1988).

Most workers (Keefe, 1982, [in Henson and Borthwick, 1984] and Schmeck, 1988) distinguish 'learning styles' from 'cognitive styles' by the breadth of attributes included in each concept. Research into learning styles was initiated to establish which particular methods of learning gave greater effect to the efforts made to learn by particular people as personalities (Squires, 1981). 'Learning style' is defined by Keefe as 'the characteristic cognitive, affective, and physiological behaviours that serve as stable indicators of how learners perceive, interact with, and respond to the learning environment'. These qualities of behaviour are said to be observed in individuals regardless of the content or context of learning. Messick (1976) defines 'learning style' as 'information processing habits' representing the learner's typical mode of perceiving, thinking, problem solving, and remembering'. Whereas, in his view, a person's 'cognitive style' is interpreted from specific behaviours resulting from test scores or test situations which attempt to categorise learned behaviours.

From observations of learning style behaviours, researchers hope to infer how people typically relate to the world and therefore, by extension, what methods they use when learning is taking place (Gregorc, 1979). This information is used by those researchers who wish to understand how to improve learning or by those educators who desire to establish more effective teaching programmes (Dunn, 1984). On the other hand, researchers interested in 'cognitive styles' as a psychological dimension of personality, hope to identify consistent behaviour, thereby revealing how typical cognitive processes occur in normal people.

Cognitive Styles: Thinking and Personality

The objective of cognitive studies is to understand thinking as it reflects identified attributes of personality. 'Cognitive style' is conceptualised as revealing attributes of the person which influence all intellectual functioning. The categories of cognitive style are typically seen as tendencies to behave in particular ways in response to particular test situations.

Messick (1976) argues that cognitive styles are distinguished from abilities by their value differentiation. That is, in contrast with abilities where more is better, more evidence of one bipolar dimensional cognitive style means less of another. Each style dimension has adaptive value in particular contexts. Entwistle (1981, 203) laments that there is no evidence of interrelationships between style types. Kirby (1984) attempted to make the interpretative integration between style types and his summary model is adapted and reproduced below in Figure 1. His conclusion is that macro scale plans, or cognitive styles, and micro scale plans, or cognitive strategies, are important. Lack of clear relationships between cognitive style measures and reports of observed behaviour in the classroom is disappointing. Part of the reason for this problem is that extended studies have yet to be carried out. The question of boundaries between concepts used to describe common terms and concepts in related disciplines is discussed in the next section.

Learning Styles: Boundaries of Disciplinary Interest

The problem of where, in this broad and poorly delineated field of study, to place divisions between the various points of disciplinary study, is made difficult by the use of common terms examined in the introduction to this chapter. There is also an inter-disciplinary division of labour in the study of learning styles which spans the interests of educators and psychologists. Educators tend to be interested in the differences in individual people as people, while psychologists tend to be interested in differences in personalities and in perceptual processes. The view adopted here is that 'style' refers to recurring behaviours that are the outcome of factors within the learner. These factors may be genetic, experientially acquired, or a direct response to factors in the environment. Both 'cognitive style' and 'learning style' refer to

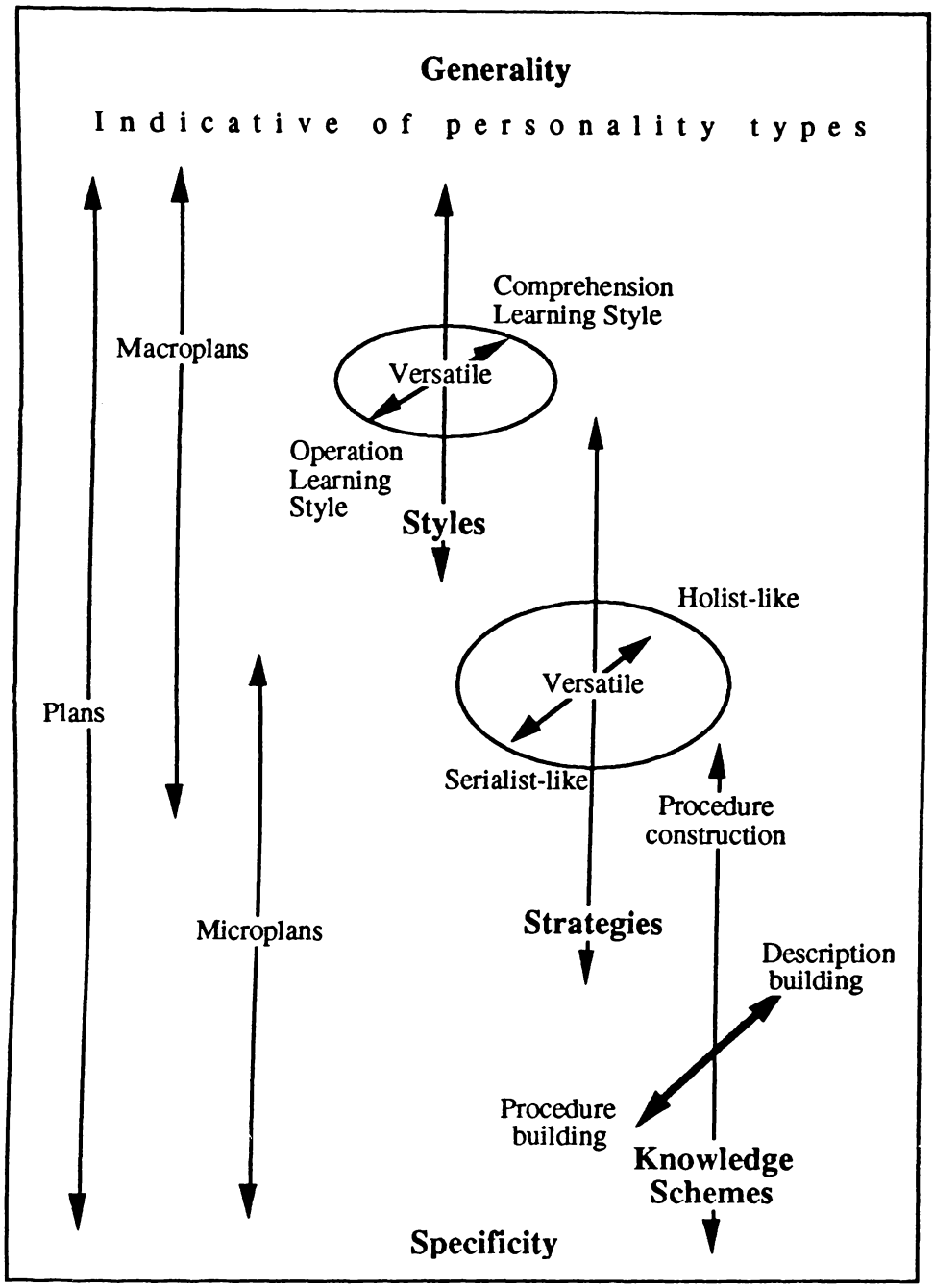

Figure 1. Cognitive styles, strategies and schemes. Strategies are medium scale approaches to learning which contribute to longer term approaches called learning styles (adapted from Kirby, 1984, 57).

to behaviour, however, the former applies to assumed cognitive or thinking activities that are inferred from behaviour (Kirby, 1984). Learning style is a more inclusive term and covers both these inferred thinking activities to the extent that they are supported by the evidence of observed behaviour. Kirby (1984, 87) is also of the view that consideration must be given to increasing teacher's awareness of how to teach planning, strategy selection, and use. Few empirical studies examine the regularities in the processes people employ while going about longer term tasks, such as learning about a curriculum area during the course of a year's work. However, Dunn (1984) has intensively investigated the effects on learning of a wide variety of factors associated with students' preferences about the learning context.

Studies in Learning Preferences

Dunn and Dunn (1978) developed learning style indicators to describe 'the way in which students absorb and retain information and skills'. Their studies show that when students are taught through their preferences they perform consistently better (Dunn, 1984, 14). They also argued that since performance is enhanced with matching, that student's preferences must be their strength. Evidence is cited to support the view that teaching through learning styles increases academic achievement, reduces discipline problems, and improves attitudes towards school (Dunn, 1984, 15).

Dunn (1984) and Curry (1990) provide an integrating and practical focus by applying the work of many cognitive psychologists to the classroom context. Their argument that students' preferences must be their strength, is of particular interest (Barbour, 1990b) and their technique of linking questionnaire data and empirical data is described in Chapter 3 and used in Chapter 4. Their work is, however, eclectic in that they include aspects of a very large and disparate research field in an aggregate of 'predispositions and proclivities' (Gregorc, 1979 and Curry, 1990) of student behaviour in particular learning contexts. The breadth and scope of the 21 categories considered by the Dunns in their work is such as to make me feel uncomfortable with the unreflective way in which a wide variety of attributions have been made of behaviour collected under the general rubric of learning preferences. While using a variety of techniques including extensive questionnaires and tests is an attractive strategy by which to sample the behaviour of large heterogeneous populations, the simple aggregation of

things people liked or did not like did not seem to provide the level of integration I sought between theory and practice. There appears to be little theoretical substance to the work of learning preference researchers, such as those in the 'Dunn school' (Curry, 1990). Empirical studies, using the Dunn and Dunn test instruments, claim significant improvements when preferences are matched with contextual conditions (Curry, 1990).

The contribution of this work to educational practice is to draw attention to the complex array of behaviours investigated by educators and psychologists and to advise teachers of the potentially large number of possible foci that could influence the behaviour of students. This view implies that changing learning styles and learning strategies is a defensible teaching goal. My research is predicated on the assumption that teachers and learners can take action to change learning strategies and, through them, effect changes to learning styles. This issue will be examined in the next section.

Changes in Learning Preferences

The evidence in the literature about changing learning style -a long term preference- is, as yet, not all in. Some researchers find evidence of changing styles, others argue that style is just another attribute like handedness. For example, Geiger and Pinto (1991a), in a longitudinal study attempting to confirm earlier work (Brown and Burke, 1987, in Geiger and Pinto, 1991a), found evidence to support the view that styles do not change over time. This finding contrasts with other work which showed changes in preferred 'learning styles' among students during a four year degree (Mentkowski and Strait, 1983, in Geiger and Pinto, 1991a). In explanation for this phenomena, Geiger and Pinto (1991b) draw attention to the use of cross-sectional data to draw longitudinal conclusions. Brown and Burke (in Geiger and Pinto, 1991a) for example sampled first and third year students in the **same** year instead of tracking them during the three years of a degree course. Geiger and Pinto worked with the same students during a three year period. Their results did not support Brown and Burke's predicted changes. This finding is consistent with Pask's (1988) view of attachment of style to persons in a context.

Ruble and Stout (1992) are critical of both Kolb's Learning Style Inventory (LSI) and Geiger and Pinto's use of it. They believe that the LSI is inadequate and Geiger and Pinto's use of it is subject to computational error

(Ruble and Stout, 1992, 697). However, it is also noted that data for Brown and Burke's study as well as Geiger and Pinto's study was derived from LSI questionnaire inventory, not from observations of actual learning behaviour. I conclude that Burke and Brown's findings are best viewed as commentary on the dangers of generalising about the behaviour of a population over time on the basis of cross-sectional samples taken at one time. I also concur with Ruble and Stout's assertion that further work is required to establish the reliability of Kolb's LSI. Whether the learning style preferences change over time is as yet an open question. At the more detailed scale of learning strategies within learning styles, the issue of changing strategies will be considered later with respect to Pask's (1976a) concept of versatility. The focus here is on the educator's perspective of observable behaviours indicative of individual difference that are accounted for with reference to a theoretical framework provided by Pask's (1975) Conversation Theory.

People demonstrating particular sets of style attributes have been divided into stereotypical categories. Two of the many categories of learning behaviour are of interest in this research. These categories are termed comprehension and operation learning styles (Pask, 1976c, 84). The main distinction is found in the types of strategy demonstrated in learning situations. Comprehension learners use holist-like strategies in which the focus is on the 'overall picture, as a guide to learning' whereas operational learners use serialist-like strategies and put 'much more emphasis on the separate topics' (Entwistle, 1981, 92). Pask (1975) argued that people adopting each major learning style have different perspectives on levels of focus. A person who is inclined to holist-like learning strategies will tend to see knowledge in terms of global or large scale relationships, such as what gravity and magnetism have in common. However, that person will reduce scale to local relationships if asked to do so and will see smaller scale knowledge items in terms of the verbal descriptions of shared features. These categories of learning are introduced here and the holist/serialist distinction will be considered more fully later in the chapter.

While style refers to consistent or typical approaches to learning, strategy refers to the steps a learner takes on a specific occasion. O'Neil (1978) recounts an early review of the literature which indicated that, in programmed learning, the sequencing of learning tasks did not appear to enhance learning. He explains that this could be attributed to the emphasis on rote learning (O'Neil, 1978). He also draws attention to the two major

categories of strategy; those primary strategies that assist the learner to maintain a suitable psychological climate, and those called 'support strategies' that 'enable' the person to use the primary strategies. Schmeck (1988) points out that 'strategy' is a military term referring to procedures required to put a plan into action. A particular procedure would be described as a tactic and, for example, could include writing out material to help with rote recall. Kirby (1984, 5) believes that strategy refers to 'a method of approaching a task'.

In this thesis, 'style' and 'strategy' refer to different phenomena. Strategy is identified in short term behaviour, whereas style is revealed by examining records of observed behaviour over a long period of time (Kirby, 1984, 9).

Kogan (1979) draws attention to the possibility that people have a repertoire of strategies that are drawn on in particular learning contexts. This is an important theme in Pask's (1980 and 1988) work. Briefly, because this point is dealt with more thoroughly in the section on learning strategies, a versatile person is able to modify material from the form in which it is received (eg., holist) to another form which is matched with the way the person learns (eg., serialist).

Studies in Learning Strategies

There are close links between Pask's research (1972, 1975, 1976c, 1980, 1984, 1988) and that of other workers, such as: Piaget; Bruner; Guilford; Kagan; Ausubel; and Wittrock (in education); Newell and Simon (in information processing theory); Landa (in logic and language learning); Das, Kirby and Jarman (in cognitive psychology); and Winograd and Flores (in computer science). The major distinction between the views of these workers and Pask's views lies in the time-scale of the learning processes being investigated (Barbour, 1984). Pask's work, from which his theories have been derived, involved intensive and extended observation of adolescent and post-adolescent learners completing tasks which extended over many learning occasions.

Pask (1980) suggested that his Conversation Theory of learning is a reliable indicator of the cognitive processes involved in large-scale learning tasks. This suggestion has been pursued empirically by Robertson (1978)

and Brumby (1982) and more recently by Dykstra and Carasik (1991). Robertson's work examined the relationships between depth and breadth of focus of attention as indicators of learning strategy. His investigation was conducted in order to explore the significance of Pask's findings for the work of Allport, Antonis and Reynolds (1972). Their work showed that some learners were able to divide attention in a way that was not consistent with a serial mode of information processing as proposed by Broadbent (1958). Using Pask's INTUITION learning environment, Robertson was able to suggest 'preliminary indications of possible relationships between attention deployment, task and strategy' (Robertson, 1978, 90).

Brumby's (1982) work examined the consistency with which learners adopted a particular learning strategy. She found that few learners could be classified as 'holist' and still fewer were consistent in their adoption of a particular learning strategy. She notes that the subjects were drawn from a science oriented population, and questions whether arts subjects would have a higher percentage of 'holist students'.

Ford (1985) employed a research design which attempted to link Pask's (1975) tests of learning strategy with established tests for learning preferences (Entwistle, 1981). His target age group was postgraduate students and he was particularly interested in finding out the extent to which successful learners were versatile in their choice of strategies. The student sample for learning preference studies contained '16 MA, 7 MSc and 3 PGCE students' (Ford, 1985, 69). He found that only two students scored equally well on both the test for matched strategy type and the test for mismatched strategy type. He also recorded a high correlation ($p<.01$ using the Wilcoxon Test) between the strategy test predictions based on observed behaviour and the preference questionnaire results. His work also showed that there was a deficit in learning ranging from between 15% to 60% where learning materials were mismatched with predicted performance. This showed that few learners had the expected level of versatility even though they were experienced and successful learners. However, he points to the serious lack of consistency between learning strategies and observed performance in four of his 25 cases. He does not draw any conclusions about interdisciplinary relationships with learning style or strategy. He concludes by saying that the Study Preferences Questionnaire, adapted here in Chapter 3, enables the identification, 'to some extent' (Ford, 1985, 76),

of students likely to learn more effectively from holist and serialist materials. He also draws attention to a need for exploring the way teachers teach and learners learn in more normal environments (Ford, 1985, 77). Ford's study was very much dependent on applying Pask's work.

Applications of Learning Theory

The studies discussed so far draw from both laboratory and classroom research, with laboratory work being predominant. Application of research studies to every day conversations is not easy. However, being able to carry on a conversation is part of the taken-for-granted characteristics of people. People involved in conversations are seen, by Postmodernist thinkers, as providing noises and marks for another person (Rorty, 1989, 14). Generally, a person who is offering new noises and marks to another person can be said to be 'in the process of teaching', while a person who is obtaining or accepting new noises and marks can be said to be 'in the process of learning'. For the purpose of this thesis it is accepted that 'conversation' refers to the joint or reciprocal processes of teaching and learning. In most interpersonal conversations the two roles are not attached to particular persons, since each person adopts one or other role at different times.

Because individual people are different, there will be differences in the quantity and quality of noises and marks that are transferred between them and in the impact of the noises and marks on recipients.

Under this definition, the majority of the formal work carried out in schools is concerned with conversational contexts and the subsequent steps taken to assess the quality of interaction that may have taken place. There has been much research work in the area of small task learning and in the area of the learning accomplished by young children (Piaget, 1968 and 1976; Wittrock, 1985). There has been much less research work in the area of late adolescent and young adult learning (Kember, 1991). There has been still less work in the area of large task learning, such as in the steps that people take in such contexts as the senior secondary school.

The age group between 16 to 18 years has been investigated in British laboratory settings and classroom settings in a number of disciplinary areas over a period of more than 20 years by Gordon Pask. Kember (1991) reports

that the bulk of the work is in Science (Physics in McDermott, 1984; Algebra in Lochhead, 1985; Chemistry in Lybeck et al., 1988). Arts and Social Sciences have had relatively fewer reported investigations. There is a very meagre research record of work which examines what people do in classroom contexts as they learn in a computer based environment. This is particularly the case with complex systems, such as the BBC AIV (described in more detail in the Chapter 3) which integrates material across a number of disciplines (Unwin, 1991). The following section begins by describing the origins of Pask's work which forms the basis of this thesis.

The Work of Gordon Pask

Gordon Pask has a background in cybernetics and a particular interest in the interaction between people and computers. His early work (Pask, 1961) focussed on steady state computers and their internal control mechanisms. He subsequently became interested in the parallels between computers and people (Pask and Scott, 1972).

An outcome of his work was an interest in the ways in which people go about learning. This interest resulted in the construction of a number of computer systems which would allow the learning steps to be examined under laboratory conditions (Pask, 1980, 1988). During this period of investigation in the early 1970s, Pask, in association with colleagues at System Research Limited, developed Conversation Theory to account for the regularities which had become apparent in his research. This work has been reported in Pask (1975, 1976a, 1976b, 1976c and 1988) and reviewed in Entwistle and Housnel (1975) and Lindstrom (1983). Pask's theory has been tested in part by Entwistle (1978), Robertson (1978), Brumby (1982) and Ford (1985). While their results support Pask's research, it must be noted that they used his research selectively to add to their existing interests. In 1986 I visited with Pask in London. On several occasions over the period of a week I discussed my understanding of his theory and methods with him. However, the following review and discussion is derived primarily from Pask (1975); Daniel (1975); Entwistle (1978, 1981); and Pask (1980, 1984, 1986 and 1988).

Empirical Research

Pask (1975) investigated learning behaviour under very strict laboratory conditions and also in schools and polytechnics in Britain. He found that on any particular occasion people tend to proceed in consistent ways while going about teaching/learning. He called these identifiable ways of proceeding, 'teaching/learning strategies', designating one set of similar approaches 'holist' and the other set of approaches, 'serialist'. Over periods of time and several large scale learning tasks, Pask found that people more often adopted one of the two strategy classes than the other. He called people who adopt holist-like learning strategies 'comprehension learners' and those who adopt serialist-like learning strategies 'operation learners'. He related comprehension and operation learning with 'style' and argued that these attributes are characteristics of people. He noted that some people seem to choose strategies that are mismatched with their learning competencies. He also noted that mismatching reduced the effectiveness of learning efforts (Pask, 1976c, 125). These empirical findings are the basis of Conversation Theory.

Conversation Theory

Conversation Theory is an integrated structure of philosophy, theory, and empirical evidence that deals with a large number of matters covered in a series of three books. The range of material and issues includes practical and theoretical aspects of learning and teaching. Theoretical studies range from a fully developed epistemology to practical advice on how to carry out a pedagogical investigation.

For Pask (1961) as a cybernetician, people are the ideal instance of self-organisation. The data for his 1975 work which examined adaptive learning and self-organising systems, was collected from the early 1960s to the mid 1970s. The techniques he used were developed in laboratory settings, and are based on conventional face-to-face Piagetian style interviews (Piaget, 1968). Piagetian research includes material objects which become the 'artefact' (Pask, pers. comm., 1986) about which the person and the participant observer conversed as learning took place.

Pask's laboratory findings were integrated into a theoretical framework which he called 'Conversation Theory'. The central idea of Conversation Theory is that the content and process of communication can not only be described, but also specified. Pask argued that the potential interactions that make up a conversation were also able to be predicted at any point in the conversation. Pask's findings are recorded in his 1970s series (1975, 1976b and 1976c), his more recent work (1980, 1984), and that of Laurillard (1981), together with review papers in Schmeck (1988) and Curry (1990). The most outstanding observation from Pask's laboratory work is that people adopt characteristically different ways of going about completing large scale learning tasks. Pask termed these identifiable and consistent ways of learning 'learning strategies'. The next section deals with Pask's work on learning strategies beginning with definition of terms and following on with consideration of each of the major strategy types.

Pask's Studies in Learning Strategies

A learning strategy is the external evidence for an assumed sequence of internal events. Strategies are evident as people carry out the task of communicating with another person in a social group. Pask's laboratory work showed some regularities in the patterns of communication that people adopt. These regularities appeared at the grain of concept building and description. Individual differences in classroom behaviour could be expected to reflect, at least in part, differences in learning strategies.

Learning Strategies: Holist-like and Serialist-like

Pask found that people tend to adopt a consistent strategy when faced with learning tasks of particular types. Pask found (1975) that what he called holist and serialist strategies accounted for most of the ways in which people go about the learning process. The range of ways (strategies) adopted by individuals as material was learned were aggregated into a bipolar dichotomy shown in Figure 2a. Pask found that some individuals learn about a topic in small incremental steps. He described these people as 'serialist-like' alluding to the linear progress they made with learning a body of knowledge. Pask found that people at the other end of the learning continuum in Figure 2a apparently understood little or nothing about a topic,

until all of the material was absorbed. Pask described these people as learning in an holist-like way.

Pask (1975) argued that the strategy adopted by the learner influences the outcome of the learning process. People who adopted a particular learning strategy, to the exclusion of others are described by Pask as having a 'learning pathology'. Pask argued that these people were less effective conversants, but may be successful learners with specialist teaching (shown as the extremes to the left and right of a range of possibilities in Figure 2b). Furthermore, he argued that people who select the strategy that is most appropriate for the learning task were the most effective conversants (shown in the elliptical area in the centre of Figure 2b). He called people who were able to fit known learning strategies to their learning problems, 'versatile' and stated that such people were capable of independent learning.

People who adopt holist conversation strategies have a preference for picking up the overall picture of a subject matter. This picture is created in the form of overall descriptions of the topic and in the descriptions of the relationships between topics. Holist strategies lead to a clear grasp of the relationships between topics in a domain and the importance of each topic in the context. During a conversation interaction the person employs the description building strategy of assembling together enumerated classes of entities, their associated attributes, and the relations between both entities and attributes. The main focus of this conversation strategy is on how everything fits together, the Know-ables in Figure 2c. The details are incidental because the learner's effort is going into presenting a description of the big picture.

A serialist conversational strategy includes a focus on details in the form of rules and methods. Procedure building activities are used to link together the material in the topic. Procedure building requires the identification of sequences of related events, the labelling of these as processes, and the assembling of temporally related individual entities in causally related chains. A basis for generalisation beyond these causally related chains of entities is rarely created. There is little or no attempt to appreciate interrelationships or what is important from what is unimportant. The process of building procedures is carried out for its intrinsic value rather than as a contribution to understanding an overall body of knowledge. It is as if the mere enumeration of sequences of actions -Do-

ables- at the lowest level of generalisation of how things got to be the way they are, captures all there is to know about them (see Figure 2c).

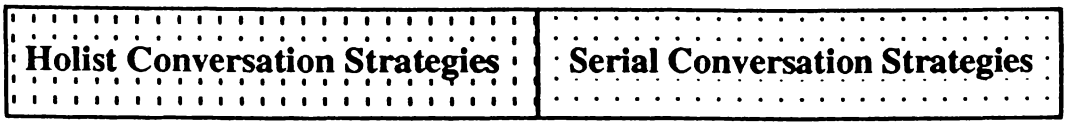

Figure 2a. Pask's early hypothesised dichotomy of learning strategies (Pask, 1975).

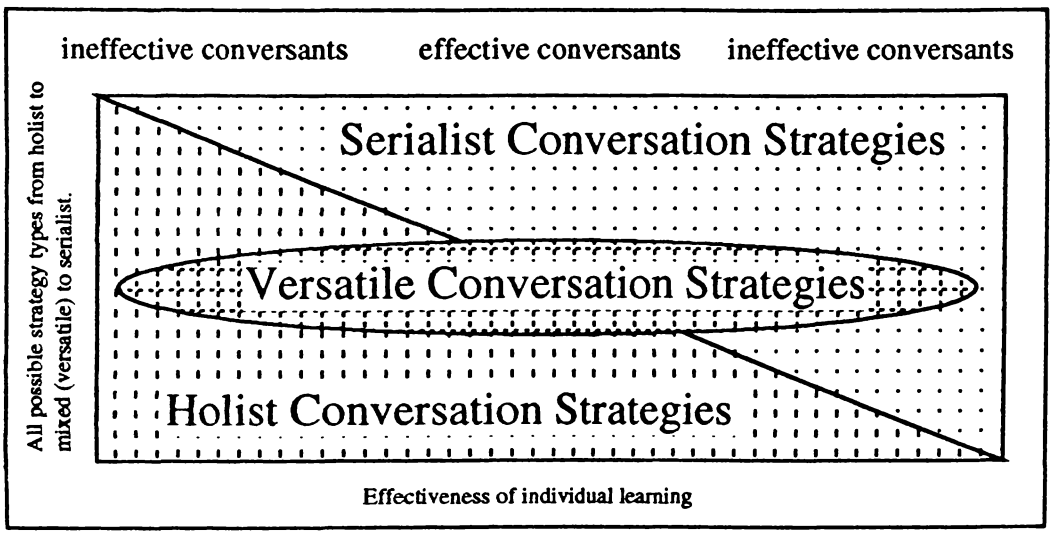

Figure 2b. The relationship between strategy type and effectiveness of learning. These attributes are shown as areas in a range of possibilities where extreme dependence on holist or serialist strategies is less effective than selecting particular strategies as appropriate.

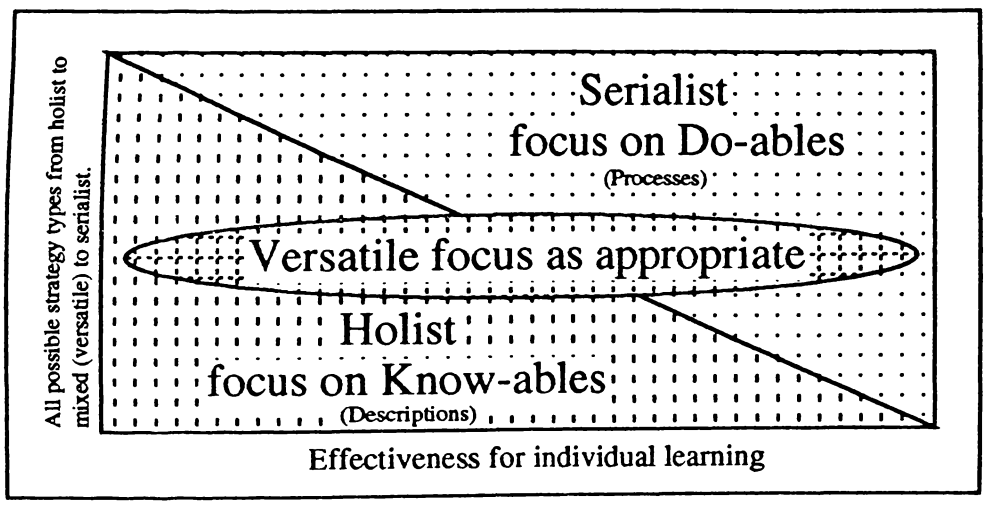

Figure 2c. The contrast is shown between holist, serialist and versatile learning strategies and characteristic types of knowledge. Note the linked areas in Figure 2b and Figure 2c where a focus on Do-ables (processes) in Figure 2c is linked to serialist-like strategies in Figure 2b.

The key point in Figure 2c is that for holists the focus is on descriptions -Know-ables- while for serialists the focus is on processes -Do-ables. Pask distinguishes between a local focus (Know-ables and Do-ables about objects) as opposed to a global focus (Know-ables and Do-ables about the Domain of Discourse), illustrated as 'Focus as appropriate" in Figure 2c.

These are fine grained theoretical distinctions which, nevertheless, point to the quite different relevance of the outcomes of cognitive activity at both the local and global levels, to different people. Even if two conversants are operating at the same level and within the same domain and focus on the same topics, they may not necessarily bring about an agreement between their views. An attempt is made to exemplify this point in Figure 3 below. This figure shows that the content of a topic may be discussed at the level of the attributes of objects, or about the relationships between objects, at the level of the domain. For example, talking about 'horse' and 'unicorn' objects is quite different from talking about learning about these objects or talking about how to go about learning about them. In Figure 3, interaction is made possible by a language. This refers to: a set of symbols -sounds and marks-; a vocabulary; grammar; series of sentences linking speech acts; and a series of objects. A subset of these items bounds a 'Domain of Discourse', and that which is talked about -the objects. Distinctions of concept are made on the basis of whether the focus is on a topic in a domain (local focus) or on the domain itself (global focus) (Figures 4a and 4b).

What makes up a conversation within Conversation Theory? Nothing unexpected or 'special', just the ordinary accepted noises and marks that people use in social groups. These noises and marks take the form of words, sentences, illustrations, gestures, and inflexions that are currently taken-for-granted in a normal communication between people. Conversation Theory is concerned with how communication is possible and what may occur when people communicate. Briefly, Conversation Theory states that each participant person must learn enough of the context so that what the other person has to pass on is able to be recognised. In order to learn what someone else knows it seems that the content must have a range of attributes.

Pask specifies a number of content criteria for a topic to be teachable and learnable in a 'conversation'. The most important is that the material must be specified as simple steps able to be connected to one

another as a set of relationships. This criterion, of specifiable steps, is of major importance because it ensures that the material is learnable incrementally - an essential attribute of 'serialist material'. 'Serialist material' is focussed on processes that explain how objects can become other objects or how to go about the process of abstract generalisation at the global level shown in Figure 4a and 4b.

'Holist material' is focussed on describing what objects are like at the local level and on describing the outcomes of abstracting at the global level. Holist learning/teaching strategies require materials offering a broad context early in the learning situation. Materials suited to holist learning/teaching strategies also require clear indications of the procedures involved in building the body of knowledge. To a holist, the detail of what is involved in the content is of lesser importance than how it is related to the context. Furthermore, the function of context is to provide opportunities for the learner to consider more than one aspect at once. Because building links between what is known and what is new is a critical holist learning strategy, rich descriptive material is required to increase the chances of the holist making connections between older and newer knowledge.

For Pask, the major distinguishing characteristic between material suited to serialist learning/teaching strategies and material suited to holist learning/teaching strategies lies in the number of aspects considered at one moment. Serialist material, having a single focus, is going to cause confusion to a person using a holist-like strategy simply because there is no way the holist can develop appropriate analogies without access to the material as a whole.

The main findings of Pask's (1976c and 1988) work suggest that the holist and serialist distinctions also apply from the level of physical objects to the outcomes of the most abstract generalisation processes. While Pask refers to these distinctions and relationships on frequent occasions, at no point does he provide either an easily grasped text description or a diagrammatic model of the relationships that extend from the phenomenal world to the world of abstraction.

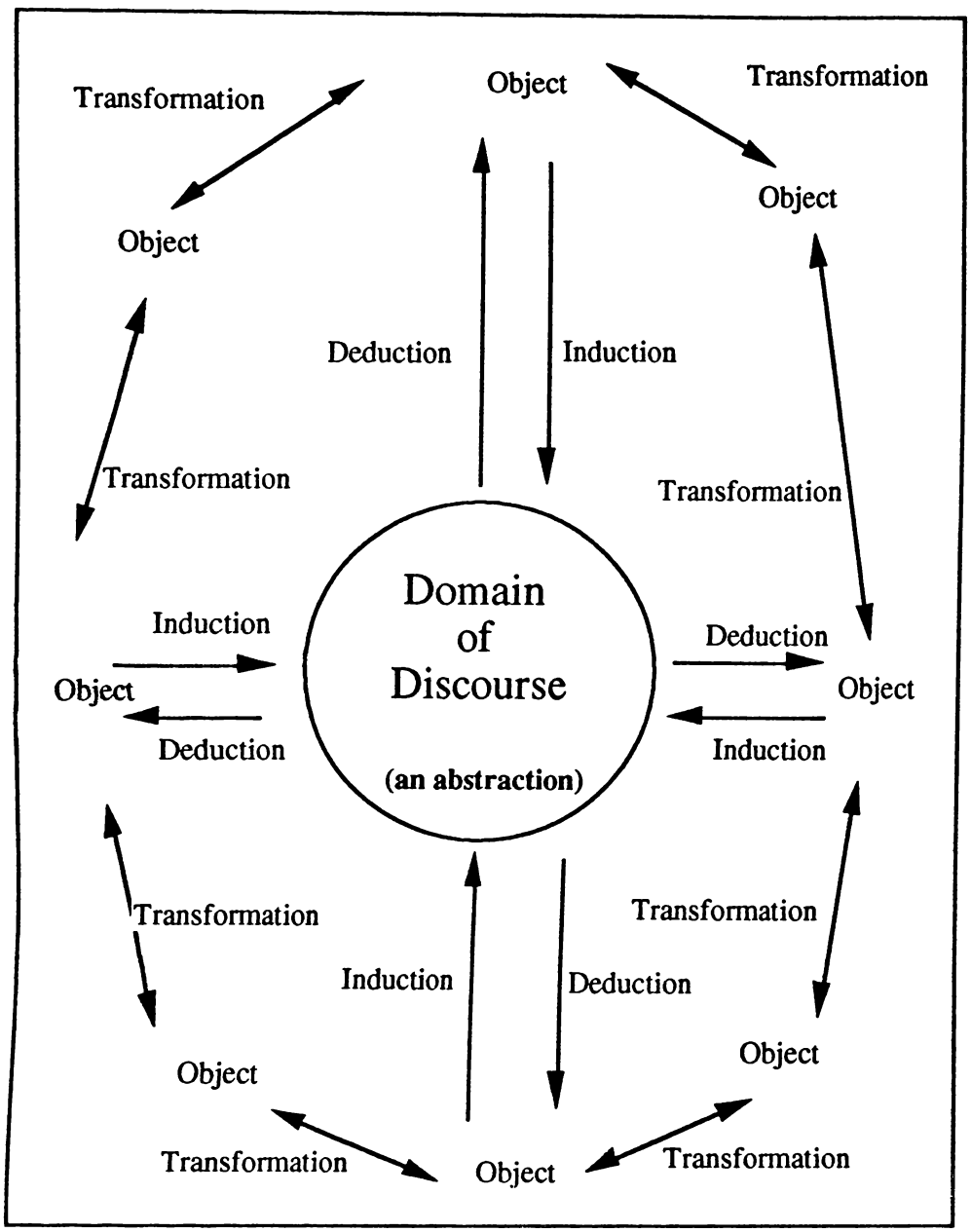

Figure 3. An epistemological structure consistent with the elements of Pask's (1976a) Conversation Theory. Objects are any item which is cognitively distinguished from other items. In this sketch, knowledge is seen as both a process and an outcome. Process aspects are evident in the ways in which any object can be transformed into any other object. Process aspects are also seen in the way knowledge is abstracted by inductive thinking or exemplified and instanced by deduction. Outcomes, for Pask, require not only a description, but also a demonstration of the ability to reproduce any of these sequences of steps.

My view of these relationships, shown in Figure 4a and 4b, is drawn mainly from Pask (1988). This model shows that the distinction in Conversation Theory between styles of learning and the traditional inductive/deductive dichotomy is clearly one of focus. While both learning strategy type can operate at the local and global level, the serialist-like focus at the local level is on how one item is transformed into another (C1 into C2 in Figure 4b). Figure 4a shows a view of the consequences of a holist-like focus where objects are described at the local level and the outcome of abstraction is described at the global level. This is in marked contrast to a serialist-like focus where the process by which one object can become another object is the main focus. At the more global level, serialists characteristically focus on the process of abstraction rather than the outcomes of abstraction.

At the global level the serialist-like focus is on the process of abstracting shown at bottom right of Figure 4b. Holists, in contrast, focus on describing the outcome of the abstraction process. A holist operating at a global level would provide a description of the relation 'circularity' (see Figure 5). This description would be an enumeration of the attributes that filled out the 'table of relation' called 'circularity'. In Figure 5 this implies the holist would select from the tables those attributes that distinguish circles from other entities. These are displayed adjacent to the boxed caption 'description building process' in Figure 5. A person operating in a serialist mode would provide a description of the actions required to bring about the relation 'circularity'. Both would recognise an instance of circularity without difficulty. The holist would see in the instance a match with an already learned general case of circularity. The serialist would see in the instance a match with existing descriptions of instances of circularity, but it would be as an exemplification of a completed 'circularity creating process'.

A key point to emerge from Pask's early research is that people who adopt either a holist-like strategy or a serialist-like strategy to the exclusion of the other, make little progress with learning unless the material is matched with the learning strategy they have adopted (Pask, 1975). Two of the three conversation strategies identified by Pask (holist-like, serialist-like and versatility) have been described. The following description is about the third of Pask's learning strategies; versatility.

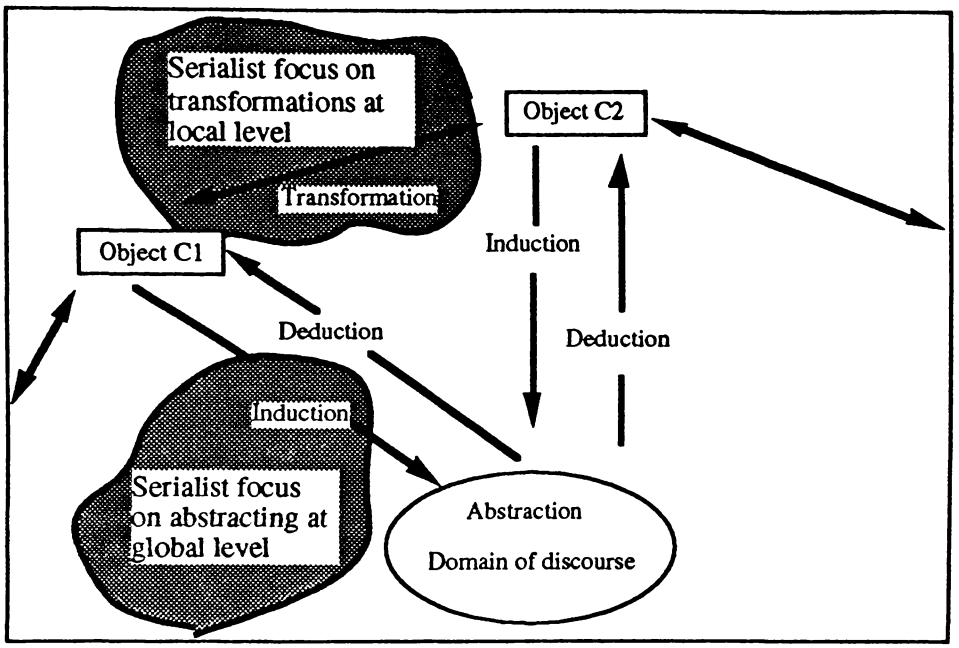

Figure 4a. The relationship between epistemology and serialist strategies. Derived from a segment of Figure 3, this diagram shows a serialist-like focus on generating knowledge through a process orientation at the local level and global levels.

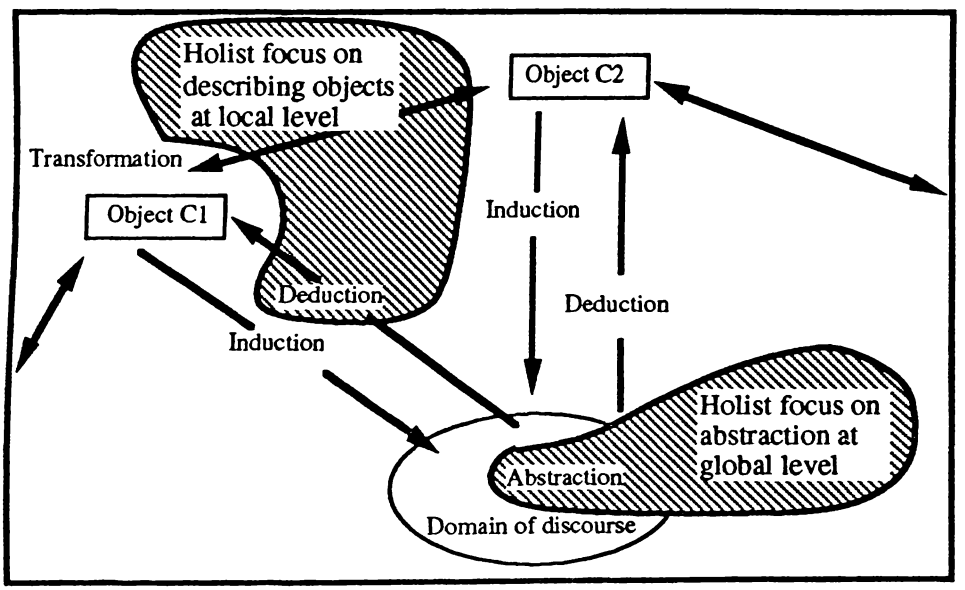

Figure 4b. The relationship between epistemology and holist learning strategies. Derived from a segment of Figure 3 this diagram shows a holist-like focus on describing the outcomes of the abstraction process at both the local, - object - level and, global -discourse -level.

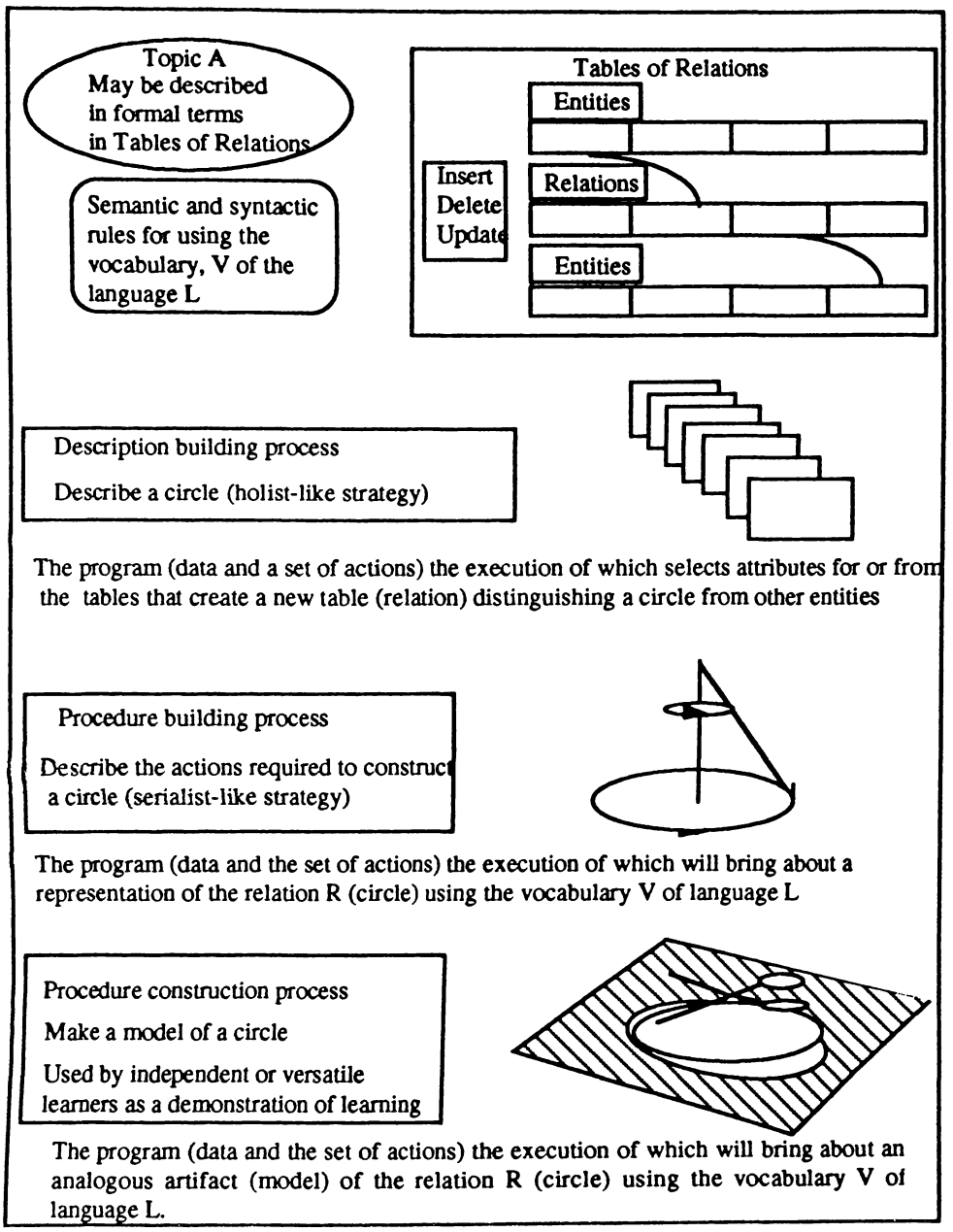

Figure 5. A relational view of epistemology. A domain of knowledge is described by a language L, made up of a vocabulary, V. Each domain may be divided into topics which are defined and described in terms of the language L using the vocabulary V following the rules for using V in the language L. People with holist-like learning strategies use a description building processes for learning and communicating. People with serialist-like learning strategies use procedure building processes for the same tasks whereas, versatile learners may use either serialist or holist strategies including procedure construction process to show evidence of learning.

Learning Strategies: Versatile Thinkers

Pask's (1988) laboratory research, while attempting to account for anomalies in results, established a need for varied experimental conditions. In some experiments the choice of learning strategy was open and in others the learning tasks fixed the learning strategy. In the latter instance the learning strategy was determined by the material. This important extension to his earlier research was necessary to ensure that a wide range of choices were offered to subjects. Pask's research showed that a more flexible cognitive strategy emerged when the experimental conditions were both of extended duration and were relaxed in structure. The varied experimental conditions permitted many different responses to learning tasks should subjects be capable of generating them.

A few individuals (according to Pask, 1975) were able to take material of either form (holist or serialist) and restructure it to make sense regardless of its original organisation. Pask noted that other people in the groups he studied did not consistently adopt particular strategies, but chose from both holist and serialist strategies those that were appropriate for communicating about the task at hand. Both these groups of people were described as being 'versatile' in their communicating strategies (Pask, 1975, 564). It appears that Pask is using this term, versatility, to describe two abilities: the restructuring of materials; and the changing of strategy type to match the materials.

His subsequent work (1980, et seq.) suggested that many people are able, with help, to develop more or less competence (versatility) in learning to cope with mismatched material, either by restructuring it or by changing strategy. Figure 6 shows the two main strategy types -holist and serialist-like- as different shapes. The convention has been adopted of representing serialist conversation strategies as a rectangle, holist conversation strategies as a circle, and versatile conversation strategies as an ellipse for the illustrations in this diagram. The ideal model shows a situation in which a person is able, because of versatility, to modify the strategy they adopt to suit the situation. Other strategy types are shown as a variety of paths indicating choices to adopt particular approaches to the learning process. In any one interaction between two conversants a number of different outcomes are therefore possible. Where one strategy type is adopted to the exclusion of all others learning is restricted. These 'learning pathologies' are dealt with in the next section.

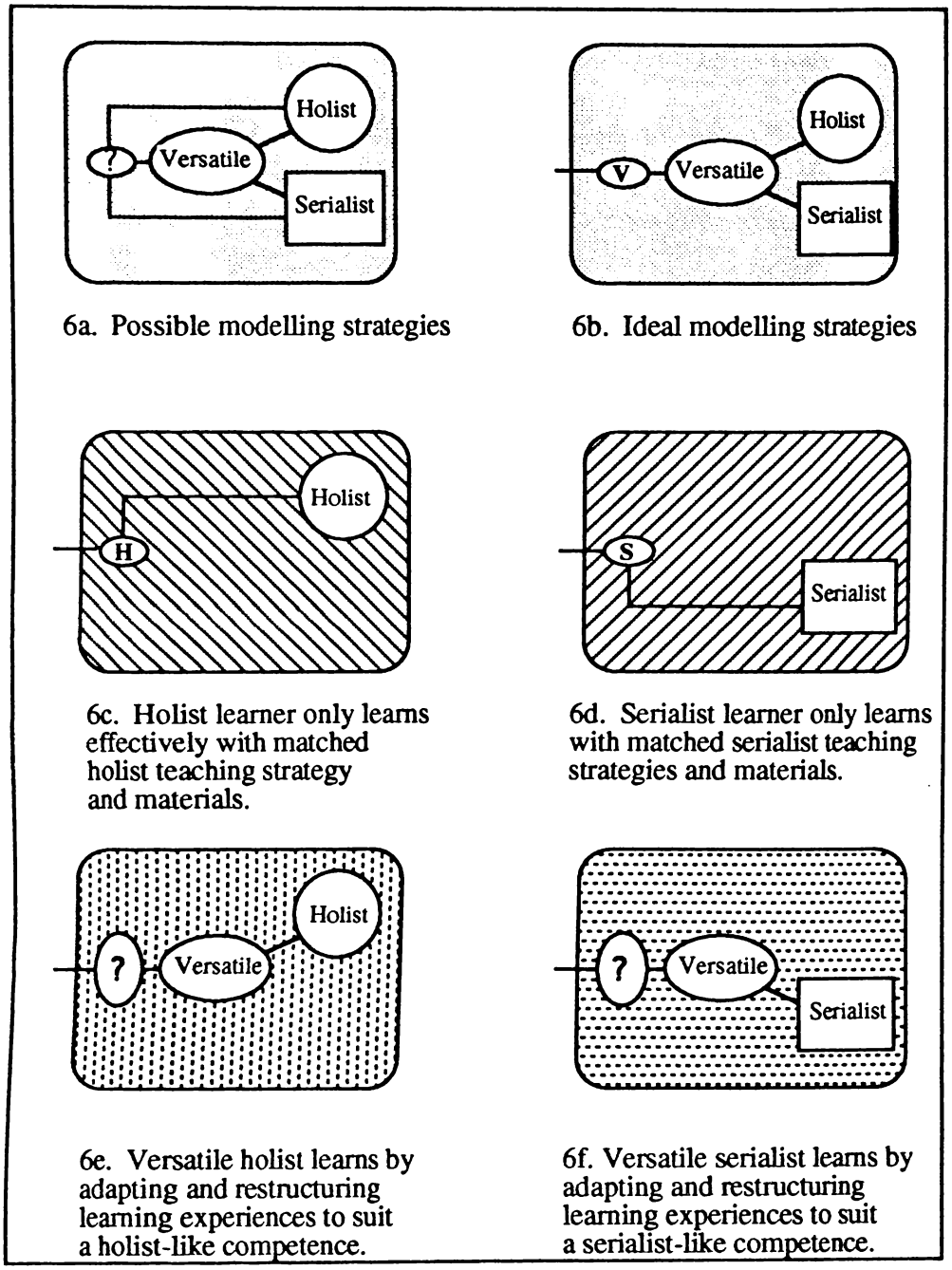

Figure 6. The interactions between learning strategies and learning experiences derived from Pask's (1976c) work. Pask's independent learners would be modelled as shown in 6a. The ideal situation tacitly assumed by normal classroom practice is shown in 6b. Figures 6c and 6d show the findings and conclusions of Pask's early laboratory work in which the evidence pointed to a learning strategy dichotomy. Figures 6e and 6f show the possible modelling strategies of people with either holist or serialist preferences who have learned how to learn. In each case the learner restructures mismatched material so that it fits the preferred learning strategy.

Learning Strategies: Improvidence and Globetrotting

The serialist-like failure to recognise what instances of a particular concept share in common is termed 'improvidence' (Pask, 1976c, Schmeck, 1988, 47). In a classroom situation this type of thinking strategy can be illustrated by reflecting on what is involved when a learner grasps the ideas in orographic rainfall, frontal rainfall, and convectional rainfall without recognising what they share in common. The outcome of this situation, for the learner, is that the same set of ideas has to be learned three times.

If, on the other hand, the learner was able to recognise in the three examples given above what each shared in common, then only one set of ideas would have to be learned, with the instances representing applications of the main ideas. Pask's use of the term 'improvidence' refers to the wasted effort of learning the same ideas three times when once would do (Entwistle in Schmeck, 1988, 26). A person who provides clear analogies between each of the rainfall types and can also tie these analogies to principles, but cannot describe in an adequate fashion how any one type of rain occurs, also has a distinctive learning problem. Pask calls such a person a 'globetrotter' (Pask, 1976c, 125). The main deficit apparent in 'globetrotting' is an inability to stop long enough on any one item to appreciate the necessity for providing supporting evidence for points made.

Pask does not suggest remedies for either improvidence or globetrotting. Harri-Augstein and Thomas (1991) provide an alternative analysis framework orientated towards self-organised learning which is suggestive of a number of techniques that could address the problems mentioned here. Full discussion of their work falls outside the scope of this thesis, but mention is made of it in the context of remediation for which it may be appropriate.

As has been made evident in earlier sections, Pask deals with a range of ideas at a number of different levels of complexity. Two of the main levels are dealt with in the next section on macro and microtheory.

Micro and Macrotheory in a Paskian Conversation

Pask has developed two levels of explanation in his Conversation Theory. The first is a macrotheory which specifies the tasks that the learner faces when working through an activity that requires problem solving.

These tasks occur in three interrelated situations: as the material is being apprehended; as it is being assimilated; and when it is communicated to a 'teacher'. The conventional term used to describe the steps the learner uses to go about learning is 'learning strategy'. The major issues raised in this chapter explore aspects of strategy as it applies in the classroom.

The second level of explanation in Conversation Theory is micro-theory. It deals with the internal events that describe the nature of the learner's thought processes during a learning experience. Pask's microtheory contains a number of special terms. Comprehending the main issues raised in the macrotheory of his research requires an understanding of these terms.

Memory

A 'memory', in Pask's theory, is a procedure for reproducing a concept rather than data recovered intact from some storage area of the brain (Pask, 1975, 559). Because attributes which make up a concept are subject to revision, Pask asserts that a concept is an evolving and replicable mental process. Since the procedures involved in evolving a concept (learning) or reproducing (remembering) a concept representing a sequence, it is likely that a new learning situation may result in counter-productive recall. The process of learning may prevent people continuing with the conversation while they are engaged in the reconstruction required by recall.

This circumstance may arise where a change in the concept a person is evolving requires a review of the sequence of steps in its generation in order to revise part or all of the sequence itself. Suppose, for example, two people are involved in a Paskian Conversation about a particular topic. It is probable that each will have had different experiences and that there will consequently be differences in the ideas each brings to the conversation. In order for the two people to share an understanding about the ideas that are being discussed, each must share personally held ideas with the other. In this sharing process, the way in which each learned the ideas will be indicated by the way the ideas are reconstructed. For each person to be able to understand the other, similar steps in idea reconstruction must be revealed in the conversation. If the ideas held by one of the persons differ markedly from those held by the other, then the participants are faced with the prospect of having to show all the steps involved in the idea or

they face the prospect of having nothing to converse about (Schutz, in Wagner 1970). Many people would find the task of recapitulating how ideas were learned a difficult one. Even supposing they were successful in recalling how the ideas were originally learned, the people may still not be able to communicate because one of the participants may find it difficult to set aside previously learned ideas to accommodate new ideas or concepts. Festinger (1957) describes this latter idea as cognitive fixity. A second Festinger concept - Cognitive dissonance - (Festinger, 1957) is a particular instance of the inhibiting effects of previously successful concept recall which may disrupt current learning activities and thus no longer be appropriate in a new context.

On a larger scale, for example looking at the steps in a learning strategy, the impact of 'cognitive fixity' extends to the steps a learner or teacher adopts while communicating, labelled by Pask as 'holist' and 'serialist' strategies. Pask's Conversation Theory predicts that these strategies for communicating will be mutually exclusive and cites cognitive fixity as the mechanism to account for this phenomenon.

In Festinger's theory, this difficulty is believed to arise because the new ideas cause an internal conflict -a possible outcome of which is a reluctance to accept a new view because the old view has an emotional commitment as well as a cognitive commitment. People seem to be reluctant to set aside ideas which are the outcome of a considerable investment of time, emotional, and intellectual energy. The history of science is replete with disciplinary conflicts (such as between Aristotelian and Newtonian views) in which scientists have historically become 'locked in' to a particular view. The notion of commitment to a 'view' is shared by Argyris (1980) in the context of 'rigorous research' and by Kuhn (1962) in the context of 'scientific progress'.

The main issue raised here is about the nature of understanding in general, and understanding concepts in particular. Pask's (1975) view of concepts and his view of understanding are related. For Pask, a concept is defined as a procedure for bringing about a relation. This contrasts with a more conventional usage where 'concept' refers to a set of things remembered or a label for a set of things that is recalled. For example, the concept 'chair' brings together all those attributes of 'chairness' that are what constitutes particular entities being called 'a chair'. It is Pask's view

(1975, 553) that the conventional use of the term 'concept' is vague in that there tends to be a focus on entities as instances rather than collections of attributes which identify a particular object as being an instance of a larger mental idea, the concept. It is as if some people talking about concepts never progress beyond giving instances and thus the concept of 'concept' is never developed beyond a collection of tangible entities (Wilson, 1963; Pask, 1976c).

Pask's view of understanding requires the confirmation of a concept in the context of a relevant topic that is part of a domain. His view carries the extra criterion that the other conversation participant must agree that the reconstructed concept is equivalent to their own view.

Teachback

In a strict sense the sharing of a concept goes only part way towards understanding. Understanding requires that one person be able to confirm to the satisfaction of the other participant the key aspects of the conversation. The confirmation process includes the ways in which the concept is described, the procedures by which the concept is (re)created, and the contexts to which it is applicable (Pask, 1976c, 153).

The theoretical understandings developed in Pask's recent work (Pask, 1988) point to reasons for the importance of sharing conversations for successful learning. Pask's work shows that many person to person interactions cannot lead to learning. The content of the interaction fails to transfer noises and marks in a way which can be successfully shared by both participants. Technically, one person has not described the topic of the conversation in such a way that another person can confirm it. All of us can recall past experiences in which not enough information of a descriptive nature was given to stimulate us into continuing to try to learn what another person was attempting communicate. Pask's work shows that failure to communicate can result from failure to provide sufficient information at the conceptual level as well as the topic level. In addition, Pask's work details what is required for a conversation to be able to be carried out successfully.

Among other factors, the steps taken in presenting information to any particular other person are critical. If the steps, as a strategy adopted by one person, are mismatched with that employed by the other person, then Pask's

work shows that effective learning will not take place. Theoretically, it is not difficult to specify how to remedy such problems in a conversation. But it is hard to have teachers recognise that there are many ways of learning, no one more or less acceptable than any other. It is also difficult to get people to recognise that there are other ways of building a picture of the world which are different from theirs, but just as valid. It is exceptionally difficult to have a person accept that the teaching/learning strategy employed in a particular context is less appropriate and then have that person take remedial steps to learn a more appropriate teaching/learning strategy. This question, of changing world views, is discussed within teaching, business, and other learning contexts through the several publications by Chris Argyris (1980, et seq.). It is also implied in theoretical terms in Festinger's work on Cognitive Consistency Theory. Pask and Argyris both point to Festinger's work as the basis of the mechanism for describing and accounting for the persistence of world views.

Paskian and Piagetian Conversations

There is a close parallel between a Paskian conversation and a Piagetian interview (Pask, 1976c, 20). The distinction lies in the fact that the grain of the investigations differ. While both are concerned with processes, Pask is particularly interested in the sequences of steps that adolescent or mature learners adopt. In contrast, Piaget's work has mainly focussed on the developmental aspects in the learning processes of younger children over a period of time. In his work, the focus of interest was on the younger child's thinking processes. The research method included talking with the child about a number of key experimental tasks in order to establish the stage of development of the child's thinking. Piagetian conversations are conducted to determine if the child can perform certain cognitive tasks (Piaget, 1968, Pask, 1976c). These tasks are of relatively short duration, involving one or two hours work.

The intention in a Paskian conversation, was to involve older learners in a problem solving experience to find out how a learner comes to know about a topic. The learning tasks are of sufficient complexity to require more than 18 hours of contact over a series of learning sessions. Pask's research also investigated the consequences for learning of variations in the way material was presented to the learner and communicated by the

learner to the teacher. The conversational tasks presented to the learners in a Piagetian and Paskian learning situation are matched with the relative maturity of the participants. The larger task in a Paskian conversation matches the increasing maturity of the learners involved. Viewed in this way, a Paskian conversation in which the participants reach agreement on understanding, has 'intersubjective validity' (Schutz, in Wagner, 1970).

For Pask there is therefore no status distinction, educationally, between the process of solving problems, the process of creating procedures for solving problems, and the process of assisting some person to carry out these activities. Traditionally, these tasks would be seen as having an hierarchical priority beginning with learning to use already provided solutions, moving finally to creating new solutions. Pask's position contrasts with more hierarchically oriented educational thinking of people such as Bloom (1964), Bruner et al., (1956), and Osborne (1984), who would hold that teaching should proceed from simpler to more complex tasks. Pask's work shows a greater concern with what the learner is attempting to accomplish rather than what the teacher is trying to teach. This is termed the learner's 'aim' or 'intention' (Pask, 1976c, 27 and Piaget, 1968). Pask's work represents a significant departure from the classical 'Piagetian interview', in that more than 'one aim at once' is permitted. This move was seen by Pask, in retrospect, to be essential for revealing differences in learning strategies. This was because holists have 'many aims at once', in contrast with the serialist's who have only one aim (Pask, 1976c, 48).

Conversation is the 'stuff' with which Conversation Theory is concerned. The central matter of interest is the transfer of noises and marks between two 'persons-in-a-context' (Laurillard, 1987 and Pask, 1986 pers. comm.). The 'persons' may be any two entities capable of processing a flow of noises and marks through a medium of communication. Pask (1980) has suggested that internal monologues where one person considers two or more points of view or perspectives can also be considered within Conversation Theory. At the organisational scale, Pask argues that collectivities of people can also be identified as conversation participants. This implies for example, that members of a Department may converse with other members of other Departments. The conversation will be conducted between people in the role of members of the Department rather than between individuals. Often changes

of role subsequent to this behaviour are predicated with statements such as 'that is the official view' or 'that is the Department policy, but my view is....'.

It is a finding of Pask's (1975) research that a person adopting a holist learning strategy requires descriptively rich knowledge with much redundant material for the learning task to be understood. The redundant material serves to make the body of knowledge memorable, because it provides contextual clues by which the holist learner integrates the new knowledge with previous experiences. The contextually rich material serves to provide data from which the holist learner can create analogies between the newly encountered material and prior experiences. Material for holists has been described by Entwistle (1981, 91) as 'rich in anecdote, illustration and analogy, while the serialist needs these sparingly if at all'.

Matching Media and Learning Strategies

An important consequence of Pask's findings is that teachers need models of how learners learn. The teacher needs to know the range of likely learning strategies that students could use to complete a learning task (Powers, 1973). With this knowledge the teacher will be able to choose learning materials that provide for both holist and serialist learners. The requirement to know of the preferred learning strategies of students is one that few teachers would claim to have met for their students as individuals. Most teachers work on the assumption that their students will learn in the same way as they have learnt. Pask's work suggests that this assumption is very often not tenable.

A Paskian conversation is about a specific body of knowledge called a 'domain' (Harvey, 1969, 89 and Pask, 1976c). The domain sets the limits to the range of content in a conversation. The scope of the content is characterised and defined by an 'entailment structure' and a 'task structure'. An entailment structure is a set of related subtopics in which the relationships between each subtopic are displayed. In this form it is a 'map' (it shows how to get from one subtopic to another) of all the knowledge that must be learned in order to demonstrate a grasp of the topic that would satisfy a subject matter expert. It shows what knowledge is 'entailed' or required for the person to have learned a topic. Lastly, the domain of the topic is the section, or sections, of a shared reality which the topic adequately covers (Harvey, 1969, 89).

In contrast, a task structure is a 'map' which shows the sequence and relationships of all the skills involved in the topic that are required to confirm a body of knowledge. For teachers, these 'maps' and their contents are usually described in very general terms in curriculum statements and referred to as a specification of required knowledge (Know-ables) and skills (Do-ables). The competence with which a learner goes about the learning process is generally referred to as reflecting 'ability'.

The construction of a body of knowledge suitable for specification and learnable in a Paskian conversation consists of a number of steps. These steps are carried out at the development stage when the selection of material is being made for the body of knowledge. Because there are difficulties in attempting to have a subject matter expert communicate directly with a learner, Pask chose to use an analyst to 'translate' the subject matter expert's grasp of the topic into an ordinary language description (L) in Figure 7. The words selected from the language which describes the topic are the vocabulary (V) in Figure 7. Thus, the order and form of word use (syntax) from a language (L) about a topic in Domain of Discourse is expressed in vocabulary (V). The vocabulary (V) conveys the semantics of the topic in the Domain of Discourse as a consequence of agreement among language users as to what meaning is associated with the selected vocabulary. The two persons in Figure 7 represent the people who agree on the use and meaning of terms. The models in the ellipses above the persons will be discussed in a section below. They are introduced here to convey the concept of conversation happening in heads.

In a Paskian context then, the first step is to define the limits of a subject matter or topic, which may be any body of knowledge. A person adopting the role of analyst discusses the subject matter with an expert in the field: a 'source'. The source is asked to specify all the ways in which the subject matter may be taught. The analyst attempts in the second step, to 'teach back' the material to the source in order to confirm an ordinary language description of the topic. There are two fundamental components

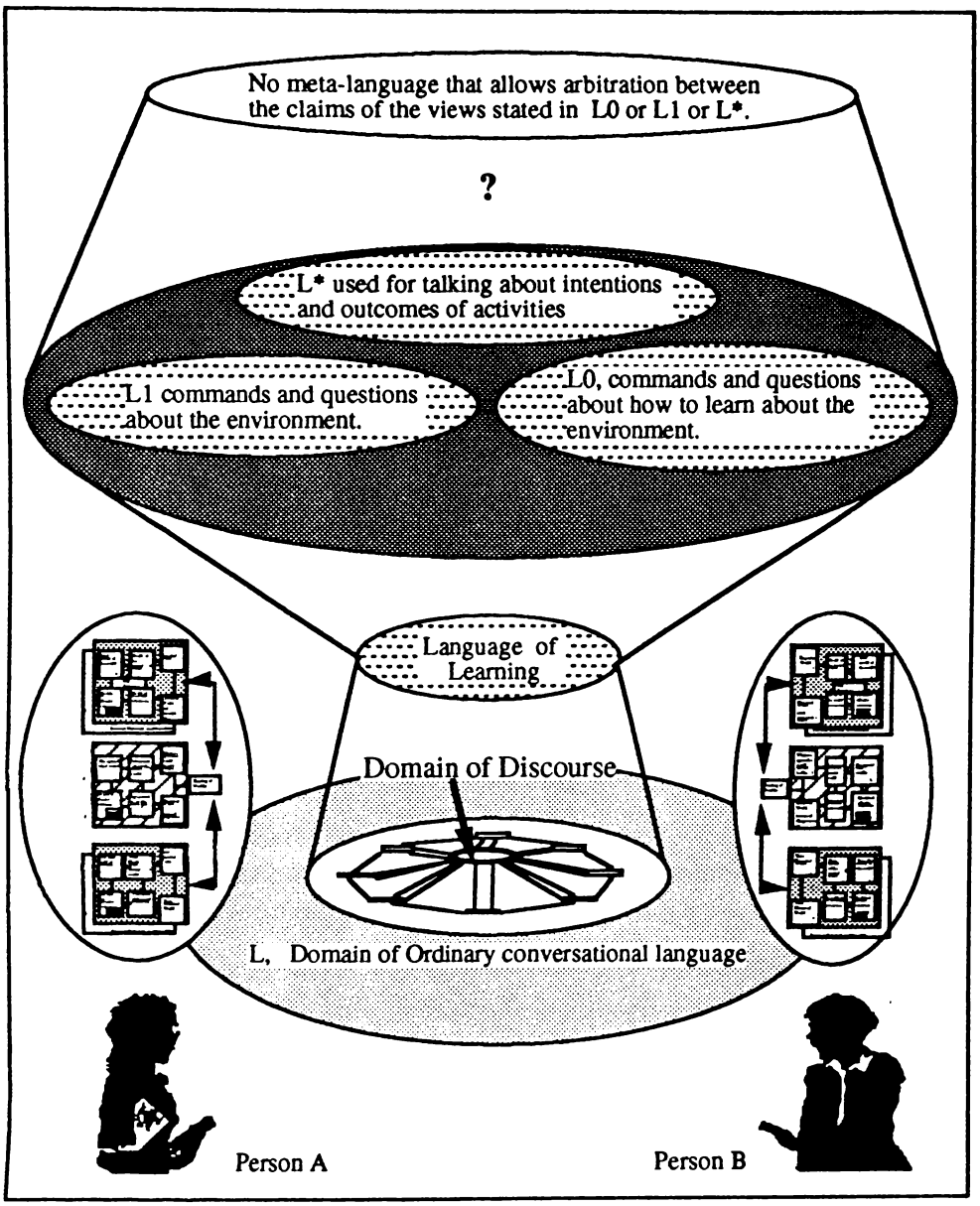

Figure 7. The possible relationships between the levels of language and the contributions of two conversants to a conversation. The ellipses above persons A and B represent the models they construct of their own and each other's views. The Domain of Discourse model is derived from Figure 3. The 'levels of language' concepts are derived from Pask (1976a).

in the specification of the topic. The first concerns describing the concepts considered by the source to be essential for an understanding of the topic. Pask terms this 'description building'. The second is detailing how the topic is constructed using the various relationships mentioned. Pask terms this process 'procedure building'. Description building is a characteristically holist approach whereas procedure building is a serialist approach.

The Agreement Condition

Before a Paskian Conversation is successfully concluded, an 'agreement' must be reached (Pask, 1980, 375). The outcome of an agreement is 'understanding', a condition in which one participant explains to the satisfaction of a second how the topic is generated. This requires the learner to show a satisfactory grasp of the knowledge and skills contained in the entailment and task structures. Agreement is a very important concept in Conversation Theory and fuller consideration is provided in Chapter 5.

For example, conversants considering circles who reach agreement on the nature of 'circles' would, in a strict Paskian conversation, be able to carry out the activities detailed in Figure 5 (after Laurillard, 1984, 138). The main features of the figure are the three part performance attributes of understanding labelled by Pask as 'description building', 'procedure building' and 'procedure construction'. For Pask, these activities are seen as sequences of related events which act on data. He calls such an activity a 'program'. Pask distinguishes between three types of programs. The first describes, by a selection process, which attributes distinguish one entity from all other entities. A second process consists of the entities and actions which, when associated together as a sequence of related events, produce an outcome such that it describes the criteria of some relation. The instance in Figure 5 is the relation 'circularity'. The procedure construction process takes several procedure building processes and assembles them together. The outcome of this process is an artefact, the circular object. Pask's view is that an independent learner must have the ability to carry out at least two of the three stratagems for communicating in order to demonstrate understanding (Pask, 1976c, 112). Pask argues that these strategies can be taught in a body of curriculum experience called 'Learning to Learn' (Pask, 1976c, 378). The basis of the learning to learn role is encapsulated in the idea of reciprocity of teacher/learner roles. This aspect of conversation theory is discussed in the next section.

Conversation Theory in the Classroom

Pask's Conversation Theory is a theory about the ways in which individuals act out roles during the learning process. It aims to make the learning process open to observation and to take the events in a

learning situation 'into the public arena' (Pask 1975, 552). Applied to classroom practice, the theory draws attention to the cooperative nature of the learning process and highlights some of the problems encountered by both learners and teachers. In the general context of learning in senior secondary schools, Conversation Theory, with its focus on strategies, could provide predictive guidelines as to the consequences for learning of adopting particular learning or teaching materials and strategies.

Pask's educational theory is built on the basis of research in which learning was conducted in a number of cooperative and extended conversations between a 'learner' and a 'teacher'. This is in contrast to more authoritarian methods where there is a clear status difference between the learner and the teacher. In a Paskian learning situation the distinction between learner and teacher is blurred to the extent that at one time the 'teacher' may adopt an information-giving role while at another time that role may be adopted by the 'learner'. This idea is not so counter-intuitive as it might at first appear, because the information given by the learner is the learner's way of communicating what has been learned, while the information the teacher contributes to the conversation is the material to be learned. Furthermore, the roles of 'learner' and 'teacher' are open in the sense that any language processor may adopt either role. Of primary importance here is the recognition of the fact that a 'teacher' can do little that is educationally valuable for a 'learner' without the active cooperation and participation of the learner. The information provided by a 'language processor' may come from a person reflecting on previous experience, or another person, or a group of people, or in Pask's view, a computer. The issue of whether a computer can act as a conversant will be discussed in Chapter 5.

A Model of Cognitive Processes

A sequence of events underlies each of Pask's categories of learning strategy. There is no easy way to establish what these processes might be because the active parts of brain functioning are hidden. Only in rare instances, such as in Penfield's research, is it possible to establish empirically and directly what is going on in the brain during communication (Penfield, 1975, 34). For the purposes of furthering this discussion it is proposed to advance a model as a framework for talking about communication. This is not a definitive statement intended to solve all the problems associated with

communication, but rather a metaphor advanced for the quite pragmatic reason of speculating about what can exchange noises and marks (Figure 8a). This model is built from the material in Pask's writings (Pask, 1961, et seq.) and the work of Rorty (1989).

The environments, external and internal to the person, will be arbitrarily characterised as separate systems. An internal mechanism is postulated for attending to and collecting data external to the person or conversant. What is attended to will depend on the relationship between the conversant and the environment, the personal history of the conversant, and conversant's current intentions and goals. It will also be influenced by the degree to which the conversant is empowered to act in the environment. This will depend on whether recall of past experiences releases or inhibits capacities to act. It is postulated that this mechanism or process of attending to perceptual data is part of a process of converting perceptions into some symbolic form, either in language or images, as an intermediary step to constructing a model of the observed world.

Pask (1975) argues that what occurs involves the processes of description building, procedure construction, and procedure building (Figure 8b). These activities, carried out during the process of cognising experience, were dealt with earlier. Penfield tells us the brain can recover the total experience of prior events. His research is in the invasive stimulation of the brain (Penfield, 1975, 34). From his research we know that the models that people have access to are potentially intact verbatim records of what happens at a particular time. These metaphorical attributes are illustrated in Figure 8c.

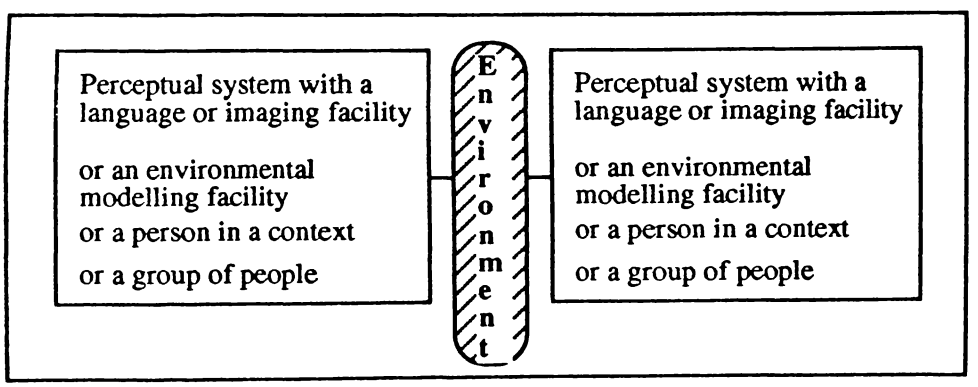

Figure 8a. A model of potential conversation participants (after Pask, 1976a).

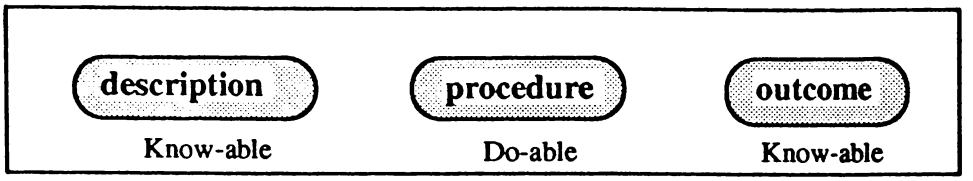

Figure 8b. Know-ables and do-ables. These items are the elements of a conversation (after Pask, 1976a). Understandable communications consist of: a description of what was conveyed; the procedure which can recreate what was conveyed; and, the outcome of what was conveyed in the form of some representation of the executed procedure.

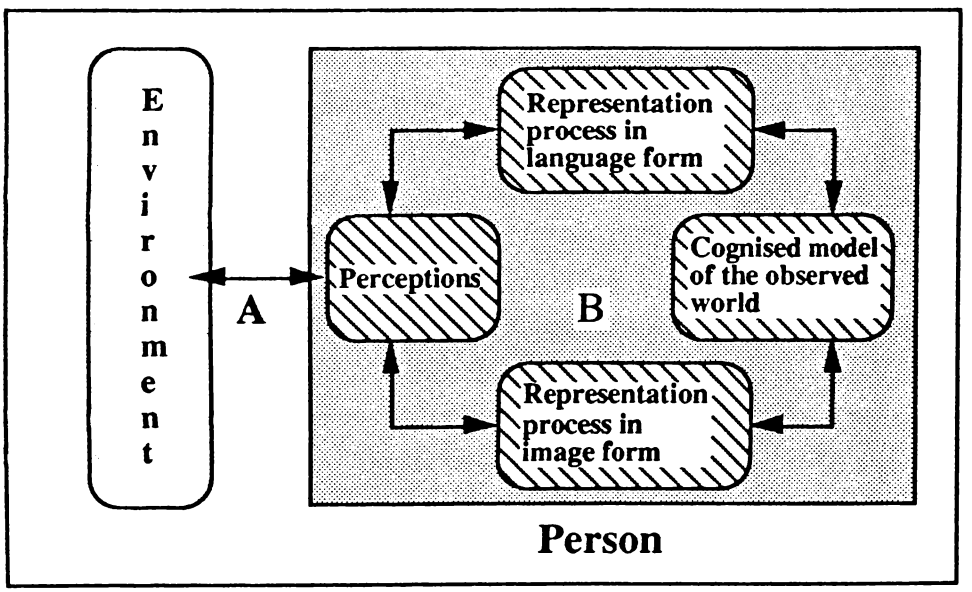

Figure 8c. The interaction between perception, representation and cognition. A is perceptual data (sounds and marks). B is a view of the brain events that may interact following perception.

A number of possible perspectives generated from this modelling process are represented in Figure 9. In this metaphor, **Model a** is constructed from the sense data which may be conceived of as a substrate underlying all the models in the diagram. **Model b** represents the result of an integration of all previous analogous models. This model is subject to constant update and review as a result of interacting with the other models. I suggest that the nearest we ever get to the Platonic world of 'forms' is **Model b.**

Model c represents a model of the world as distinguished from the present model by whatever events have caused the person to become aware of change. Among these may be the tick of the clock or an earthquake as an

instance of a change. **Model d** represents the aggregate of all previously attempted behaviours as sequences of events and their consequents that are related to the ideal model in **Model b**. **Model e**, the observed world, is the outcome of actively taking cognisance of the model of the sensed world. It is this world that is imbued with uncertainty. It cannot be known unless it is one of **Models a, b, c, and d.** It is suggested that a model of the expected world (**Model f**) results. This model is the basis by which the observed and sensed worlds are distinguished. In order for two people to communicate some exchange of noises, marks or gestures are normally required. The actual mechanisms are not identifiable at the level of the external observer so I take refuge in the metaphor of conversation to propose the following perspective on what is a difficult problem.

Let it be allowed that two persons are metaphorically endowed with abilities to attend to the external world in roughly similar ways and that each is capable of carrying out roughly the same activities as the other. In conversation, each is capable of converting a set of noises and marks in a way that is recognisable to the other. However, each person has a unique personal history. This may influence what is offered to the other and (what is accepted from and attended to) what the other offers. Thus, it is theorised that each conversant *makes a model of the perspective* that the other person is advancing as if it was the consequence of a personal construction from the noises and marks supplied.

During a conversation each person fills out the **Models a to f** from the apprehended noises and marks as if the noises and marks were from the actual process of building the model from real world personal experience. In other words, the conversants use noises and marks to create images of what they understand. This is shown for one person in Figure 9 in the top and bottom diagrams. For two people to be sure that they have in fact attended to the other's view and reflected it appropriately, they must be able to teach back what the other has said, either directly or by less overt feedback in a variety of forms from gesture to direct questioning. This metaphoric outcome is shown in the centre diagram of Figure 9. This metaphor applies Pask's Conversation Theory by making his text and formalism accessible to those people who learn best from diagrams. The formalisms and text are most completely and succinctly presented in Pask (1980).

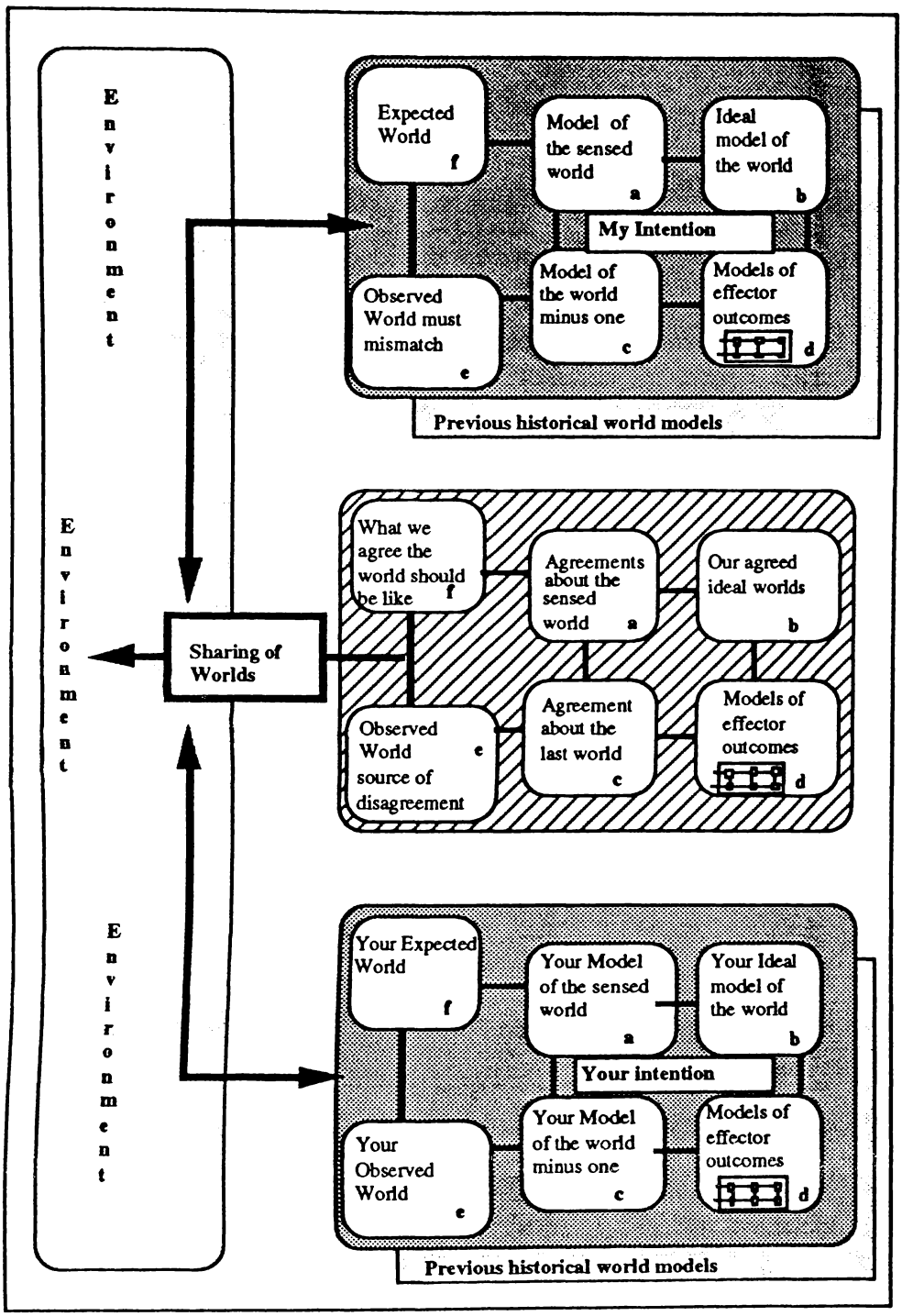

Figure 9. A suggested outcome of a conversational agreement as seen from one head. The major components of the model show the individual has three submodels of the shared worlds. An idiosyncratic or personal view, a view of the world created from sounds and marks provided by an other conversant, and a model of what the participants have agreed or disagreed about

Conversation Theory has empirical content. That is, in a strict conversation the material communicated about can be made open to public scrutiny. The means by which Pask and his team of four or five researchers made the substance of the conversation open to scrutiny was through the technique of recording and processing the conversation by a participant observer (Pask, 1986 pers. comm.). Pask argues that a second 'person' (the other partner in a conversation) may be another person in communication with a learner or may be present in surrogate form as a set of coded computer instructions, a computer program. To participate in the conversation the other conversant must be able to interpret the various interactions that occur. The necessity for an interpreted interaction is that only through interpretation can a failure to understand be recognised, probed to clarify the misunderstanding so that the cause of the failure to understand is identified and thus be made open to further discussion and remediation if necessary.

The dynamic give-and-take in conversation occurs among other things, as noises and marks are transferred, misunderstandings checked, concepts verified, and agreement reached either to proceed or adopt some other course of action. Laurillard (1984) discusses the attributes of a learning context which is conducive to testing Conversation Theory in the classroom. Her description mirrors some of the attributes of the learning context identified in Barbour (1986). The outcome of a successful interaction between conversants is agreement about a shared or understood concept (Pask, 1976c, 153). Figure 10 shows the way in which each participant creates a model of the view of the other participant. Participants compare these models, with personally held views, thus establishing what is common or shared or agreed in the central model.

Applications of Conversation Theory

This section begins by exploring the situations in which Conversation Theory is appropriate and may therefore be applied. The first point about applying Conversation Theory is Pask's insistence that both syntactic and semantic aspects of language be included in any discussion about conversations. For Pask, 'syntax' refers to the rules governing how the noises and marks are organised (Pask, 1976c, 54). Semantic rules are those

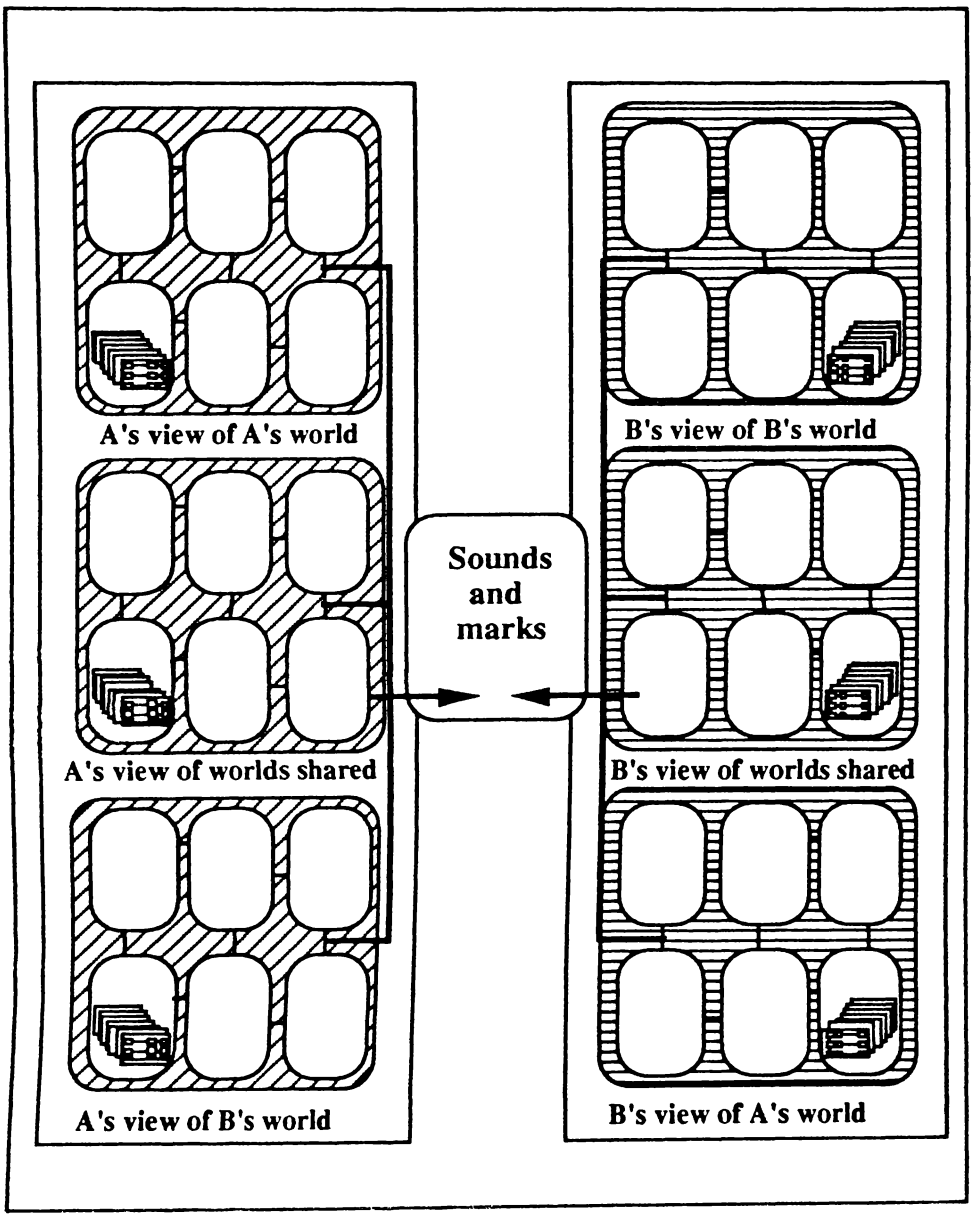

Figure 10. A Paskian view of a conversation between two people, A and B. This model is adapted and extended from Laing, Phillipson and Lee, 1966, and Rorty, 1989.

that describe the universe of interpretation to which a particular set of noises and marks applies (Pask, 1976c, 57). The rules for the form of sentences -sets of noises and marks- in a language ensure that it is syntactically correct. The rules for how sentences -sets of noises and marks- can convey meaning ensure that ambiguity is reduced to a minimum. These aspects of language may be exemplified in a variety of different ways among which are the tables of relation shown Figure 5, page 30. The top right hand diagram is intended to represent a table of relation in a database. In the database there are entities, which have attributes, which are in turn associated with other entities by relations. These associations are the human constructions by which people create a more or less coherent view of the world.

Conversation Theory provides, among other things, a description of, and explanation for, the cognitive interactions that occur when one person communicates with another person. As such, Conversation Theory is a theory in the field of epistemology. It is a theory about what people can learn and about how people go about learning. The diagram in Figure 11, adapted from Marton's (1988) work, places emphasis on the interpretative nature of Conversation Theory. In this diagram the twin attributes of knowledge, 'how' and 'what', provide the basis for interpreting conversations. The epistemological basis of Conversation Theory rests on what Pask (1975) called a 'strict conversation'. A strict conversation is one in which there is an understanding as a consequence of an interaction preceded by teachback and an agreement.

Pask argued that a topic is an arbitrary part of a domain in ordinary language, shown as L in Figure 7, page 41. Noises and marks used to communicate about the topic can be classified into 'activities' that he considers are one of three types (Pask, 1976c, 164). As noted earlier, these are description building, procedure construction, and procedure building. The meaning constructed during a conversation may be specific content, analogies to content, or some abstract model or theory of the content. The basis of the communication will be acts in the form of noises and marks or non-verbal behaviours identified as Know-ables and Do-ables above.

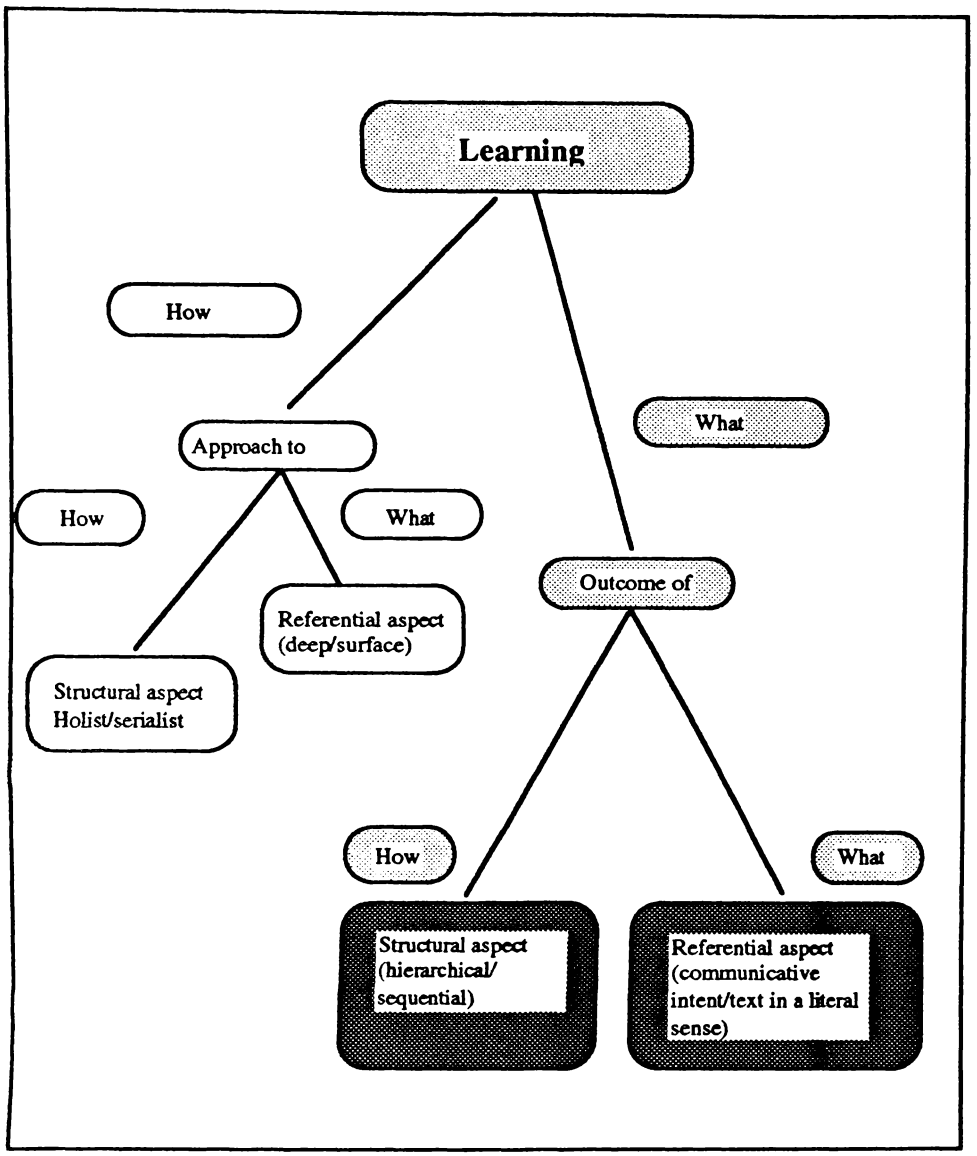

Figure 11. Marton's (1988) view of various components of the learning process. The shaded area of this diagram represents the outcomes of learning which have structural and referential aspects. My research was concerned with these areas, the evidence from which was used to infer structural aspects of learning in the unshaded area.

Pask postulates three other levels of communication used to conduct meta-level conversation activities (Levels L1, L0 and L* in Figure 7). He places experimental work in the meta-level of conversation. The distinctions within meta-level activities are the least clearly spelled out concepts in Pask's work. This is unfortunate because the conversations about conversation are lightly treated in Pask's written material. The evaluation of Pask's theory is

clouded by the difficulty involved in establishing the role of meta-level languages L1, L0, and L*. It is not clear why they should not simply be collapsed into L (the language of conversation). These meta-level languages and associated concepts are dealt with in detail in Chapter 5, but some aspects of Pask's epistemology, the study of learning, require consideration here.

Pask's work, even briefly described as it is in this thesis, infers that a number of well established philosophical positions require critique. For example, the 'analytical/synthetic dichotomy' can no longer be accepted as having substance despite its widespread acceptance among traditional philosophers. To illustrate this point, the concepts of 'subjective' and 'objective' will be examined as contributory concepts to the analytical/synthetic dichotomy. Furthermore, the argument is advanced that if Pask's criteria for understanding are accepted then it follows that the content of a strict conversation has a special kind of 'objectivity'. This objectivity is known as 'intersubjective validity', a term coined by Schutz (in Wagner, 1970). 'Objectivity' is one of the requirements of setting up the conditions through which the principles of Conversation Theory may be tested and either falsified or verified. The participants come to see that the content has an 'independence' in that it is not just the shared understandings both persons have of internal cognitive processes.

The sharing and verification of the meanings constructed during the conversation also ensure that the many other people making up the social group to which the participants belong may be substituted for either participant in the conversation. Thus, the outcome of the strict conversation -verified understanding- is not continuously dependent on any particular individuals being involved. Dependence on people in conversation but independence of outcome on particular individuals, is what is meant by 'intersubjective validity' in the context of Pask's Theory.

Significant Classroom Learning Experiences

For Pask (1976c, 18), 'significant learning' is a key global concept. This refers to those learning situations in which the topic that forms the content of the learning situation is of less importance than learning how to learn. Pask says: 'This crucial accomplishment ... (having learned how to learn) ... has occurred when ... a student is able to impose a personal

structure on otherwise unstructured information or upon an often perverse environment' (Pask, pers. comm., 1986).

There is a growing body of research confirming the idea that individuals have preferences in handling material presented in particular ways (from Ausburn and Ausburn, 1978; to Kirby, 1984; to Geiger and Pinto, 1991b). If the applications of programmed learning theory teach nothing else, it should to be recognised that what works for some students will cause confusion or boredom for others .

That there is more than one way of doing something causes many people a good deal of distress, no more so than the student or teacher who learns step-by-step. It is de Bono's view (1977) that each person can benefit from assistance in the following ways. The person who sees many ways of doing something needs help in determining the most appropriate method in a particular context. The person who restricts approaches to one method needs help to broaden a perspective and so comes to see that there are many possible ways to learn. Thus, a significant learning experience is one in which, for some, a broadening of perspective is gained. For others, a significant educational experience is one in which the question of appropriateness of approach is raised, examined and clarified.

Sources of Research Questions

The literature review in this chapter has discussed the nature of learning from a number of different view points. These could be summarised as a list of criteria which is my interpretation of what was needed for learning to take place in a way which is publicly demonstrable. The list was derived by asking what is required of an interaction for it to meet the implications of Pask's Conversation Theory. Thus, a significant educational experience is one which (in addition to minimal physical characteristics, such as readability and age related interest):

1. is clear as to what is to be learned;

2. permits the learner to identify a way to proceed, and encourages the recognition that any procedure is only one of many ways in which progress may be made, while developing the understanding that in some circumstances particular ways of proceeding are more appropriate and therefore acceptable than others;

3. enables the learner to reconcile personally held views with those of disciplinary experts, realising that each reflects differences in content, context, perspective and intention;

4. is matched with the learner's language and conceptual abilities;

5. guides the learner towards a 'preferred' view while at the same time allowing for the existence of and recognition of the value of alternative views;

6. is matched with the learner's preferred form of material presentation;

7. ensures that the evaluation process occurs at the point at which the learner is able to demonstrate understanding, and is matched with the learner's preferred form of presentation.

These criteria can be integrated with items in Schmeck's (1988, 47) diagram which has been extended to highlight holist-like and serialist-like strategies of interest in this research (Figure 12). Of particular note in this diagram are the three major approaches to learning: surface; deep; and strategic. Extending down the page from these approaches are links between motivation, intention, process and outcome. This extended model, developed by Entwistle, summarises data from a large number of sources (Pask, 1975; Entwistle, 1981; Marton and Saljo, 1976; and Ramsden, 1988). From this integrated model, and the literature review, a large number of interesting areas of research became apparent that might have been examined in this thesis. Some of these are:

- Process questions which could involve exploring the genesis of learning strategies in the very young learner, following Piaget but with a strategy emphasis;

- Process questions related to longitudinal studies in which groups of young people are followed through primary, secondary, and tertiary learning experiences into adulthood. It would be expected that, as Pask predicts (pers. comm., 1986), people shift in their predominant strategy preference as they mature;

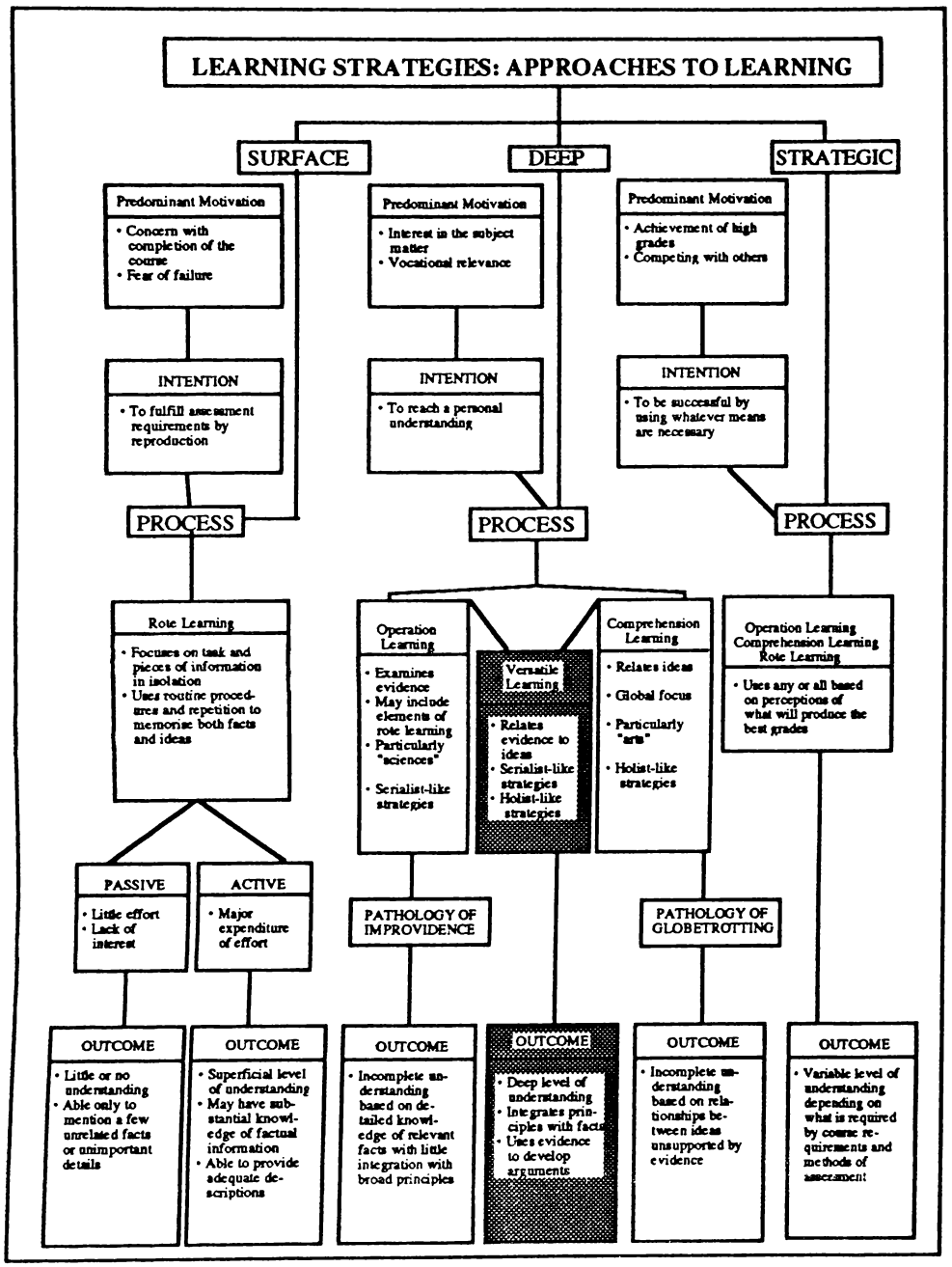

Figure 12. Entwistle's model of the relationships between motivation, process, and outcome (in Schmeck, 1988, 47). The focus of my research was on examining ways in which a computer could be used to achieve the outcomes in the shaded boxes.

- Intervention studies which could be undertaken to establish techniques that would provide students with a repertoire of strategies;

- Studies could be undertaken with a view to finding out what sort of assistance, in the form of teacher training, is needed to ensure that teachers acquire and adopt a variety of learning strategies;

- Studies could be undertaken to establish whether people with a range of learning styles differ in their ability to cope with conceptual, circumstantial, or personal change;

- Studies could be undertaken to confirm the work that Pask and others have completed on strategies and styles.

Framing research questions for this general area of research is made difficult because there is no one set of preferred definitions of fundamental concepts, such as style and strategy. There is also no unequivocal framework in which to place human behaviour that is as complex as learning strategies. However, if it can be shown that learning preferences are reliable indicators of learning strategies, as Dunn and Dunn (1978) maintain, and that an individual is able to develop new strategies as de Bono (1977) maintains, then this would suggest that strategy-related aspects of Pask's laboratory work could be moved into the classroom.

The trends in education theory discussed in this chapter show that learning preference studies are of continuing interest (Wellmer, 1991). For the purposes of the present study, the following areas were of special concern:

- The range of individual differences in geography student's learning strategies. The literature strongly suggests that establishing differences in learning strategy is achievable.
- Capturing learning strategies by computer as learning takes place. This is new work that will be explained in more detail in Chapter 3.
- The possibility of a computer acting as a conversation participant.

Given these concerns, the overall aim of the present study was to enhance learning. Pask's work was of special interest because it involved a reflective theory which was consistent with my observations of the importance of the different strategies that learners adopt during classroom learning.

Other theorists, such as Piaget, focussed on people in a younger age group than those I was dealing with in senior secondary school classes. Nothing in the particular learning activities or the analysis offered in Piaget's research was comparable with the learning activities in secondary school geography. The task structure, magnitude and duration were all at comparably low levels of complexity and did not lend themselves to contributing to understanding the learning process in terms of large learning tasks. Class work tends to require whole sessions involving ongoing evaluation of complex functioning, rather than Piaget's single evaluative moment at the end of an interaction. Piaget's work, which was built around one-to-one interaction with the researcher, was not appropriate to a busy classroom context, although I am sure that many teachers have been informed by contact with Piaget's research. Pask notes that Piaget's methods directly influenced his own research activities (Pask, 1976c).

The work of a number of psychological and educational researchers has also been examined (from Bruner et al., 1956, to Kogan, 1979, and including Witkin et al., 1977), but these people were involved in psychometric analysis, laboratory work, or other work which is far removed from the activities of the everyday classroom context.

In summary, the preference for Pask's Conversation Theory reflects my interest in: epistemology; a phenomenological perspective on methodology; expanding learning competencies through active intervention (teaching) in learning; and investigating large-scale learning behaviours comparable with those encountered in the classroom context.

The literature suggests that a range of possible learning strategies can be found by observing what people actually do or by asking them how they go about learning. Chapter 3 is focussed specifically on a design to answer two questions related to these suggestions. The first asks whether Ford's questionnaire can be used in modified form to establish differences in strategy preferences. Comparable results would confirm the initial claim made by Pask that differences in learning strategies can be established in a classroom. A

related aspect is to determine whether the claims of Ford and Entwistle for a relationship between preference and behaviour are borne out in the observed behaviour of students in the classroom. Positive answers to these questions could suggest ways in which to enhance learning in the classroom. If the intention of using a machine as a conversant is to enhance learning by matching strategies with material, then identifying strategies seems a critical first step. This information is essential if the computer is to be programmed to detect learning strategies.

Chapter 3 details the research design used to carry out the empirical work required to capture learning strategies in the classroom by means of a questionnaire and a computer.

CHAPTER 3

RESEARCH DESIGN AND METHOD

Outline: The research design, which has five steps in a Two Phase design, is described in the six sections of this chapter. Each step is related to a research question. Steps 1 to 3 are contained within a Phase 1 Design and Steps 4 and 5 within a Phase 2 Design. The overall research problem, the research questions, and a broad description of the tools and procedures are described in Section 1. Section 2 explains Step 1 used to investigate the first research question. This was about identifying a range of preferences in learning strategies using a questionnaire. In Section 3 a description is given of the computer based tools used to investigate Step 2 in which learning strategies were captured by the computer as a part of a monitoring process. Section 4 outlines Step 3 in the research design used to investigate the third research question about comparing preferences and observed behaviours. Section 5 details the first of the two Steps in the Phase 2 Design. In Step 4, the techniques used to examine the theoretical possibility of matching computer responses with learning strategies are described. Step 5, outlined in Section 6, describes the methods used to explore the second theoretical question about whether a computer can act as a conversant. The chapter concludes by introducing the results reported in Chapter 4.

The Research Problem

My classroom observations, discussed in Chapter 1, revealed that while two subjects could attend to the same experience, each person often talked about these experiences in markedly different ways. A variety of possible explanations for the processes by which this could have occurred have been outlined in the literature review in Chapter 2. The main points to emerge from that review are that: 1) on any given occasion people choose one particular learning strategy for carrying out a learning task; 2) over a number of occasions people tend to adopt consistent learning strategies; 3) these characteristically consistent behaviours are called 'learning style'; and 4) people tend to learn more effectively when the material they are learning from

is matched with their learning strategy, and less effectively when these aspects are mismatched.

Coping with the variety of possible student behaviours in an ordinary classroom is a complex problem for a teacher. It was thought, however, that a computer could help match subjects' preferred learning strategies with appropriate materials. Programmed to act in this way, a computer would emulate a person in a conversation. The overall research problem stemming from these considerations was thus:

> **Given that individual difference is expressed in the different strategies people use while learning: Can a computer be used to enhance individual learning by having it match materials with individuals' learning strategies, thus, acting as a conversant?**

Research Design

The complex research question above was approached initially in a single phase design consisting of three steps. However, emergent problems lead to a second phase and further research steps. Each step in the exploratory research design of Phase 1 and the emergent research design of Phase 2 was addressed through a research question. The investigation as a whole is summarised in Figure 13 which highlights the two research phases, the specific research questions and the procedures followed in each research step. Phase 1 was concerned with collecting and using data about learning preferences, and was made up of the first three steps and their associated focussing questions.

The main questions asked in Phase 1 were:

Question 1. **Can a range of people's preferences for learning strategies be identified using Ford's questionnaire?**

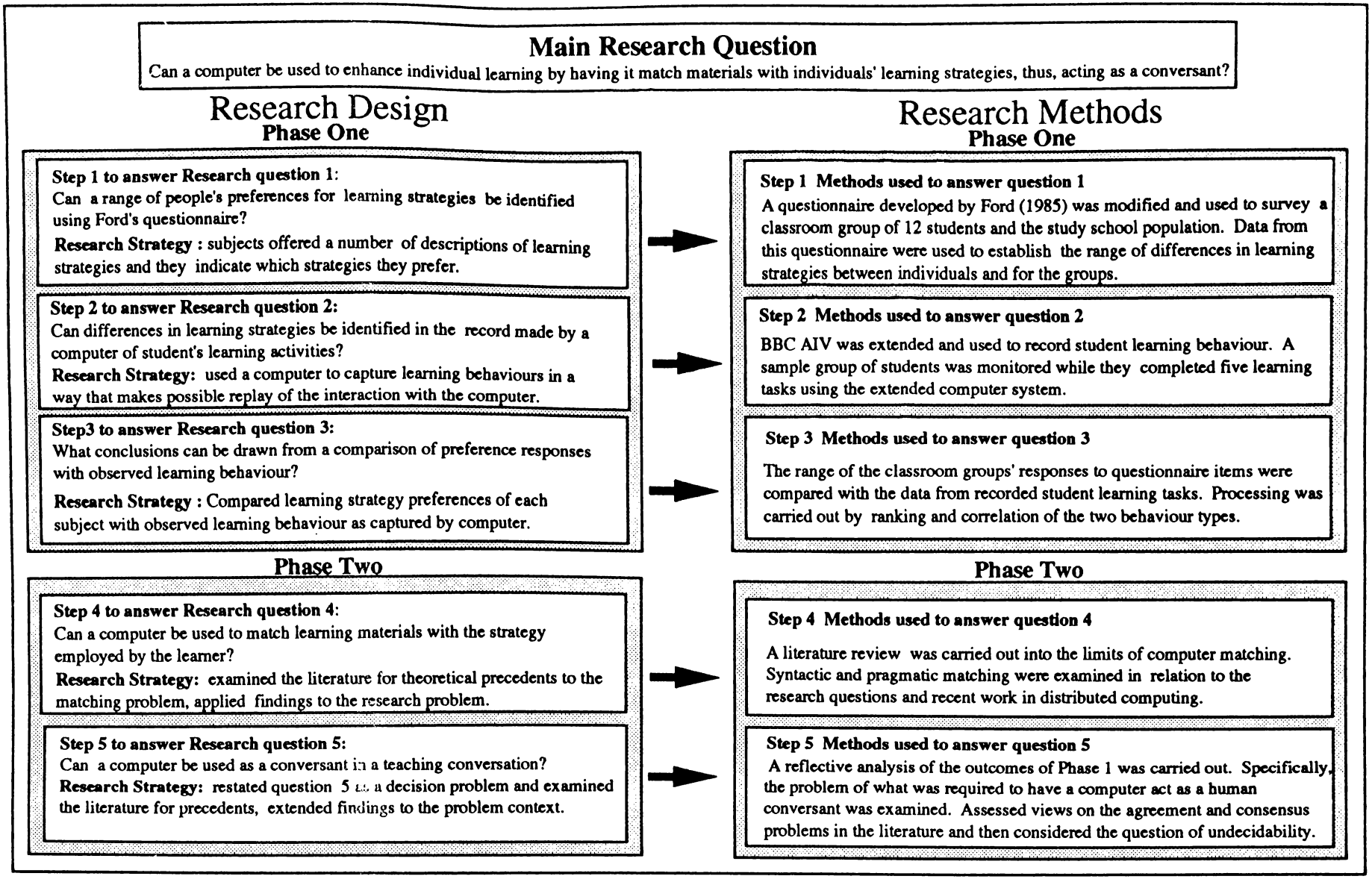

Figure 13. Outline of the two phase research design, questions and associated methods.

Question 2. **Can differences in learning strategies be identified in the record made by a computer of students' learning activities?**

To help answer the first question, research subjects were asked to complete a questionnaire adapted from Ford (1985). This was Step 1 in Phase 1 of the design. Subsequently, in Step 2, a modified computer environment was used to capture data about subjects' learning strategies. A comparison of Step 1 and 2 data was carried out as Step 3 in Phase 1.

The main research question in Step 3 of Phase 1 was:

Question 3. **What conclusions can be drawn from a comparison of preference responses with observed behaviour?**

Phase 1 of the present study confirmed essential elements of Pask's (1975) design. The main difference was that software modules, in a microcomputer environment, were used to replace the people whom Pask employed to carry out monitoring activities. While Phase 1 was empirical in nature, Phase 2 of the study was concerned with exploring whether the data about preferences and observed learning strategies could be used to enhance learning. It was concerned also with informing other related disciplines such as Geography, Education and Computer Science practice by referring to the implications of Computer Science theory for other research.

The research questions guiding Phase 2 of the study were:

Question 4. **Can a computer be used to match learning experiences with the strategy preferences of the learner?**

Question 5. **Can a computer be used as a conversant in a conversation?**

Step 4 of Phase 2 carried out a theoretical examination of whether a computer could be used to match learning strategy preferences with appropriate learning materials. Step 5 focused on what is required for a computer to act as a conversant. In Phase 2 of the research the intention was to explore what was needed to link together data about learning strategies with data about learning strategy preferences. The outcome of this comparison was intended to provide understandings to facilitate computer matching of materials with subjects' learning strategies. Successful matching would allow further extensions to the computer software already developed in Phase 1, so that a computer might ultimately act in a way that was 'equivalent to' a person in conversation with another person. The sections below provide a more detailed account of each step in the two-phase research design.

THE PHASE 1 DESIGN

STEP 1

Step 1 was designed to address the first research question which was concerned with **identifying the range of preferences people have for approaches to a number of learning tasks.** The section begins by outlining the pilot study used to inform the research on the appropriateness of Ford's (1985) questionnaire for the subjects. The characteristics of the small classroom group used for the preference survey are described next, and then the features of the survey questionnaire are outlined. The initial subject sample consisted of 12 available Sixth Form geography students attending a small rural secondary school. Their ages ranged from 17 to 18 years (mean = 17, SD = 0.4). These subjects were asked to complete the modified Ford (1985) questionnaire.

The questionnaire for identifying learning preferences was administered also in a modified form to the school staff and other students in the school. There were 195 completed responses from the 300 people in this wider school survey. Ages of this group ranged from 12 to 50 (mean = 15.2, SD = 7.3). The purpose of the whole-school survey was to check whether the large sample had a comparable distribution of preferences with the small sixth form group.

The Preference Survey

The questionnaire used for the survey was based on Ford's (1985) work in which he attempted to confirm and extend Pask's (1975) findings. Ford was interested particularly in whether successful post-graduate students would demonstrate evidence of versatility in learning. He compared outcomes from a series of questionnaires and empirical work with Pask's strategy identification tools (1975), as a basis for his determination of whether subjects could learn equally well from holist or serialist materials. From this data Ford developed a questionnaire which he claimed successfully predicted the learning strategies of 19 out 23 students. These predictions, based on student's questionnaire responses, agreed with student's behaviour identified by Ford using Pask's strategy identification tools.

Ford designed his questionnaire for use with advanced learners. It was not appropriate for the secondary school context in its original form. This conclusion was confirmed in a pilot study with adults and teaching staff of junior classes and by consulting the school's reading teacher. Comment about the questionnaire pointed to the complexity of Ford's original phrasing, this was taken into consideration when adapting the questionnaire for this study. The adaptation was carried out by simplifying the strategy descriptions in the questionnaire. The items identified by Ford (1985) as suitable indicators of learning preference (Q2, 8, 9, 10 and 18) were integrated with others specifically related to Pask's work and the learning context under investigation. In all, 20 paired items made up the adapted questionnaires (Appendix D).

The questionnaires were used to collect data from the **small classroom study group** and the **whole school group** indicating what students and their teachers said about how they liked to carry out a number of learning and teaching related tasks. The items were intended to capture preferences for holist-like or serialist-like learning strategies. Subjects recorded their preferences for each item by circling one of five numbers from 1 to 5. For example, circling 1 or 2 meant a preference for the left (serialist-like) item, while circling 4 or 5 meant a preference for the right (holist-like) item (see below and Appendix D). Two further means of indicating choices were available to the subjects. They could declare a preference for neither choice or indicate that they used both approaches. No choice for either alternative was indicated by circling '3', while circling all 5 available numbers

indicated the use of both approaches. Circling all five numbers was taken as an indication of versatility, but was integrated with the '3 no preference option' because it did not discriminate between strategy types.

Discussion with the school staff at a staff meeting gained their cooperation in taking responsibility for administering the questionnaire during Home Room times. Each Home Room session involved students ranging in age from 12 to 18 years. Special arrangements were made to allow adult students to participate during the Sustained Silent Reading period scheduled after the lunch break. Younger children and slow readers took up to 20 minutes to complete the questionnaire, while most of the adults were able to complete it in 10 minutes.

Three versions of the questionnaire were prepared: one for staff, one for older students, and one for younger students (Appendix D). The main difference between the questionnaire versions was the sophistication of the language used in the questionnaire items. The teacher's version is reproduced below, together with explanatory notes. Questionnaire stems which are **holist-like** are presented in the 'courier font' while those that are **serialist-like** are in '*italics*'. The items in the questionnaire below are annotated as a way of providing the reader with information about how differences in preferences for learning strategy were interpreted.

The Questionnaire items

Q.1 When I am reading a novel or a fiction book I tend to turn over pages that do not interest me.	1 2 3 4 5	*I read every page so that I do not miss anything.*

The first item in the 20 item questionnaire taps a preference for page skipping as a particular recreational reading strategy. This question was selected to cue subjects into the intent of the exercise.

Q.2 When I am reading a textbook I read only the bits that refer to what I want to know.	1 2 3 4 5	*I read textbooks carefully page by page so as not to miss the ideas and facts in the book.*

Strategies for reading a textbook are distinguished in Item 2 which is designed to cue the reader into changing roles from recreational reader to

teacher. A key attribute in Pask's description of the versatile learning strategy is the ability to restructure formal learning material into a preferred mode. Versatility implies a strong sense of what the learner needs to understand from the text. The bipolar opposite suggests a willingness to allow the book author to determine through the text material what is important.

Q.3 When I'm collecting information for a lesson or assignment for students I like to begin with as much information as possible at the start.	1 2 3 4 5	*I prefer to locate information when I need it.*

Item 3 asks about data collection strategies related to a specific task. The intention here was to help the subject a preference for a defined holist-like strategy, improvidence (collecting everything about everything), in contrast to a more serialist-like incremental approach.

Q4 *I like to look carefully at one bit of resource material before I move to the next*	1 2 3 4 5	I like to move between a number of sources of material at the same time.

The fourth item picks up on the local/global distinction between focussing strategies. Holist and serialist thinkers tend to operate at different scales. This question attempts to gain some indication of those who think in terms of detail (operation learner or serialist) or in a more generalised way (comprehension learner or holist).

Q5 I like to have a clear picture of the whole topic or task in my brain while I am working on a task.	1 2 3 4 5	*I like to divide topics up into their parts and do each part in turn building up an overall picture bit by bit.*

Responses to Item 5 indicate a fundamental distinction between holist-like and serialist-like strategies. While both are concerned with learning all the material, the holist-like thinker is capable of suspending judgement until all the material is assembled. The serialist-like thinker, on the other hand, moves from one certainty to the next.

Q6 *When I am researching for source material I am generally looking for a single book or item*	1 2 3 4 5	I tend to spend a lot of time browsing in resource material and the library.

Item 6 seeks to highlight the subject's preference for a research strategy which looks for single or many sources. It also acts as a check for consistency of response with question 4.

Q7 When I am preparing an exam I spend a lot of time putting material into a logical order so that I can see how all the questions fit together.	1 2 3 4 5	*When I am preparing an exam I tend to test each topic in the order covered in the course outline.*

Item 7 seeks information on a preference for: ordering notes and material on some personal basis; or for the acceptance of a taught order. Following the taught order is, characteristically, a serialist-like strategy.

Q8 When I am reading a book or other information source to students I skip about quite a lot dipping into material to give students a clearer picture of the main ideas.	1 2 3 4 5	*I prefer to get into detail as soon as possible because the meaning becomes clearer for pupils when I use this approach.*

Item 8 relates to skipping around data to give a clear picture of ideas or moving from one detail to another detail, again reflecting the perception that knowledge is given (Serialist-like) rather than constructed (Holist-like).

Q9 *Generally I concentrate on only one or a few aspects of a topic at any one time.*	1 2 3 4 5	Generally I teach about a number of different parts of the topic at the same time.

In Item 9 the subject is asked to reflect on whether s/he concentrates on few aspects of a topic at one time or different parts of one aspect. This item taps into the local/global distinction again, but **during** the learning process.

Q10 Once I present all the bits of a topic fitted together I put effort into teaching the details.	1 2 3 4 5	*I like to teach generally how the bits in a topic all go together because the topic makes better sense when students can see why all the bits are important as the work progresses.*

In Item 10, the respondent is asked to reflect on when the integration of material is attempted. The global/local distinction in approach to learning is inferred from this response which is seen **at the end** of the learning process. This item contrasts the possible points in the lesson where integration of the topic content is achieved.

Q11 When *I prepare lessons I use any prepared resources/material I can get my hands on.*	1 2 3 4 5	I prepare all my own work because I prefer to organise it to suit methods I find successful.

Item 11 asks teachers to consider whether they provide all the experiences for their students by creating their own material or whether they use already prepared material. The contrast of provided order/created order again taps the responsibility-for-learning question, but from the point of view of organisation of materials.

Q12 When I present material in a class context I usually tend to outline what material will be covered in the lesson first.	1 2 3 4 5	*I let the content to be covered unfold as the lesson progresses.*

In Item 12 a preference for an introductory outline suggests an approach that is holist-like in mode of teaching, whereas unfolding the material in sequential presentation is more serialist-like.

Q13 I add interest to lessons by telling small stories anecdotes to make the lesson more enjoyable.	1 2 3 4 5	*I generally stick to the main points of the lesson and don't add extra information.*

Item 13 focuses on constructive invention, augmenting narrative by adding stories, as a holist-like strategy, contrasted that with the 'no stories', 'no inventions' serialist-like strategy.

Q14 I spend a lot of time describing the main ideas in a topic.	1 2 3 4 5	*I spend a lot of time showing the steps that make up the ideas and the processes in a topic.*

In Item 14, describing the main ideas, a holist-like strategy, contrasts with learning the processes which bring about the main ideas, a serialist-like strategy.

Q15 I sometimes invent new ways of looking at topics in order to make the material easier to remember.	1 2 3 4 5	*I use the examples given in the texts and other information sources.*

Item 15 contrasts personally created stories which make material memorable and contrasts this a holist-like strategy with serialist-like acceptance of existing constructions.

Q16 I use pictures and sketches to make the ideas in my subject easier to remember.	1 2 3 4 5	*I find words the best way to convey the ideas in my subject.*

Item 16 is meant to contrast pictures and sketches, which are reported as holist-like strategies (Pask, 1976c, 350), with spoken language, which is a serialist-like mode of communication.

Q17 *My best subject is presented as a whole lot of smaller and separate subtopics.*	1 2 3 4 5	My best subject is presented as connected aspects of the same subject.

In Item 17 serialist-like 'subtopics' are contrasted with holist-like 'whole topic' teaching approaches. The item taps a preferences for particular teaching strategies.

Q18 My *subject ..... is best taught one aspect at a time, one principle, then an example, and so on.*	1 2 3 4 5	My subject..... is best taught by passing on principles first then the examples next.

Item 18 asks the subject to reflect on the strategies used to talk about a topic. One aspect at a time is the serialist-like strategy which is compared with the holist-like strategy of presenting the main ideas and then examples.

Q19 *Thinking logically is more important than being creative in my subject.*	1 2 3 4 5	Being creative is most important in my subject.

Item 19 attempts to identify a preference for the certainty of logic as opposed to the freedom to be creative and inventive in a preferred subject.

Q20 *I like material I work with to be well organised and clearly set out in text notes and other source material.*	1 2 3 4 5	I like to organise material for myself the ways that make sense for me.

Item 20 focuses on serialist-like people who prefer organised material in contrast to people who are holist-like and tend to want to organise material to suit themselves. This item looks at the issue of responsibility for the outcome of a teacher/learner interaction.

The responses to the questionnaire were analysed by summing the number of holist and serialist-like strategy choices. The horizontal sum of questionnaire responses for each subject gave an indication of whether the subject was holist-like or serialist-like. A simple discriminating expedient adopted was: those whose scores were greater than 60 selected more holist-like strategies; those with a sum of less than 60 were serialist-like because they selected mainly lower scoring serialist-like items.

Summing the columns for both the small classroom group and the larger whole school group gave a view of the strategy that the group thought was best for each questionnaire item. This data is presented in tabular and graphical forms in Chapter 4 and allowed for the comparison of the small classroom group survey and the larger school wide survey.

This section has been concerned with describing Ford's questionnaire and the way in which it was modified for use in this research. The next section briefly introduces the rationale for using the second tool, the BBC AIV, and describes the changes made to it. During Step 2 this tool captured student's learning strategies. The section begins with an outline of the reasons for the choice of the BBC AIV.

THE PHASE ONE DESIGN

STEP 2

Step 2 was concerned with capturing classroom learning behaviours using the BBC AIV in a way that allowed students' learning behaviour to be confirmed for further study. The second research question was: **Can differences in learning strategy be identified in the computer records of the student's learning activities?** The present section begins by outlining some reasons for selecting a computer to do the monitoring of normal classroom behaviour.

Capturing Learning Strategies by Computer

In a normal classroom, most teachers are fully occupied by the demands of the professional responsibility involved in interacting with a large number of students. In conventional classroom teaching the constant demands on teachers of face-to-face interaction and quick decision-making usually preclude reflective monitoring of the students' learning. Yet it can be argued that such data is critical if the teacher is to review and plan adjustments to teaching strategies on a more than superficial basis. The present research explored these problems using a range of computer controlled devices (Barbour, 1991b). While any research findings would clearly relate most directly to this special computer controlled environment, it was hoped that principles would emerge that had transfer value for teaching in the more conventional classroom setting.

Monitoring student approaches during a learning occasion requires close attention to the student's activities. Adding monitoring functions to the teacher's role materially degrades the teaching/learning interaction. It does so by taking away from the interaction the teacher's thinking resources that could be employed in the presentation of information of one kind or another. It was considered, however, that monitoring learning activity and presenting learning materials were tasks that could be automated. Thus, in the present study a modified computer system was used to provide: a) a body of knowledge in the form of a micro-world; and b) monitoring functions. A micro-world was viewed as an internally coherent aggregate of data, hardware, and retrieval software. The BBC AIV provided a constrained learning environment which became the 'artefact to be thought about' (Pask, 1986, pers. comm.) by the teacher and the learner. It became the context and the content, in and through which teaching/learning took place.

Pask (pers. comm., 1986) informed me that his laboratory experiments involved up to four persons in addition to the learner. The functions of these other persons were essentially that of support staff in that they provided intelligent responses to requests for information as well as acting as participant observers. Thus, in Pask's work, the interaction he observed was between **one person and a number of other persons**. The subject and the participant observers conversed about the topic through the medium of an information artefact (a combination of flash cards, dials, gauges, and other

materials specifically designed to describe the topic. In my research the interaction under observation was between **one person and one machine.** The functions of providing information and recording the learner's activities were given over to software control. The information required by subjects was provided by the BBC AIV retrieval software. The retrieval software was used in my research to recover data in response to a learner's inquiries. The monitoring functions were also assigned to software control. But the process of matching learning materials form the BBC AIV with the particular learning strategies employed by a particular learner at any stage in the research could not be mechanised. The reasons for this are discussed more fully in Chapter 5 on the limitations of the BBC AIV.

The main purpose of Step 2 in the research was to capture evidence supporting the contention of individual differences in learning strategies. The interaction between a person and a machine can be captured in a variety of ways. A tape recorder can be used to capture sounds, or a video recorder can be used to capture the combination of on-screen activities, the students actions, and sounds. Both tape recorder and video recorder were tried, but quickly abandoned because their addition to the learning context severely disrupted the learning process. The problem was resolved by adding software modules to the BBC AIV. The additional software did more than just log student activities. A data-logging module usually captures just the input to the application and not the application's response (Gettys and Berglan, 1989). The software modules that I developed for carrying out monitoring functions included data logging of student activities, machine responses, playback facilities, provisions for obtaining hardcopy, and reporting facilities. These features are discussed later in this chapter in the section dealing with software modules. Data was therefore collected 'on the fly' as learners worked through the five tasks described below. A floppy disc record was made so that the interaction could be played back verbatim at any time after the interaction.

The subjects for Step 2 of Phase 1 were a group of 12 Form Six geography students. They were an available sample of the school population. For them, the BBC AIV experience was directly related to the curriculum content of their course of study. The BBC AIV was the best available teaching resource for about half the curriculum content of the Sixth Form geography course in 1989. This course content was related to Britain as an example of a developed nation.

The BBC AIV Domesday System

The BBC AIV Domesday System (BBC AIV) (Goddard and Armstrong, 1986, Rhind and Mounsey, 1986) gives effect to the seminal work of Bush (1945) on multimedia interactive data base systems. It provided my students with a vast and compelling store of multimedia data about the British Isles (Chalmers and Forer, 1987). For the teacher, the BBC AIV offers a means to investigate some very elusive attributes of human learning in the classroom environment. The system was designed to meet the specific needs of people searching a multimedia database for information about the British Isles. The BBC AIV contains maps, collected data, and visual material in a 'slice of British life' (Maguire, 1989; Owen, et al., 1986). When it appeared in the United Kingdom in late 1986, the BBC AIV broke new ground for the ease of access it provided to a vast image and information store (Armstrong, pers. comm., 1986). There is, for example, enough data about Britain on the two LVROM (Laser Vision Read Only) discs to occupy a user for 40 hours per week for seven years (Openshaw, Wymer and Charlton, 1986). During the empirical part of the research, the BBC AIV was housed for the year in a high school classroom. Thus it became a student resource along with other geographical resources, such as textbooks, maps and audio visual material.

The BBC AIV illustrates the multimedia aspect of an advanced interactive learning environment. The system contains media in the form of text, still and moving images, graphics images, charts, tables, diagrams, and maps to five scales for most of the British Isles. However, the limitations of the system lie in what may be done with the multimedia, and in how the media may be presented to the user in the course of an inquiry. Most significantly, the media and the information in the BBC AIV comes to the user as a finished product, complete and unalterable.

For example, suppose a person wished to show another person how to use the BBC AIV. Doing so would mean retracing the steps taken in the initial search of the database. It would mean that all the items that were looked at in the first search would have to be looked at again in order to physically point out what was important. By way of analogy, consider a tree. At the end of a branch is a leaf. The user has seen the leaf in a search through the foliage on the tree. The user wants to draw some other person's attention to the leaf.

With Domesday, it is not possible to start the system and to straight away point to a single data item which would be equivalent to the single leaf. The user must first move up the trunk of the database, through all the smaller branches and twigs until the leaf can be seen. A user is unlikely to be able to remember all the steps that were required to locate a particular item of data (the leaf). It is very difficult to recount a previous search pattern. It is impossible to edit a previous search pattern to show an improved strategy for searching. The evidence for progress is not available because the interaction between the person and the computer is lost, it is ephemera. The monitor is wiped as clean as a TV screen when a screen changes.

In any one recalled search pattern, it is possible that less important items would intrude on the communication process. There is no easy way a student could indicate which of the items were more or less important than any other. There is no easy way either, that a student could order or manipulate any of the media in ways that would be required to demonstrate an individual grasp of a topic.

Given these facts, the BBC AIV concept is only one half of the conversation required to test Pask's Conversation Theory. What the System provides is the material that a teacher might use to interact with a learner. Because no monitoring facility is provided, we cannot know from the operation of the BBC AIV what either participant, the computer or the person, has done. For an educator, this is a little like knowing the spoken lines for one character in a two character play without being able to hear what either person said. A better system would provide a record of the user's input, and the computer's responses, that is, a record of both sides of the interaction.

To test the major principles of Pask's theory, it was necessary to attempt to capture **both** halves of the conversation and make the interaction open to examination in an objective way. The process of requesting a data item, locating it, and placing it on the screen, is the conversation the student has with the system. This interaction of the student and the system is lost with most current computer systems. Capturing the student's input and using this to regenerate the BBC AIV's response was required for the classroom research. Section 3 below describes the modules that were developed to support Step 2 in the research.

Extensions to the BBC AIV

Four types of software, outlined first and described below, were used to record the subjects' learning activities (Figure 14). The first type was the retrieval software supplied with the BBC AIV. The second type - Scriptfile - used to capture aspects of conversation, was an inhouse BBC software package. I was unable to locate a software engineer willing to adapt the software for my purposes so I adapted the third type of software from commercially available packages. The Teachback and Edit Teachback modules were written in BBC Basic IV, a structured version of the Basic programming language. Teachback and Edit Teachback were strictly linear programs which play back material in a fixed sequence much like a tape recorder. This form of playback was appropriate for serialist teachback, but inhibits the making of links between subtopics that encourage holist strategies. I therefore constructed the Versatile Teachback module out of the Teachback and Edit Teachback modules to provide subjects with the greater flexibility needed to capture a range of teachback strategies. I wrote the fourth type of software (Lister and Lookit) to provide access to records of student activities. Lastly, I linked all the software together with further original code called Arete.

Generally speaking then, commercial software was adapted for subjects use during the learning tasks. The programs I wrote (Arete, Lookit, Lister and Versatile Teachback) were specifically written for recovering and presenting recorded data to teachers and researchers.

Scriptfile

The inhouse Scriptfile software was originally written by Logica, England for BBC. It was intended to check whether the person who provided the sound track for demonstration files in the BBC AIV system followed the script, hence 'Scriptfile'. This program was written in BCPL. It was supplied to me on a one-off basis in two forms, the compiled version and the source code. Although it was carefully examined for possible improvement, I used it as supplied. Scriptfile works in the following fashion. A person interacting with the BBC AIV carries out 'actions'. These 'actions' cause 'events' or changes in the computer environment. For example, the actions used in typing in a name of a place are key-pressing and trackerball-button-pressing.

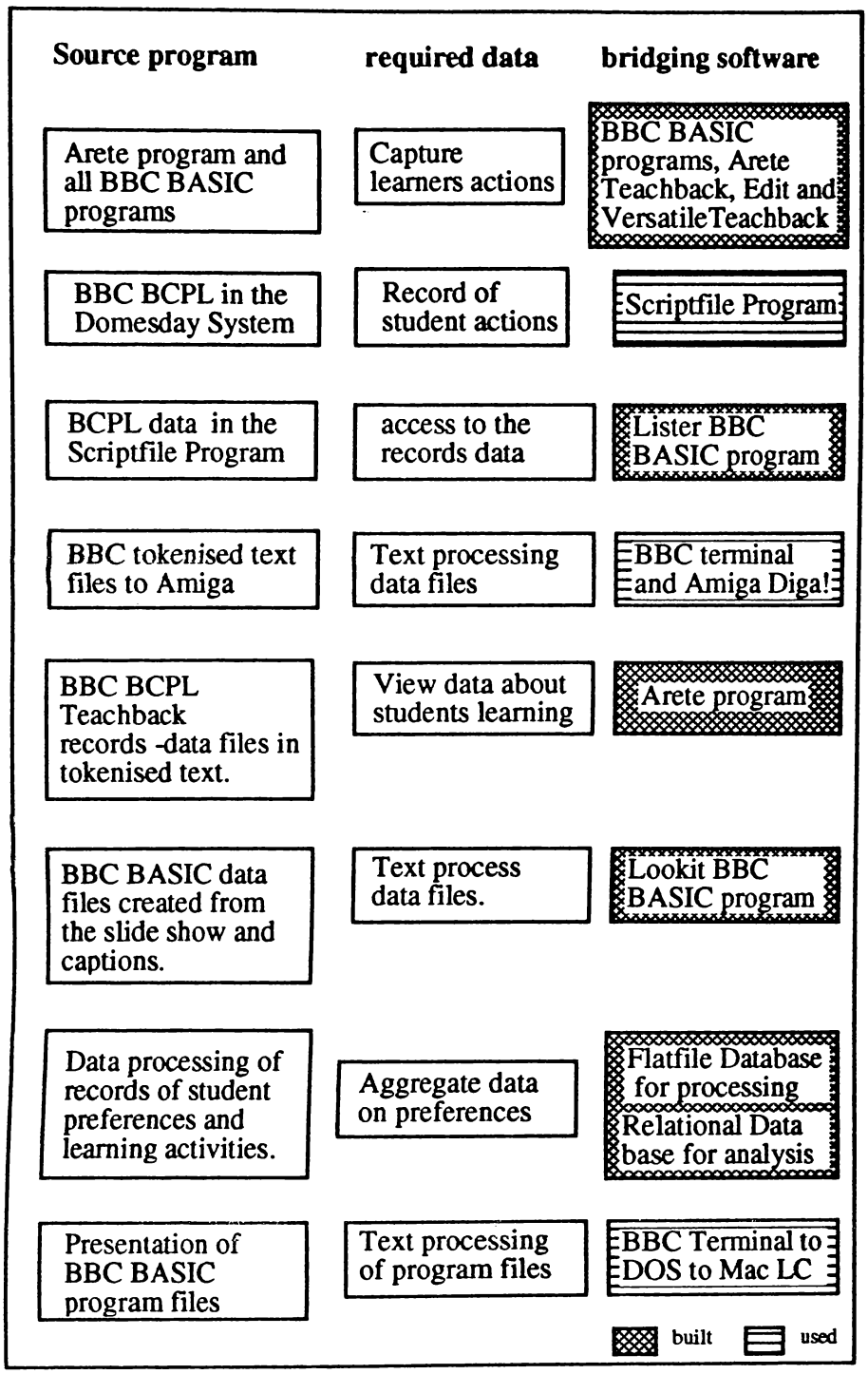

Figure 14. Software bridges used between application environments. Heavily shaded items were specifically written for this research while other software solved the identified problems.

These actions are the way we communicate our wishes to the computer. The actions the person takes and the computer responses to the actions are the history of the interaction. The Scriptfile program is a real time 'monitor' for

recording what the user does while investigating a topic, and on replay, using that data to prompt the computer to respond to the user's replayed actions. The file created by Scriptfile was stored on 'events', and timing data, without any implication of interpretation.

Teachback Program

This modified commercial program was originally designed to assist people to make a linearly sequenced slideshow from still caption-less video images and unillustrated text material in the BBC AIV. Modifications made to the program were mainly concerned with house-keeping matters such as ensuring that naming conventions were consistent and that this program would integrate with the others used in my research.

Editing Teachback

This modified commercial program, associated with Teachback as a menu selectable option, was originally designed to allow people to edit their Teachback material. The algorithms contained in this program enable the recovery and re-sequencing of previously selected material. The ability to review and edit material was an important facility which encouraged expression of thought while not requiring a correct first time response.

Versatile Teachback

This software module was designed by me and constructed from the existing Teachback and Edit Teachback modules to permit the student to select any of the image screens including still images, graphics and text screens from the BBC AIV. To each screen may be added up to four additional lines of comment. This comment could be spread over two or more screens. The program enables the BBC AIV to be extended beyond a read-only format. Because versatile teachback requires the form of teachback to be 'open', the software was a less restrictive environment than others developed for the research. The Versatile Teachback module allowed the subject this freedom of expression by enabling the addition of captions to visual material. Further development of this program could include suggestions as to efficient ways to carry out activities, such as topic selection, or may provide advice to teachers or researchers on student or subject progress. Development of diagnostic software will be discussed in the 'further work' section of Chapter 7.

Custom Extension Software

I wrote three further modules in BBC BASIC IV to extend the usefulness of the BBC AIV. These modules were in two forms. The first module, Arete, linked all other modules and allowed the student, teacher, or researcher to select specific activities related to stored student slideshows. These activities included exploring a topic, viewing existing displays, editing existing slide displays, or building new displays. The remaining two modules (Lister and Lookit) were specifically designed to give access to the records of the strategies that subjects employed when using the system.

Arete

Using the BBC Computer required software at three levels: the operating system, the disk filing system, and the application software. Arete was a menu-based application program for researchers which took control of the BBC AIV by making use of the BBC disk filing system and the operating system facilities. This module integrated all the other modules treating the other programs it used as files to be opened, worked with, and then closed. It enabled the user to know what was available, and provided control over what was shown, when, and for how long.

Lister

The Lister program enabled teachers to recover event and action records created during a student interaction with the BBC AIV. These records were stored in a file created by the Scriptfile software. It was the Lister program that allowed the first part of the analysis of the conversation process. The material from the student's disc files could then be made available for further examination on screen or in paper form.

Lookit

The Lookit or Display Teachback program was designed to allow a teacher to obtain a listing of the comments added to the conversation file. The algorithm reads the data files and returns only text data. It was from this file that assessment of one of the outcomes of a conversation could be carried out. This material was a record of what the user did during a search of the BBC

AIV database. It was analogous to the commonly available logging facility in many mainframe and network computer systems. It is very rare for such a system to be provided in a microcomputer application (Gettys and Berglan, 1989). While the Teachback software carried out the tasks involved in recording subjects' work, these records were not humanly readable. The Lookit program contains the algorithm needed to read the file that subjects created during the Teachback process. These files may be written to the screen or printed out to a floppy disc file. The function of this program was to allow the recovery of the Teachback process for subsequent analysis and processing.

Technical Problems

BBC disc files, whether BASIC or BCPL, were stored in an unusual way. The data type was written to disc first, followed by the data proper in three different styles. For example: each file created with the Teachback module consisted of integer values, numbers for the slides, and text strings for the captions. Integer data was preceded by the type byte - &40 - followed by four bytes for the number value. String data was preceded by the type byte - &00 - followed by the characters in the text in reverse order. Files created in this way use disc space very efficiently, but required that I write a special program to make them humanly readable. In most implementations of BASIC, the files created on disc can be typed to the screen. In BBC BASIC, this was not possible because the data was tokenised. A special algorithm was written to recover the data from the files. The skeleton of the algorithm was provided in the BBC Master Reference Manual, Part Two, 1986, K3-11. I used this program skeleton to write the program for recovering the data in the Teachback files.

This section has described the main tool for capturing learning strategies, the BBC AIV and software extensions to it. The next section describes how it was used in Step 2 to capture the learning strategies of the sample group of 12 subjects.

Learning Experiences

This section details the learning five tasks required of subjects. These tasks required subjects to learn how to use the BBC AIV and a number of software extensions to that system. They were organised to extend Pask's work in a natural setting, a secondary school geography class. Figure 15 summarises the tasks that engaged subjects in the learning process. In the next section (Tasks for Learners) an account is provided of the way in which these tasks were used to capture the learning strategies of the sample group of 12 subjects.

The group of subjects (n=12) was provided with incidental instruction on how to use the system during geography lessons in which the tasks were related to the current topic or theme of study, such as 'New Towns'. Each student was encouraged to spend up to two hours in class time over several sessions becoming familiar with the computer and software controls. During this time, subjects explored the range of information types stored on the video disc multimedia database -the BBC Domesday Advanced Interactive Video System. A simple task sheet, with a range of geographically related topics, was given to the subjects as a basis for an individual study of the information contained in the BBC AIV.

Students were asked to make a selection of a particular topic among the many they had seen. The topic was comprised text and image data (slides). The frame numbers, the name for the slide, and the caption were supplied by the BBC AIV and were recorded by the subjects as a basis from which to build the slideshow. To each image in a selected set, subjects added their own commentary in the form of up to four lines of text. Additional text could be added by requesting that the same image be screened two or more times.

Tasks for Learners

In Step 2, the second of the research questions - **'Can differences in learning strategies be identified in the record of student's learning activities?'** - was directly addressed. Records were made of the subjects learning strategies while they carried out five tasks. The assembled hardware - the BBC AIV, the associated software, and extension programs described above were used during these tasks to collect data about how the

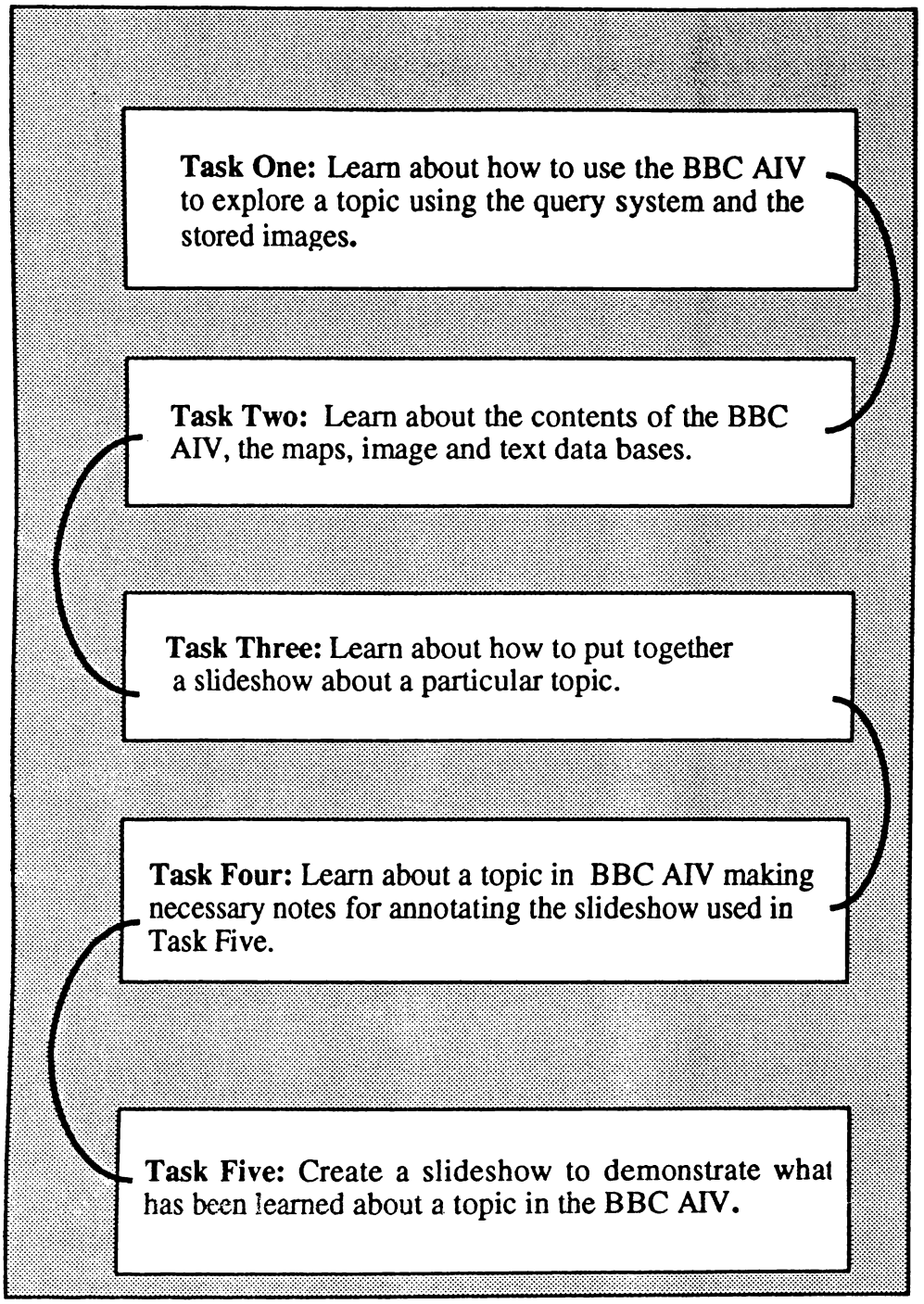

Figure 15. Five learning tasks, each of which provided a BBC AIV related learning experience for the subjects. These tasks were the basis of the interaction between subjects and the BBC AIV. The extension software captured the outcome of subjects' work as they completed the tasks.

subjects interacted with the system. As described briefly on pages 72-73 and Figure 15, page 81, the 12 subjects carried out these smaller tasks as a convenient way of partitioning the larger task of exploring how to use the system. Each task is described in the order subjects completed them.

Task 1

During this part of the research subjects learned how the BBC AIV could be used as a database. This task involved subjects interacting with the researcher and the system over a period of 1 to 3 hours. Task 1 was designed simply to familiarise the learner with the system and its search metaphors. The researcher adopted a participant observer role during a guided discovery approach to this interaction, providing information only as it was sought.

Task 2

During this task, the content being extracted by the learner from the system was of general geographical interest, and secondary to the process of learning how to use the system. In general, as little information as possible was offered to learners about how to carry out the actual tasks. A floppy disc record of this interaction was kept as a basis for comparison with later interactions. The data was recorded by the Scriptfile module and then read into the Lookit module. The record contained the steps subjects took while searching for data and the content of requests.

Task 3

For this task, subjects applied the knowledge acquired during the first part of the work. The task followed the overall steps detailed for Task 1 and included searching a selected portion of the database prior to focussing on a single topic. Students learned how to put together a slideshow using the Teachback module. The Scriptfile software was used to access the video disk frame number which was displayed for each image on screen. The intention was to establish whether the learner had grasped how to use the system, in a constrained search, independently. During this session further data on learning activities was recorded.

Task 4

Students next learned about a topic in Domesday. They recorded the frame number and a note about the content of the illustration in a record sheet.

This interaction was also recorded on floppy disc so that the search strategy used could be examined or replayed.

Task 5

The fifth task required the subjects to create a short captioned slideshow about a selected topic. Subjects were asked to 'teachback' what they knew of the topic learned in Task 4. They used the Versatile Teachback software to create a slideshow about the topic. Each slideshow contained between 10 and 20 slides, with captions added by subjects to indicate the nature of the content of the slide in relation to the topic. In this stage of the research, the Scriptfile module was again employed to record subjects' use of the BBC AIV.

The records of Task Five were analysed by extracting the text used by students to annotate their slideshows. This material is analogous to Pask's Teachback 'protocols' to which he applied a content analysis procedure.

In Chapter 2 it was pointed out that a continuum of behaviours involving sequences of learning activities have been identified in the literature. Pask used the terms 'holist' and 'serialist' to distinguish learning behaviours on any particular occasion in a particular context. He argued that people adopt these consistent behaviours over many tasks having similar contexts. People who adopt holist-like strategies were called comprehension learners, while people who adopt serialist-like strategies were called operation learners. Pask used the terms holist-like and serialist-like to refer to learning behaviours revealed through content analysis. His content analysis categories were:

1. falsehoods or corrected falsehoods
2. inventions
3. statements of information to come or delivered
4. statements deduced
5. irrelevant
6. redundant
7. total number of statements.

Pask (1975) used a different and less accessible set of indices for his detailed analysis of learning strategies. He was most obtuse in stating these indices, or criteria. I was unable to apply them for lack of a clear exemplar in Pask's work. A more detailed examination and discussion of these categories and criteria is provided in Chapter 4.

THE PHASE 1 DESIGN

STEP 3

Methods for Data Processing and Analysis

This step of the research procedures examined the following research question: **'What conclusions can be drawn from a comparison of preference responses and observed learning behaviour?'**

Data Processing Software

The records of subjects' learning behaviour were extracted by the Lookit program. The data from the questionnaire survey provided indicators of the range of subjects' preferences for particular approaches to learning tasks. The Macintosh Excel program was used to integrate the outcomes from the modified Ford preference questionnaire and the Teachback slideshows.

The software for analysing questionnaire responses was written using the Superbase relational database program on a Commodore Amiga 2000 computer. A database model was constructed with 30 fields. The data structure, and calculation formula for this database is shown in Figure 16. Information about the subject was keyed in directly from the questionnaire sheets. Data items 0 to 4 hold information about the person. To protect confidentiality of subjects' data, fields one and two were expunged from the data base search queries.

Processing of questionnaire responses was carried out at the time of data entry. A single character answer, representing one of the six possible responses for each question, was entered into the database. Because the questionnaire was designed to prevent subjects detecting pattern in their responses, a calculation formula converted the input data into values that could be further processed. Processed data was transferred, using communications software, from the Amiga to a Macintosh LC for further analysis using Microsoft Excel and Word 5.

The record of the way subjects completed tasks using the BBC AIV was processed also by moving it as a text file to a Macintosh LC and then into

```
FILE STATUS REPORT FOR SUPERBASE ANALYSIS PROGRAM

Current index: Choice1
File is valid              Record count: 254
Password:     No           Field count:  30
Privileges:   All          Index count:  20
Block size:   64 Bytes     File size:    45504 Bytes


Field name    Attributes    Format  Location  Formula

Fname                       TXT   1    0    0
Sname                       TXT REQ   10    1    0
Gender                      TXT        2    2    0
Age                         TXT   2    3    0
Questions                   TXT   60   4    0
Choice1                     TXT  CLC  REQ  IXD 3       5     0 >
Choice1  = "f" ? "H":Choice1 = "2" ? "h":Choice1 = "3" ?  "N/A":   Choice1 = "4" ? "s":Choice1 = "5" ? "S":Choice1 =
"6"?"V":Choice1
Choice2                     TXT        CLC  REQ  IXD 3       6     0 >
Choice2 = "1" ? "H":Choice2 = "2" ? "h":Choice2 = "3"? "N/A":   Choice2 = "4" ? "s":Choice2 = "5" ? "S":Choice2 =
"6"?"V":Choice2
Choice3                     TXT        CLC        REQ  IXD 3       7     0 >
Choice3 = "1" ? "H":Choice3 = "2" ? "h":Choice3 = "3"? "N/A":   Choice3 = "4" ? "s":Choice3 = "5" ? "S":Choice3 =
"6"?"V":Choice3
Choice4                     TXT        CLC        REQ  IXD 3       8     0 >
Choice4 = "1" ? "S":Choice4 = "2" ? "s":Choice4 = "3"? "N/A":   Choice4 = "4" ? "h":Choice4 = "5" ? "H":Choice4 =
"6"?"V":Choice4
Choice5                     TXT        CLC        REQ  IXD 3       9     0 >
Choice5 = "1" ? "H":Choice5 = "2" ? "h":Choice5 = "3"? "N/A":   Choice5 = "4" ? "s":Choice5 = "5" ? "S":Choice5 =
"6"?"V":Choice5
Choice6                     TXT        CLC        REQ  IXD 3       10    O >
Choice6 = "1" ? "S":Choice6 = "2" ? "s":Choice6 = "3"? "N/A":   Choice6 = "4" ? "h":Choice6 = "5" ? "H":Choice6 =
"6"?"V":Choice6
Choice7                     TXT        CLC  REQ        IXD 3       11    O >
Choice7 = "1" ? "H":Choice7 = "2" ? "h":Choice7 = "3"? "N/A":   Choice7 = "4" ? "s":Choice7 = "5" ? "S":Choice7 =
"6"?"V":Choice7
Choice8                     TXT        CLC        REQ  IXD 3       12    0 >
Choice8 = "1" ? "H":Choice8 = "2" ? "h":Choice8 = "3"? "N/A":   Choice8 = "4" ? "s":Choice8 = "5" ? "S":Choice8 =
"6"?"V":Choice8
Choice9                     TXT        CLC        REQ  IXD 3       13    0 >
Choice9 = "1" ? "S":Choice9 = "2" ? "s":Choice9 = "3"? "N/A":   Choice9 = "4" ? "h":Choice9 = "5" ? "H":Choice9 =
"6"?"V":Choice9
Choice10                    TXT        CLC        REQ  IXD 3       14    0 >
Choice10 = "f" ? "S":Choice10 = "2" ? "s":Choice10 = "3" ? "N/A":Choice10 = "4" ? "h":Choice10 = "5" ? "H:Choice10 =
"6"?"V":Choice10
Choice11                    TXT        CLC        REQ  IXD 3       15    0 >
Choice11 = "f" ? "S":Choice11 = "2" ? "s":Choice11 = "3" ? "N/A":   Choice11 = "4" ? "h":Choice11 = "5" ? "H:Choice11 =
"6"?"V":Choice11
Choice12                    TXT        CLC        REQ  IXD 3       16    0 >
Choice12 = "1" ? "H":Choice12 = "2" ? "h":Choice12 ="3" ? "N/A":Choice12 = "4" ? "s":Choice12 = "5" ? "S:Choice12 =
"6"?"V":Choice12
Choice13                    TXT        CLC        REQ  IXD 3       17    0 >
Choice13 = "1" ? "H":Choice13 = "2" ? "h":Choice13 ="3" ? "N/A":Choice13 = "4" ? "s":Choice13 = "5" ? "S:Choice13 =
"6"?"V":Choice13
Choice14                    TXT        CLC        REQ  IXD 3       18    0 >
Choice14 = "1" ? "H":Choice14 = "2" ? "h":Choice14 ="3" ? "N/A":Choice14 = "4" ? "s":Choice14 = "5" ? "S:Choice14 =
"6"?"V":Choice14
Choice15                    TXT        CLC  REQ  IXD 3       19    O >
Choice15 = "1"  ? "H":Choice15 = "2" ? "h":Choice15 ="3" ?"N/A":Choice15 = "4" ? "s":Choice15 = "5" ? "S:Choice15 =
"6"?"V":Choice15
Choice16                    TXT        CLC        REQ  IXD 3       20    0 >
Choice16 = "1"  ? "H":Choice16 = "2" ? "h":Choice16 ="3" ?"N/A":Choice16 = "4" ? "s":Choice16 = "5" ? "S:Choice16 =
"6"?"V":Choice16
Choice17                    TXT        CLC        REQ  IXD 3       21    0 >
Choice17 = "1"  ? "S":Choice17 = "2" ? "s":Choice17 ="3" ?"N/A":Choice17 = "4" ? "h":Choice17 = "5" ? "H:Choice17 =
"6"?"V":Choice17
Choice18                    TXT        CLC        REQ  IXD 3       22    0 >
Choice18 = "1"  ? "S":Choice18 = "2" ? "s":Choice18 ="3" ?"N/A":Choice18 = "4" ? "h":Choice18 = "5" ? "H:Choice18 =
"6"?"V":Choice18
Choice19                    TXT        CLC        REQ  IXD 3       23    0 >
Choice19 = "1" ? "S":Choice19 = "2" ? "s":Choice19 = "3" ? "N/A":Choice19 = "4" ? "h":Choice19 = "5" ? "H:Choice19 =
"6"?"V":Choice19
Choice20                    TXT        CLC        REQ  IXD 3       24    0 >
Choice20 = "1" ? "S":Choice20 = "2" ? "s":Choice20 = "3" ? "N/A":Choice20 = "4" ? "h":Choice20 = "5" ? "H:Choice20
= "6"?"V":Choice20
Diary                       DAT  REQ  dd mmm yyyy      25    0
Phase                       TIM       REQ  hh:mm am          26    0
FIC                         NUM              99 .           27    0
Comp                        TXT               4             28    0
Numbers                     NUM CON      999.               29    0
```

Figure 16. Data dictionary for analysing the questionnaire responses. The data structure for the Superbase analysis program included the calculation formula for determining holist-like and serialist-like preferences.

Excel and Word for further analysis. This data provided evidence about actual behaviour. Statistical analysis by comparison of the two sets of data - questionnaire responses and BBC AIV data - was undertaken to establish the extent to which observed behaviour could be predicted from questionnaire preference data. Recall that this was suggested by Question 3 derived from Ford's work. The comparison was carried out by ordering the data for each subject on the basis of number-of-extension-items discussed in Chapter 4. The ordered data were compared for agreement or disagreement with the preference questionnaire predictions. Tabular and graphical data was presented. Results from the comparison are provided in Chapter 4.

THE PHASE 2 DESIGN

STEP 4

The Matching Question

At the close of Step 3, it became evident that serious unforeseen constraints on the intended research design meant that adaptations were required to the intended research activities. The necessity for these adaptations was an emergent aspect of the research and fundamentally concerned extending the boundaries of current knowledge. This aspect of the research was not evident at the outset. The views of both Pask (pers. comm., and in Schmeck, 1988) and followers of Turing's work (in Herken, 1988) expressed confidence in the eventuality of person-machine interaction analogous to human conversation. More generally there was, and still is, a whole cohort of computer scientists actively working on the assumption, succinctly put by the more recent commentator Partridge (1991, 506), as 'AI (artificial intelligence -implying machines doing what people do) is a winner'.

The key question addressed in Step 4 was: **'Can a computer match strategies with the learner's preferred strategy'?** The main problem that emerged through experience in using the BBC AIV was that it seemed the inquiry strategy employed by the learner could not be controlled by the teacher, because the BBC AIV was in read-only format. This meant that the teacher could not selectively remove irrelevant parts of the database, or change the response strategies, or carry out any of the desired changes required to test

the 'match-mismatch hypothesis', while still using the BBC AIV query software. I had hoped to overcome these limitations which are not addressed in the literature in the form used in this thesis.

In addition, the BBC AIV was built on a number of epistemological assumptions about how knowledge should be organised. No information was provided with the system about this organisation of knowledge. It may be that the people who constructed the system were not aware of the impact particular organisations of learning material has on users. Finally, the BBC AIV's hierarchical organisation meant the learner must access the data from the system in a strictly linear way.

Pask's person-to-person laboratory work enabled him to maintain the very strict control over the content and concept structure needed to carry out matching and mismatching activities. Unfortunately, the practical constraints identified above, and the theoretical constraints outlined later in Chapter 5, meant that I was not able to write a program that would detect the strategy a student was using while any learning activity was going on with the BBC AIV. It was essential to identify this strategy because it could provide a basis for machine matching or mismatching subsequent material. Initially, the matching of subjects' learning strategies with teaching strategies was intended to enhance learning. Changes were not able to be made to the database to test Pask's assertion that mismatching inhibits learning. It was not possible to overcome the limitations of the BBC AIV. The step of testing the matched-mismatched hypothesis remained untested because the BBC AIV could not be modified while still retaining its interactive attributes.

THE PHASE 2 DESIGN

STEP 5

Searching the Philosophical Literature

The limitations identified in Step 4 led to a further examination of the literature, and a theoretical investigation of the matching problem identified in Question 4. The investigation concentrated on the literary record of attempts to use a computer to carry out matching tasks and subsequently on the nature

of decision problems. The key question followed up through a literature search and the reflective analysis in Step 5 is: '**Can a computer be a conversant'?**

Relevant literature about a computer acting as a conversant was traced to Turing's (1950) paper and more recent commentary located in Winograd and Flores (1986) and Herken's (1988) work on computers and cognition. Winograd and Flores work drew on philosophical research into the nature of cognition and involved questions about the perception of reality. Common references in recent geographical work to Wittgenstein's (1968) *Philosophical Investigations* suggested the inclusion of an examination of the basis of modernism in geography -the study of reality at the human scale. The nature of the school classroom based investigation of Steps 1, 2 and 3 clearly placed my research in the context of education also reflected in Pask's research. Findings from the philosophical sources were integrated with Pask's (1976c) work. Outcomes from Phase 2 of the research, that is Steps 4 and 5, consist of a theoretical discussion linking work in education, geography, philosophy, and social science and extending this discussion into computer science theory in Chapter 5.

Chapter 4 describes the outcomes of Phase 1, Steps 1, 2 and 3 of the research design. Outcomes from this phase take a number of forms. A number of new tools were developed which were new software modules form the BBC AIV. The outcomes of Phase 2 of the research are presented in Chapter 5 and take the form of theoretical discussions which help to explain the difficulties encountered in Phase 1 of this study.

CHAPTER 4

OUTCOMES: THE PHASE 1 RESEARCH DESIGN

Outline: Findings for Phase 1 of the research on the identification of individual differences in learning strategy are reported in three sections. First, results are given from the administration of a modified version of Ford's (1985) questionnaire to a small sample of Geography students (n=12), as well as to a larger sample of students and staff (n=195). Second, a description is provided of how the small group of Geography students (n=12) learned about and used the extended BBC AIV to complete an annotated Teachback slideshow. The slideshow was about a curriculum related aspect of senior school geography. The third section compares the data from the preference questionnaire with the data from the records of the students' interaction with the BBC AIV.

This study adopted Pask's (1975) theory on learning strategies as a model for investigating differences in classroom based learning. The research design discussed in Chapter 3 outlined a series of research questions and activities which brought together specific tools to address the questions raised in the first phase of a two-phase design. These tools (a questionnaire and a computer based learning environment - the BBC AIV) were used to identify individual differences in learning strategies in the school context. It was believed that if the observed behaviour of students could be linked to their preferences for learning strategies, and that if these strategies were adopted consistently, then matching learning and teaching strategies on the basis of preferences could be a step towards enhanced learning.

PHASE 1

OUTCOMES FOR STEP 1

Learning Strategy Preferences

The research question addressed here was:

> **Can a range of peoples' preferences for learning strategies be identified using Ford's questionnaire?**

The aim in using Ford's questionnaire was to identify the range of subjects' preferences for particular learning activities. In aggregate, the nature of this range might indicate the pattern of subjects' preferences for holist-like or serialist-like learning strategies. It was also hoped that the nature of the range of preferences could help shed light on the importance of strategy-related aspects of classroom learning behaviour. It was intended to use the place of a student in the range as a way of providing matched learning experiences which, Pask (1975) predicted, would enhance learning.

The Sample Classroom Group Survey

Subjects' responses from the preference questionnaire surveys are presented in a series of figures. The results from the sample classroom group survey are presented first, followed by the school-wide survey. The twelve senior geography students who made up the classroom survey group responded to a modified version of Ford's questionnaire. In Figure 17 these subjects are listed in the left-most column as S1 to S12. Subjects' age is listed next, followed by 20 columns which record each subject's response to each of 20 questions. The sum of these responses is shown in the second last column. The rows in Figure 17 record the respondents' preferences for how each questionnaire item should be answered. The sum of the preferences in each row provides an indication of the overall preference of each subject for

	Age	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13	Q14	Q15	Q16	Q17	Q18	Q19	Q20	SUM	Prefs
S1	17	2	4	5	5	5	4	5	5	4	5	4	5	4	4	4	2	5	5	5	4	86	H
S2	17	2	4	5	3	4	3	2	3	1	5	2	5	3	3	2	4	5	3	3	5	67	H
S3	17	2	4	5	1	1	4	2	4	2	4	3	3	5	3	4	3	3	3	3	5	64	h
S4	17	3	3	4	4	4	4	3	4	4	3	2	4	4	3	3	4	2	2	2	1	63	h
S5	18	1	5	1	5	2	4	3	5	5	4	2	5	4	4	2	4	4	1	1	1	63	h
S6	17	3	5	4	5	1	4	2	4	3	3	3	2	4	3	4	4	1	1	3	4	63	h
S7	17	4	4	2	4	4	4	1	4	2	2	2	2	4	4	1	2	2	2	4	5	59	s
S8	17	1	5	5	5	2	4	1	4	1	4	4	3	3	2	1	5	3	1	3	1	58	s
S9	17	2	5	4	5	1	4	2	3	1	4	2	2	3	5	1	5	1	1	3	4	58	s
S10	17	1	5	3	4	3	2	3	2	2	3	3	2	4	3	4	4	1	1	3	4	57	s
S11	17	2	4	4	2	2	2	2	4	2	4	2	5	2	2	2	4	4	1	2	4	56	s
S12	17	2	3	3	3	2	5	2	3	1	3	3	3	3	3	1	2	4	2	3	2	53	S
		25	51	45	46	31	44	28	45	28	44	32	41	43	39	29	43	35	23	35	40		
		S	H	S	H	S	H	S	H	S	H	S	H	H	h	s	H	s	S	s	h		

Figure 17. Raw preference data for the sample classroom group. The questionnaire responses have been summed by rows and columns. Row totals indicate whether the person preferred holist-like strategies or serialist-like strategies. The column totals are an indicator of how the subjects, as a group, thought the questionnaire items should be approached. The H/S preference columns indicate an overall assessment of the strategy preference of the learner.

holist-like or serialist-like strategies for approaching the learning tasks encapsulated in each questionnaire item. For example, Subject 1 chose predominantly holist-like approaches to the 20 questionnaire items. Subject 12, on the other hand, chose predominantly serialist-like approaches to the questionnaire items. The overall contrast in these two extreme cases is highlighted in the total scores for the sum of their responses (86 and 53 respectively).

Summaries of the total behaviour patterns of these contrasted learners were built up from the collected responses to the questionnaire items. For example:

Subject 1, a person with a holist-like preference would tend to:

> select and read only the parts of the textbooks relevant to personal interests. When collecting information for assigned work this person would be eclectic in resource material selection, combing all available sources before beginning to work at the learning task. The search process would include much browsing with little apparent progress while a grasp of the whole of the topic suggested by the resources was

> achieved. When preparing for examinations the material would be ordered, but with respect to a self-imposed structure that may be idiosyncratic. Exam preparation may seem uncoordinated and 'butterfly-like' as the learner moved from topic to topic. Once a total grasp had been achieved the person would focus on details. Conversation with other people would tend to be in generalities, perhaps spiced with anecdote and visual imagery. Complex ideas may be summarised with pictures and sketches which link together many ideas seen as a coherent whole. The holist-like thinker values creativity, general principles, and subscribes to a view of the connectedness of knowledge. Overall, the holist is a 'hunter and gatherer of knowledge within a knowledge ecosystem'.

An exemplar for a person using the learning patterns of the holist thinker would be R. Buckminster Fuller.

Subject 1, the holist-like thinker, stands in contrast with Subject 12, a person with a serialist-like preference. A person with a serialist-like learning strategy preference would tend to:

> read every page of the set textbooks relevant to courses of study. When collecting information for assigned work, this person would stick strictly to the required items for the learning task. There would be a search process confined to acquiring the details of each aspect of the topic required by the boundaries of the context. When preparing for examinations, material would be ordered in the same sequence as it was taught. Exam preparation would be highly focussed on sequence and process aspects of the content. Once a topic had been assigned, the person would focus on details to exclusion of all else. Conversation with other people would tend to be in details shed of complexity and often abstracted from context. Complex ideas would be described by taxonomic descriptions. Taxonomy would be used to link together many ideas seen as a coherent whole. The serialist values certainty and subscribes to a view that

knowledge is divisible. Overall, the serialist is the 'millet farmer of knowledge within a knowledge ecosystem'.

An exemplar for a person using serialist-like strategies is Aristotle.

For the classroom group as a whole, data shown in the columns of Figure 17 may be viewed as a type of 'vote' for a particular learning strategy related to each questionnaire item. The data for the outcome of this vote are listed in the second to last row in Figure 17 for the sample group by summing the subjects' preferences for each question down a column from Subject 1 to Subject 12. For example, Question 1 could be viewed as 'How should the task of reading a recreational book be approached?' Question 2 could be seen as ' How should the task of reading a textbook be approached?' The majority of subjects saw these questions as being best approached serially for Q1 and in a holist-like way for Q2.

The values representing holist and serialist responses to the questionnaire are presented as 3D columns in Figure 18. These values are a count of the times when either holist or serialist strategies were selected by a subject. To enhance clarity in this diagram, 'No-preference' responses have not been shown. The columns illustrate clearly that subjects select a variety of strategies depending on the context, although for most subjects one strategy is chosen more often than the other. The overall pattern in Figure 18 shows a transition from predominantly holist-like responses to the left, to more serialist-like responses to the right. With the exceptions of Subjects 1 and 12, however, subjects chose at least 8 holist-like alternatives. Serialist-like items were less often chosen and rarely form more than half of the responses. This distribution of preference choices indicates the perception of the group that holist-like strategies were required for the set of tasks described in questionnaire items.

In Figure 19 (which represents a further level of description derived from Figure 17), the five-point scale was translated into positive and negative numbers and the signed values used to designate holist-like and serialist-like preferences. These values have been sorted in column order from highest (to the right) to lowest (to the left). The 'Sum of the prefs' row and the 'Ave of Prefs' row containing the arithmetic average of the sum of the preferences were sorted on the same basis. Each item in the 'Ave-3' row was examined

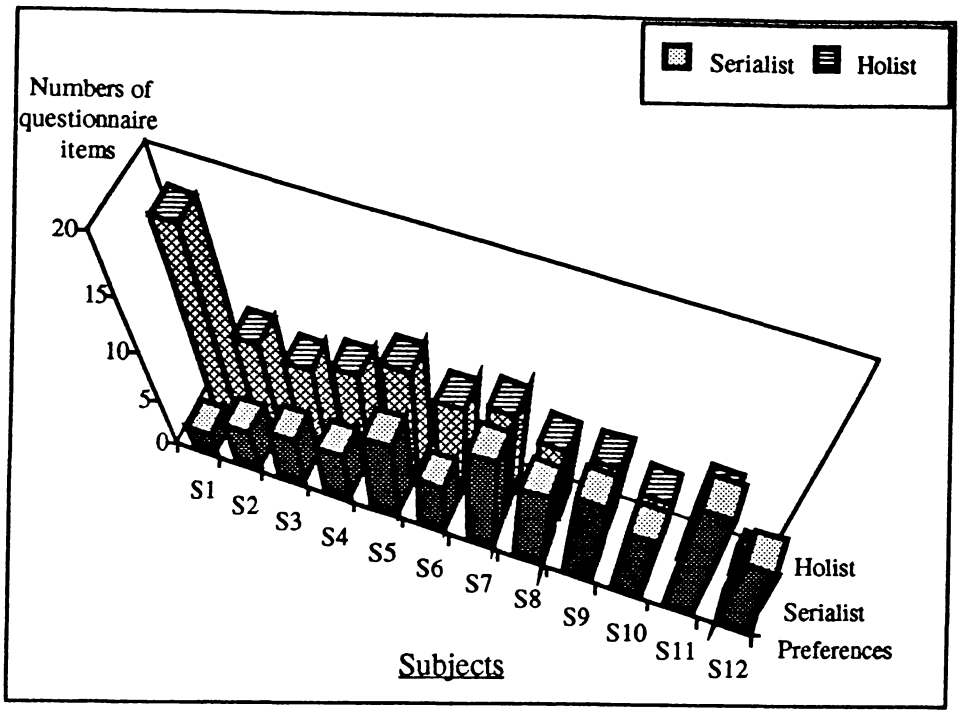

Figure 18. The ranked sum of holist-like and serialist-like preferences are shown as 3D columns (see Figure 17). The most holist-like questionnaire responses are shown to the left of the graph while the most serialist-like responses are shown to the right. Neutral responses have been removed for clarity.

for sign, either positive or negative. Values from zero to 0.5 were assigned 'h' for holist. Values over 0.5 were assigned 'H'. Zero values indicate no predominant preference and were assigned 'N'. Values between zero and -0.5 were assigned 's'. The remaining negative values were assigned 'S'. The summary value (Ave-3) is the overall preference of the people in the classroom sample group as to how each question in the questionnaire should be approached. Ave-3 is shown in the fourth row of Figure 19.

Quest	2	4	3	8	6	10	13	16	12	20	14	17	19	11	5	15	7	9	1	18
Sum	51	46	45	45	44	44	43	43	41	40	39	35	35	32	31	29	28	28	25	23
Ave	4.3	3.8	3.8	3.8	3.7	3.7	3.6	3.6	3.4	3.3	3.3	2.9	2.9	2.7	2.6	2.4	2.3	2.3	2.1	1.9
Ave-3	1.3	0.8	0.8	0.8	0.7	0.7	0.6	0.6	0.4	0.3	0.3	-.1	-.1	-.3	-.4	-.6	-.7	-.7	-.9	-1.1
Pref	H	H	H	H	H	H	H	H	h	h	h	s	s	s	s	S	S	S	S	S

Figure 19. Summed preferences for the sample classroom group. The data has been ordered by preference from most holist-like to the left to most serialist-like to the right. H and h indicate holist-like preferences while S and s indicate serialist-like preferences.

The range of preferences may be seen in the sum of the preference values for each subject. This value is shown in Column 23 in Figure 17. For the sample classroom group, this range extends from 53 to 86. Assuming that subjects had no strategy preference, the extent of the range would be very small, perhaps under 5, greater or less than a 'no-preference' value of 60. Under this assumption, the value for the 'no-preference' option was calculated by summing a value of 3 for each of the 20 questionnaire items. Therefore, if all students had selected 'no-preference', or if selections had been distributed about a 'no-preference' mean, then a sum-of-preference-items of about '60' would be expected.

In contrast, a very extreme serial preference would be reflected in a minimum total of 20 found by summing a value of 1 for each of the 20 questionnaire items. A sum of 100 (5 times 20) would be obtained by a subject who selected totally holist approaches. These values gave a range of 80, 40 above and below the expected no-preference value of 60. Values between the extremes would indicate mixtures of holist-like and serialist-like preferences. The sample classroom group declared overall preferences, from Figure 17, that were distributed about the median value of 60 (sample classroom group range of 33, with a maximum of 86 and a minimum of 53). The sum of preferences of most subjects was within seven of the value of the 'no-preference' assumption. The one very high value (86), belonging to Subject 1, is of particular interest and will be returned to again in Step 3.

The Whole School Questionnaire Survey

Data from the whole school group, which also responded to the Ford questionnaire, are displayed in Figure 20. It shows four sections from the full data set listed in Appendix A. Although all 300 school members were offered the questionnaire, 195 responses were completed in a useable form. The whole school group questionnaire responses were tabulated and examined by ranking to establish the range of learning strategy preferences. Indicators of the nature of this range were found in extremes of the sum of subjects' preferences and in the way the sums of the preferences were distributed. Assuming that subjects had no strategy preference, the extent of the range would be very small, perhaps under 5. Under this assumption, the expected range was calculated by summing a value of 3 for each of the 20

		Questions																				Sum	Pref
F/M	Yr	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20		
f	17	2	4	5	5	5	4	5	5	4	5	4	5	4	4	4	2	5	5	5	4	86	H
m	40	5	3	5	5	5	5	3	5	5	1	5	5	5	5	3	5	5	5	1	3	84	H
m	18	1	5	3	1	1	5	5	1	5	5	3	5	5	3	5	3	3	1	1	1	62	h
m	17	1	5	1	1	1	3	3	5	5	1	3	1	5	5	5	5	1	5	5	1	62	h
m	16	1	1	5	5	1	5	1	1	1	5	3	5	1	5	1	5	5	5	5	1	62	h
m	16	1	5	1	3	5	5	5	3	1	5	1	3	5	5	1	5	1	1	5	1	62	h
f	16	2	2	5	4	5	4	4	2	1	2	1	5	4	2	2	5	1	2	4	2	59	s
f	16	5	4	5	1	5	1	4	4	3	1	4	1	1	1	2	5	1	1	5	5	59	s
f	16	5	5	3	4	3	1	4	3	2	3	3	1	5	5	1	5	1	1	3	1	59	s
f	14	2	5	3	3	4	3	2	4	2	4	2	5	4	2	3	2	2	2	4	1	59	s
m	15	1	1	1	1	5	1	1	1	1	3	1	3	1	3	3	5	1	5	3	1	42	S
m	15	1	1	1	1	5	1	1	1	1	3	1	3	1	3	3	5	1	5	3	1	42	S
m	15	3	5	1	1	1	5	3	1	1	3	1	1	1	3	1	1	1	3	3	1	40	S
Quest		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20		
Prefs		452	722	711	585	594	639	514	604	508	642	597	650	690	586	588	671	548	548	603	610		

Figure 20. A section of the whole school group questionnaire preferences. The complete listing is provided in Appendix A as responses (n=195) to Questionnaire items (n=20).

questionnaire items. In a similar way to the sample classroom group, if all of the whole school group had selected no particular preference, or if selections had been distributed about a 'no preference' mean, then a sum of preference items of about '60' would be expected. A person with this sum of preference items would be described as totally serial in their approach to learning. A sum of 100 would be obtained by a subject who selected totally holist-like approaches. These values gave a range of 80, 40 above and below the expected no-preference value of 60 in the same fashion as the sample classroom group. Values between the extremes would thus indicate mixtures of holist-like and serialist-like preferences. The whole school group declared overall preferences that were distributed more evenly about the median of 60 than the sample classroom group (whole school group range of 24 below and 26 above 60, respectively). The spread was about what would be expected for a larger group and demonstrated the effect of averaging on the range of values.

To illustrate this point, the questionnaire data were further analysed in Figure 21. The items in the columns of Figure 21 are the sum of the preferences of the whole school group for holist-like or serialist-like approaches. These data were sorted on column order from most holist-like towards the left of the table to most serialist-like towards the right. In this

figure, the sum was further analysed. The 'Ave-3' row was listed because subtracting 3 from each preference average facilitated graphing of holist-like preferences as positive values while serialist-like preferences were shown as negative values. This step made the contrast between holist and serialist preferences clear because the values lie above (holist-like) and below (serialist-like) the horizontal axis (Figure 23).

Quest #	2	3	13	16	12	10	6	20	8	19	11	5	15	14	4	17	18	7	9	1
Sum	722	711	690	671	650	642	639	610	604	603	597	594	588	586	585	548	548	514	508	452
Ave	3.7	3.6	3.5	3.4	3.3	3.3	3.3	3.1	3.1	3.1	3	3	3	3	3	2.8	2.8	2.6	2.6	2.3
Ave-3	0.7	0.6	0.5	0.4	0.3	0.3	0.3	0.1	0.1	0.1	0	0	0	0	-.2	-.2	-.4	-.4	-.7	-1
H/SPref	H	H	H	h	h	h	h	h	N	N	N	N	N	N	N	s	s	s	s	S

Figure 21. Summed preferences for the whole school group. The data has been ordered by preference from most holist-like to the left to most serialist-like to the right. H and h indicate holist-like preferences and S and s indicate serialist-like preferences.

Comparison of Sample Classroom and Whole School Groups

Examination of the columns of data in Figure 17 (the sample classroom group) and Appendix A (the whole school group) showed the expected wide variations in the preferences people say they hold for the strategies reflected in the questionnaire items. This generalisation applied at the group and individual level.

Questionnaire items identified in the preference questionnaire responses as requiring similar approaches by both the sample group and the larger population are shown in Figure 22. The most outstanding feature of Figure 22 is the similarity of preferences people record across 10 of the 20 items. This feature of the responses to the survey is also shown by graphing the 'votes' for both groups as was shown in Figure 23.

Figure 18. Sample Classroom Group's preferences for approaches to tasks (n=12).

Quest #	2	3	13	16	12	19	11	5	17	1
Ave-3	1.3	0.8	0.6	0.6	0.4	0	0	0	0	-1

Figure 20 Whole School Group's preferences for approaches to tasks (n=195).

Quest #	2	3	13	16	12	19	11	5	17	1
Ave-3	0.7	0.6	0.5	0.4	0.3	0.1	0	0	0	-1

Figure 22. Comparison of questionnaire responses which showed strong agreement between sample classroom group and the whole school group.

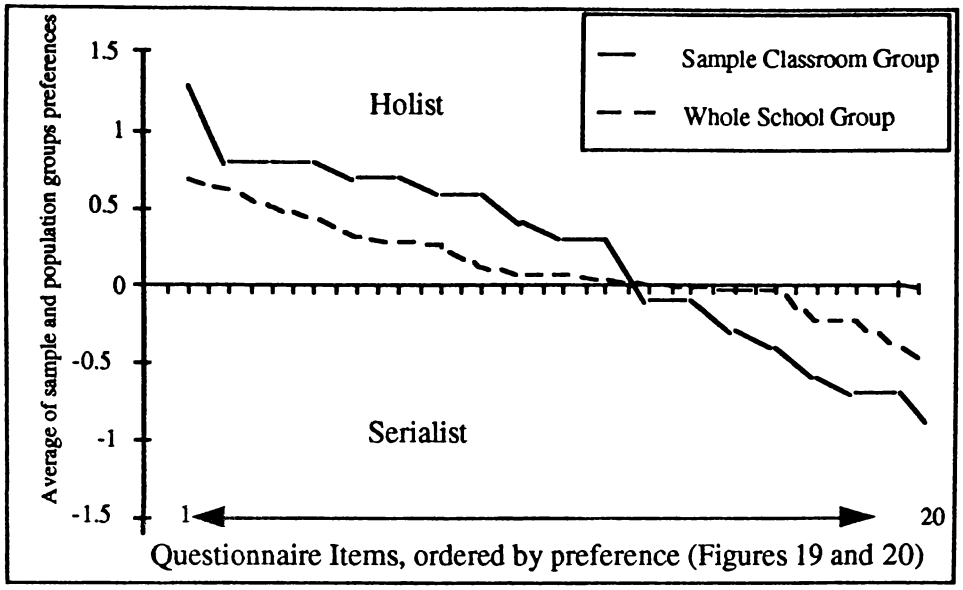

Figure 23. A comparison of the preferences of sample classroom group and whole school group 'votes' for holist-like and serialist-like strategies to questionnaire items.

The differences in slope of the lines graphed in Figure 23 were those that would be expected in any comparison between a sample classroom group and the whole school group. Since the slope of the lines in the graph in Figure 23 is in a similar direction, it can be concluded that the two groups had a similar range of preferences.

The second feature is the distribution of preferences of people in the sample group who select items reflecting holist-like strategies. The sample group's responses to more than half of the questions were clearly holist-like in the Figure 17 preference row. Differences were noted in the data of the sample classroom group and the whole school group in that some tasks in the questionnaire were viewed differently. Evidence for this is seen in the changed perception of focus in approach to learning (Q4, 66) in Figures 19 and 21. A longitudinal study may establish whether the shift from a neutral preference to a strongly holist preference was peculiar to the sample classroom group or was a characteristic of learners moving through a school experience over a number of years.

The questionnaire responses in Figure 17 give a clear indication that people do have a range of preferences for approaching learning tasks. A statistical calculation was carried out to establish the correlation coefficients for each of the questionnaire data items. The intention in carrying out this

type of analysis was to test whether there was a statistical relationship approaching significance between each of the distributions of data items.

Correlations between 'votes' for learning strategies, as reflected in questionnaire responses, were carried out using the Pearson's Product Moment Correlation. This statistical procedure enables comparisons of the way variations in two or more sets of data are distributed. A positive correlation of 1 would mean that an increase in one data item would result in an increase, of the same magnitude, in the other data item. On the other hand, a negative correlation of -1 would indicate that as values in one data set increased in magnitude, items in a second data set decreased by the same magnitude. Data following the first example would be described as positively correlated while data in the second example is termed negatively correlated. Figure 24 shows the correlations for the sample classroom group.

If it is accepted that Pask is correct, and people do adopt consistent learning strategies, then correlations between items requiring similar strategies could have been expected. The data in Figure 24 did not provide confirmation of the expected consistency of strategy from one problem context to another. A range of possible explanations for the failure of my research to support Pask's findings are that Ford's questionnaire was not sensitive enough to identify fine grained learning strategies. Shifting the focus to the tasks, it may be that subjects' learning strategies were not able to be discriminated because the tasks set did not either force or permit subjects to adopt their preferred strategy.

Correlations which are interestingly large are listed in bold font in Figure 24. However, the outcomes should be treated as no more than indicators. For example, age is negatively correlated with Q3 and Q19, but positively correlated with Q9. In both instances, the correlation accounts for more than 30% of the variance. Since age varies by only 1 point (subjects are aged 17 and 18) these correlations are spurious. The higher correlations were found between the following question pairs with the holist-like description given first followed by the serialist-like description next:

- 5 and 18: dealing with picture of the whole of the topic and principles first, details later (holist-like strategy). Or, division into parts and learning one aspect at a time (serialist-like strategy).

Question	AGE	Q1	Q2	Q3	Q4	Q5	Q6	Q7
Q1	-0.379							
Q2	0.313	-0.435						
Q3	**-0.672**	-0.059	-0.117					
Q4	0.275	-0.063	0.496	-0.238				
Q5	-0.133	0.250	-0.415	0.038	0.156			
Q6	0.118	0.265	-0.272	-0.080	0.255	-0.124		
Q7	0.196	-0.220	-0.112	0.066	0.232	0.471	-0.064	
Q8	0.455	0.146	-0.035	-0.061	0.196	0.133	0.355	0.293
Q9	**0.613**	0.049	0.000	-0.360	0.331	0.273	0.100	**0.659**
Q10	0.118	-0.531	0.136	0.557	-0.051	0.099	-0.154	0.414
Q11	-0.270	-0.346	0.155	0.453	0.204	0.028	0.219	0.254
Q12	0.380	-0.263	-0.299	0.121	-0.164	0.406	-0.182	0.474
Q13	0.165	0.180	0.038	-0.111	0.014	0.076	0.301	0.285
Q14	0.273	0.204	0.174	-0.346	0.432	0.095	0.355	0.293
Q15	-0.100	-0.032	0.069	0.283	-0.112	0.105	-0.260	**0.603**
Q16	0.121	-0.427	0.584	0.179	0.261	-0.431	-0.347	-0.261
Q17	0.227	-0.263	-0.381	0.176	-0.279	0.376	0.045	0.300
Q18	-0.233	0.170	-0.462	0.441	-0.174	**0.616**	0.220	0.569
Q19	**-0.606**	0.313	-0.091	0.407	0.125	0.436	0.171	0.198
Q20	-0.455	0.354	0.075	0.262	-0.393	0.068	-0.360	-0.070
SUM	0.028	0.045	-0.053	0.373	0.229	0.562	0.109	**0.750**

	Q8	Q9	Q10	Q11	Q12	Q13	Q14	Q15
Q9	**0.689**							
Q10	0.237	0.025						
Q11	0.135	-0.057	0.219					
Q12	0.500	0.421	**0.677**	-0.119				
Q13	0.232	0.474	-0.215	0.196	-0.255			
Q14	0.091	0.230	0.000	-0.270	-0.180	0.298		
Q15	0.100	0.472	0.130	0.327	0.048	**0.619**	-0.100	
Q16	-0.218	-0.143	0.221	-0.180	-0.059	-0.326	-0.170	-0.123
Q17	0.401	0.103	**0.658**	0.129	**0.848**	-0.260	-0.192	-0.119
Q18	0.317	0.178	0.468	0.345	0.415	0.331	0.190	0.359
Q19	-0.026	-0.244	0.069	0.547	-0.249	0.182	0.237	0.168
Q20	-0.260	-0.342	0.085	-0.121	-0.200	0.118	0.195	0.272
SUM	0.542	0.509	0.580	0.372	0.481	0.369	0.288	0.521

	Q16	Q17	Q18	Q19	Q20
Q17	-0.358				
Q18	**-0.637**	0.580			
Q19	-0.540	0.056	**0.656**		
Q20	-0.277	-0.062	0.333	0.528	
SUM	-0.324	0.444	**0.832**	0.519	0.199

Figure 24. Correlation coefficients for questionnaire responses of the sample classroom group. These responses were summed and compared question by question with the each other using Minitab, a statistical analysis program. Bold items are discussed in the text.

- 7 and 9: ordering material to see how it fits into a pattern and learning a number of topics at the same time. Or, following another person's order of presentation in which only a few aspects are presented at any one time.

- 7 and 15: ordering material to see how it fits into a pattern and inventing new ways of looking at topics. Or, following another person's order of presentation in which examples are selected from textbooks.

- 7 and the 'sum': ordering material to see how it fits into a pattern and adopting an overall holist approach. Or, following another person's order of presentation in a serialist-like way.

- 8 and 9: skipping about in resource material to get a clear idea of the main ideas in a range of topics. Or, focussing on the details of a few ideas at any one time.

- 10 and 12: attempting to understand the overall organisation of the topic before dealing with the details. Or, grasping the details in a sequential order as the material is learned.

- 10 and 17: attempting to understand the overall organisation of the topic as connected subject matter. Or, grasping the details in a sequential order as a whole lot of smaller separate bits.

- 12 and 17: able to learn from material that covers many topics in a single session where everything can be connected together. Or, able to work confidently with ordered material that is carefully structured for ease of understanding.

- 13 and 15: learns well when stories and anecdotes are added to the learning situation whether these are told by others or self created. Or, able to stick closely to taught content, accepting examples given in text material.

- 16 and 18: uses pictures and visual imagery to grasp and build on topic content, returns later to learn details. Or, prefers describing learned material and principles rather than building on them.

- 18 and 19: is creative and prefers working with principles rather than details. Or, prefers working with one item at a time in a logical way.

- 18 and 'sum': is creative and prefers working with principles where there is no limit on what is learned. Or, prefers learning in a bounded way where limits are clear.

The questionnaire responses obtained by Ford (1985) were confirmed by this adaptation of his questionnaire in only one pair of items: Q8 and Q9 which refer to the following related items:

> skipping around data to give a clear picture of ideas or moving from one detail to another detail (Q8); focussing on a number of parts of the topic at the same time or a single part(Q9).

Limited agreement with Ford's results may be attributed to the changes made to the questionnaire in the process of adjusting it to school-age respondents. The outcome may also reflect a peculiarity of the population under study. Question 8, which was equivalent to Ford's best strategy predictor, was only slightly in agreement with the overall pattern shown by the sum of the responses. The correlations of 0.54 were too small to inspire confidence in predictions about overall strategy preference made on the basis of the small classroom sample group's responses to Ford's questionnaire. The majority of responses to Q7 and Q9 were in agreement with the overall pattern of Ford's questionnaire responses. Responses to Q7 were in greater agreement with the overall pattern reflected in the sum of responses than Q18.

It is noted that people with extreme preferences (at the top, 86 and 86, and bottom, 53 and 40, respectively) of the sample classroom group and the whole school group in Figures 17 and 20, could be candidates for the learning strategy pathologies identified by Pask (1976c) as 'improvidence' or 'globetrotting' (see page 102). Further testing may show that Ford's questionnaire could function as a useful tool for identifying these learning pathologies as a first step to assisting students with the process of developing versatility in learning strategies.

What was evident from the preference survey was a range of responses reflecting differences in preferences for the particular strategies required to carry out the tasks specified by the questionnaire items. This range of responses to questionnaire items did not reveal a simple dichotomy, such as

suggested in Pask's earlier work (Pask, 1975), between people who are holist-like and those who are serialist-like in their preferences. Rather, a continuum of preferences was identified in the ranked records of the questionnaire responses of the sample classroom group and in the responses of the whole school group. This continuum was like that recorded in Pask's later work (Pask, 1988) and applies not only to the preferences of the individual subjects in an overall sense, but also to the preferences of both the sample classroom group and the whole school group for particular approaches to specific questions. The next section details what was achieved in recording learning in the classroom context and makes up Step 2 of Phase 1 of the research design.

PHASE 1

OUTCOMES FOR STEP 2

Monitoring Learning Strategies

This section reports on the extent to which the BBC AIV software extensions successfully monitored learning strategies and recorded the interaction between a student and the extended BBC AIV. Answers to the second research question are reported here. The question was:

> **Can differences in learning strategies be identified in the record made by a computer of student's learning activities?**

Chapter 3 described the limitations of the system and the software extensions needed to record the actions that subjects took in a learning session with the BBC AIV. Using these extensions, a verbatim replayable real-time record of each interaction was obtained. This record is akin to the monitoring system described in a later study by Ransdell (1990) for a word processing program. Ransdell's records contained replayable event sequences -analogous to tape recordings of human-computer interaction- which could be replayed for further analysis. In the present study, the interpretation of the data during a real-time session was, however, beyond the processing power of the BBC System. As far as the monitoring record was concerned, the key analytical task

in my work was to establish what, in the large amount of data that could be collected, was actually worth examining. For example, in a normal session (about 45 minutes) the recorded data filled a floppy disc file of about 80 to 100k. The exercise of logging the interactions was fundamental to the research for three main reasons. First, it enabled the replay of a subject's interactions with the BBC AIV. Second, it was from these replayed interactions that an understanding of the interaction between subjects and the BBC AIV developed. Third, the logged interaction files contained the data that generated the empirical basis for the study.

Most of the data consisted of: the record of the states of the keyboard; contents of the trackerball buffers; and the timing data needed to permit the replay of the session. Several aspects of the initial monitoring attempts showed that the scale of monitoring available with Scriptfile was not appropriate for the level of analysis needed to examine the strategy predictions stated in Pask's work. These aspects were: an inability to obtain trackerball movement data; and, an inability to map search patterns onto an epistemological framework.

The actual basis of the structure of the BBC AIV was not undetermined, although Armstrong and Tibbetts (1986) provide a descriptive account suggesting a logical positivist conceptual framework. It may be that deeper analysis by other researchers will establish the basis of the knowledge structures in the BBC AIV. That work, because of the magnitude and range of data, fell outside the scope of this research (see page 72). However, my lack of a precise definition of the knowledge structures in the BBC AIV meant that a deeper understanding of learner's interactions with the system was not possible in the way that Pask used with his specially created laboratory systems. Part of the explanation for this situation was that Pask was studying the interaction between people, whereas I was investigating the nature of the interaction between a person and a machine. The immediate consequence of that lack of indepth knowledge was that it was not technically possible to carry out a detailed epistemological analysis of the subject's work because of the inability of the Scriptfile software to deal in any way with knowledge structures. Consequently it was not possible to take into account the actual state of the knowledge structure in the BBC AIV. That was because the BBC AIV was not created in the same form as Pask's epistemological structures.

Analysis of the Teachback Material

In reporting on the analysis of the Teachback material, this section draws attention to the difficulties in matching Pask's approach to the analysis. No single completely worked and analysed example for a single subject is reported in Pask's publications (1975, 1976a, b, c, 1980, 1984, 1988). Such an example would have increased the possibility of confirming the detail of his work. It would need to include: unprocessed data; criteria for processing; and a description of the actual processing steps. The appendix to Pask's 1975 book *Conversation, Cognition and Learning* does give several partially analysed examples, but it is not clear how these examples relate to the categories (or indices) that Pask (1976a, 88) lists as key features extracted from his records of student **learning strategies** (see page 22). The example in his 1975 work deals with 'holist' and 'serialist' Teachback material, but uses criteria which were **style discriminators** in his work of 1976a. Pask was using an earlier set of immediate indicators of **learning strategy** to make decisions about a second longer term attribute of behaviour he called **learning style**. In his later experiments Pask was concerned with the questions which arose out of attempts to find out what effect matched/mismatched teaching and learning activities had on the learning process. He wished to know whether matching learning strategy made a difference to learning progress. He chose small groups of students (n=9) and provided matched and mismatched materials for the students.

Categories for Distinguishing Learning styles.

In his 1976a work, Pask tabulated partially processed data under the general heading of 'Content Analysis of Teachback Protocols'. He listed seven categories of statements within a Teachback session. These categories are related to the structures of knowledge Pask created for his **learning style** experiments. His content analysis categories for distinguishing between comprehension (holist-like) and operation learners (serialist-like) were:

1. falsehoods or corrected falsehoods;
2. inventions;
3. statements of information to come or delivered;
4. statements deduced;
5. irrelevant;

6. redundant;
7. total number of statements.

Criteria for Distinguishing Between Learners.

Because Pask defined the 'knowledge world' within which his subjects worked, he had very close control over what was acceptable or not. The present study took the view that Pask intended 'inventions', the second of his categories, to refer to extensions-beyond-the-material-provided in his original learning materials. In the analysis of the Teachback material which follows, the term 'extensions' is used to refer to what Pask called 'inventions'. The reason for doing so is that I could not determine whether the subjects I studied 'invented' the words for a particular phrase in their Teachback slideshows during the research, or simply applied them serendipidously from an existing vocabulary. In contrast, Pask would know exactly what was invention because he defined all-that-there-was-to-know of the topic through his entailment and task structures as discussed in Chapter 2.

Pask's analysis of the content of Teachback protocols included listing the totals of words subjects used and a comparison of means and standard deviations for each of the seven categories listed below with each paired group of subjects. He records items 2, 3, 4, and 5 and 6 as significant at 0.001 using the Mann-Whitney U-Test for a matched/mismatched comparison. Although I was not, at this stage, interested in the matched/mismatched issue, these categories were used because they were from the most completely documented and detailed of Pask's experiments in the public domain. I am aware of other technical and military reports by Pask not freely available which may have more explicit information. I have used the total number of statements (category 7) as a summary for Pask's Content Analysis categories because I have no detailed instances of his intentions with regard to the other six categories. I note also that Pask's data show marked contrast in this attribute and thus accepted that the discriminator was well chosen.

Among Pask's descriptions of holist-like and serialist-like **learning strategies** was a further set of seven discriminating indices or criteria listed in his recent summary (in Schmeck, 1988) from his original 1975 work. Pask's indices are quoted below in each of the seven cases. These indices were not, however, useful as a means for identifying learning strategies

particularly as their relationship to one another was not clearly stated. It was not possible to apply all of Pask's criteria (in the form of the indices listed below) to my students' records, but all of them are included here to exemplify the problems of extending Pask's work from person to person conversations to the interaction between a person and a machine. Reasons for these difficulties are discussed in Chapter 6, but in essence relate to the fundamental difficulties faced by an analyst where the content was derived from a common sense epistemology. Following each index reproduced below is a comment in parentheses on whether I was able to use the index in my research. The indices in quotation marks are from Pask, in Schmeck, 1988.

1. "A versatility index (V) based upon forecasting rather than given data, interpolative or predictive, and requiring the invention of more or less perspicuous analogy relations."

[Pask (1976a, 86) ran several experiments in a highly complex research design. In each case he had total control over the knowledge accessible to learners. Previous results enabled him to make predictions. In my research no predictions were made before the data was analysed in order to avoid finding what was desired rather than what was actually in the record.]

2. "An index (X) chiefly of global recall pattern".

[In my research this attribute was not an issue since subjects always had access to all the database material. Because all subjects completed the task of building a slideshow it was concluded that all subjects could recall how to locate the data in the BBC AIV. A second recall item was knowledge of how to use the system. The subjects had spent enough time to become familiar with how to the system, before developing the Slideshow. Thus, recall did not appear as an issue in terms of the holist and serialist distinction.]

3. "An index (Y) of global rule recall. The sum of X and Y is the score called comprehension learning or C score".

[The Teachback data files in my research indicated a high level of comprehension of the system and its use in that all subjects were able to complete the task of using the BBC AIV facilities. Again, this did not appear as a suitable index by which to distinguish between different students' performances.]

4. "An index (U) of local rule and operation recall. Rote learning of lists of details, in contrast to what the details are used for, is discounted, so far as possible."

[All subjects in my research applied the rules for using the BBC AIV in a way that produced an acceptable outcome.]

5. "An index R of rote recall (chiefly of message lists). On the whole, with performance in mind, this index should be counted against the learner."

[Pask used the strict 'understanding' standard as evidence of learning. This meant subjects had to teachback what was learned not just parrot it in a rote learning fashion. Pask's advice was followed and simple lists which exactly confirm what was in the BBC AIV were considered in my research to reflect a serialist-like strategy.]

6. "An index (S) of semantic recall."

[In my research, all subjects successfully used terms, illustrations, and the BBC AIV in appropriate ways indicating a high level of semantic recall.]

7. "A neutral score, indicating that the material has in fact been studied. This index has no discriminative stylistic value but, if it is below a reasonable level, the data may well be guess work."

[No evidence of guess work was found in the Teachback slideshows in my research. The nature of the Teachback program required mastery for it to be used at all. All twelve subjects successfully used the system.]

(Indices in quotation marks are from Pask, in Schmeck, 1988)

Students' Work in the Present Study

The students' Teachback text listings below were from the record of the Teachback slideshows. Pask's techniques for differentiating learning strategies (1975, 451, but actually listed out in detail in Pask, 1988, 94) refer to a variety of types of data that might be expected in the Teachback files. Of the 14 differentiating items, seven from the Content Analysis in Pask (1975) (called 'categories') and seven from Pask (1988) (known as 'indices'), only information derived from the actual source slides and additions -or extension information provided by subjects- were identified in the students' material. Other categories used by Pask were not identified; that is: redundant

information, superfluous information, inference, false statements, self correction, comments and interjections were not identified in the Teachback material. These categories were of a type that might normally be expected in the anecdotal interactions Pask was investigating, but not in a prepared slideshow in my research.

However, the interpretation of contributions to any conversation requires common sense, a most difficult attribute to program in a machine (Winograd and Flores, 1986, 98). It was realised that the logged interaction records were of a different type and in a different form from those analysed by Pask's participant observers. The fundamental distinction lies in the fact the Pask's subjects were working within a precisely defined epistemology whereas the BBC AIV knowledge base was structured in a much more epistemologically eclectic way. It this respect it more nearly resembled the complexity of normal discourse. The implications for the research of this issue are dealt with more fully in Chapter 7.

The monitoring record did contain the text characters that appeared in the captions to student's slideshows. This material was extracted from the record using the Display Teachback module which also processed this data into the series of annotations -phrases and sentences.

The following three items are the literal text (including errors) of students' slideshows. The balance of nine slideshows are listed in Appendix B. The underlined items are additional information identified by applying Pask's second Content Analysis Category, inventions (here called 'extensions') to the text. The extensions were sentences not found in the BBC AIV, but added by the subject during the Teachback process. Because style and strategy are intertwined as part of a continuum in Pask's work, especially in the empirical studies, I chose to use style distinctions to support strategy distinctions. Specifically, since comprehension learners use predominantly holist-like learning strategies and operation learners use mostly serialist-like learning strategies, I took the view that an indicator of comprehension or operation learning was better than no strategy indicator at all. A summary comment in parenthesis following each listing states what designation, either holist-like or serialist-like, could be given to each slideshow on the basis of the presence of extension items and the number of words in the Teachback material. That attribute, and the length of Teachback, were the main characteristics of Teachback used to make the classificatory comment at the

end of each of the slideshows listed below. The three Teachback slideshows are described first then listed in the form in which they were recovered from the disc files.

Subject 1, a person who indicated an overall preference for holist-like learning strategies, prepared a slideshow dealing with transportation and communication. The annotations extended beyond the material in the BBC AIV. The large number of extension items (17) and the length of the Teachback material in relation to other slideshows (twice the average length) placed this slideshow in the category of a holist-like production.

Subject 9 declared a preference for serialist-like approaches and prepared a slideshow about geology. The slideshow was concise and the annotations were strictly limited to the BBC AIV content. This slideshow was in marked contrast with the first and in relation to it, and the other slideshows of the classroom group, was clearly in the category of a serialist-like production.

Subject 8 declared a preference for serialist-like approaches, yet the slideshow about British Historic Places had many extension items beyond the information contained in the BBC AIV. The number of these extensions and the length of the slideshow were taken as indicators of a holist-like production. The anomaly of lack of agreement between questionnaire responses and observed behaviour in the form of Teachback slideshow is discussed in Step 3 below.

Subject One Annotated Teachback Slide notes.

Topic: Transport and Communication

Transport and Communications in England have changed dramatically since the turn of the century, making improvements to everyday life.
One of the earliest forms of everyday transport was the horse drawn cart here we see a traditional Brewers dray probably in use during last century.
In the early days of mechanical transport, the cost would prevent ordinary people purchasing anything but the reliable bicycle.
With the arrival of the horse-drawn tram, short journeys within the towns were made cleaner and quicker for those with the available money.
The train made the workloads in many jobs lighter. For example, coal from the mines would no longer be hauled by hand up the steep mine shaft transformed into an efficient service which has been taken underground.
Comfort and speed are the requisites of todays busy lifestyles.
For the shorter journeys across cities the bus service has proved invaluable for those families without cars. (Keighley Bus Station, York.)
A black-cab taxi will cater for the exact needs of the passenger. Although the cost will be higher, the preset destination means less worry.

The Panther Solo is just one example of improved technology. The car, for those who can afford it, offers status and speed for the owner.
With the increase in industry has come an increase in the need for heavy transport. The Bedford range of trucks offer reliability and efficiency.
The car of the future has become the failure of the past. The Sinclair C5 was designed to be cheap, economical and popular. However, the idea never really took off because of the size of the vehicle. If the C5 was universally accepted, there would need to be total restructuring of the road system.
A ever growing population means more people must travel daily to work. The excellent train services in many areas offer these commuting facilities.
Bank Holiday traffic is unfortunately a result of cheaper prices on the most popular form of family transport - the car. As more and more people are able (across two slides) to purchase their own, scenes such as these will become increasingly common. However, this is a small price to pay for the efficiency a car offers. Transport and Communications have made remarkable developments during the last century. It remains to be seen what the future will bring.

(14 extension items in a **holist-like** presentation)

Subject Nine Annotated Teachback Slide notes.

Topic: Geology

This is a series of slides showing some of the geological structures that can be found in Britain.
Fault lines
Great Glen fault
East Golds clay pit (faulting)
Fault in limestone and mudstone
Syncline in Pembrokeshire. This is caused by plate movement
Anticline in Cornwall
Erosion and weathering
River erosion of limestone
Frost action causing erosion, Cumbria
Wind erosion of millstone grit
Erosion caused by the action of waves
Natural arch, offshore island
Spheroidal weathering
Onion skin weathering

(No extension material in a **serialist-like** presentation)

Subject Eight Annotated Teachback Slide notes.

Topic BRITISH HISTORIC PLACES

A brief look at some of the historic places I have visited in past years!
Stonehenge standing alone on the Wiltshire planes near Salisbury
A close up view of the stones.
Stonehenge again from some distance away from the stones, probably near the underground tunnel. When visited it was a rather cold and blustery day.
Flatford Mill in East Anglia. The painting grounds of Constable. This was one of the many sights we saw while on our week stay in the area.
The Lavenham Guildhall, again in East Anglia. This building was the centre of British wool production for quite some time. Viewed from the square.
Melford Hall, in East Anglia. The day we were there the clouds were low, so a look at the countryside surrounding the hall was not very good.

Penrhyn Castle, Wales. This castle is only 2-3 hundred years old. Someone wanted a castle, but could not buy one so he made one! Good weather that day.
Wimpole Hall, in Cambridgeshire. This is seen without the scaffolding that was in place while we were there, thus making for better photographs.
Hadrians Wall, built to keep the Scot at home by the Brits. Later used by the romans. We visited this on the way back from our tour of Scotland.
Housesteads Fort on Hadrians Wall.
The forts were made by the romans as "halfway houses". Although some way from the road, it is worth the walk.
A birds eye view of the old fortified town of Colchester. The photo appears to be around the wrong way!
Polbadarn. This "castle" is seen just of a welsh road, which is used to get to an old slate mine.
Caernarfon Castle, on the coast of Wales, the "home" of the Princes of Wales.
York Minster before the disasterous fire that destroy part of the Minster. We saw this in the early 80's on a day trip from Manchester.
My family visited Ightham Mote while visiting "The Great Aunt". I stayed in the car and had a afternoon siesta! They said it was rather good.
Viewed the morning that we saw Ightham Mote. The trees in this photo of Knole House have suffered severe loses due to the big wind. Met a deer here.
Another Scotish sight. Holyrood Palace in Edinburgh. We visited this after a tour of Edinburgh and the Castle.

(Extension material 17 items in a **holist-like** presentation)

Differences noted in the gross characteristics of the Teachback data were in the length of the production and in the complexity of the presentations as determined by the number of extension items. The differences are summarised as a single factor - the total number of words in each student's Teachback file.

Step 3 takes these data and with it explores the possibility that a comparison of preference data from questionnaire responses and Teachback slideshow data could provide predictive information. Two subjects' data were examined more closely in an attempt to explain the outcomes of the comparison.

PHASE 1

OUTCOMES FOR STEP 3

Comparison of Strategies and Behaviour

This section examines the third research question in Phase 1 of the research design. The question was:

What conclusions can be drawn from a comparison of preference responses and observed learning behaviour?

The aim in making this comparison was to establish if any important relationships, in the form of correlations, existed between the data items gathered from students responses the Ford's questionnaire, and data gathered from the Teachback slideshows. Pearson's Product Moment correlations were carried out on the subjects' responses to each questionnaire item, the sum of their responses and the sum of the number of words in their Teachback slideshow. This comparative data is shown in Figure 25.

Question	AGE	Q1	Q2	Q3	Q4	Q5	Q6	Q7
SUM	0.028	0.045	-0.053	0.373	0.229	0.562	0.109	**0.750**
WORDS	-0.083	-0.401	0.347	0.530	0.325	0.212	0.017	0.313
	Q8	Q9	Q10	Q11	Q12	Q13	Q14	Q15
SUM	0.542	0.509	0.580	0.372	0.481	0.369	0.288	0.521
WORDS	0.332	0.091	0.540	**0.836**	0.197	0.136	-0.222	0.322
	Q16	Q17	Q18	Q19	Q20	SUM		
SUM	-0.324	0.444	**0.832**	0.519	0.199			
WORDS	0.056	0.306	0.413	0.460	-0.062	**0.613**		

Figure 25. Correlation coefficients for questionnaire responses and Teachback word length for the sample classroom group. These Teachback word length responses were summed and compared with the total numbers of words as a surrogate of the actual performance of students on the Teachback task. Bold items are discussed in the text.

Preferences Compared with Length of Teachback Slideshows

Detailed examination of word length and the sum of preferences revealed further aspects of importance. For example, responses to Q11 are consistent with 0.84 of the ordering of word length. However, the 'number of words' item is not in strong agreement with the overall pattern with a correlation of 0.61. Responses to Q18 show a 0.83 correlation with the overall sum of preferences and this single item may indicate whether people have an overall preference for holist-like strategies or serialist-like strategies. Higher correlations were found also between the following question pairs, with the holist description given first followed by the serialist description next:

- 11 and 'words': confident to prepare own resource material provided there is no limit on the number of words that can be used to cover the topic. Or, only confident with prepared resource material where there are clear guidelines provided by experts.

- 'sum' and 'words': prefers scope for creative and unlimited work. Or, prefers controlled learning in a bounded situation working from one known to another.

The correlation of the 'sum of preferences' and the 'words' is 0.61 and this value just reaches statistical significance at the 5% confidence level. The Teachback slideshows were compared also with the logged work of the subjects as they went about the learning process. Only a single very minor difference between the detailed log file records of individual subjects was noted: the number of slides examined was greater by only two or three items for holist-like learners as determined by the preference questionnaire results. This single and very minor variation suggests that perhaps the differences in learning strategy were variations of the same type of search activity rather than distinctive learning strategies. A more plausible explanation is that the BBC AIV user interface so constrained search activity that it masked any differences that may have been picked up with Pask's person-to-person conversations. For example, Ramsden (in Schmeck, 1988) states that Laurillard (1987) found that providing a similar tool results in similar products. If this is indeed generally the case, then it may be that the tool is the most important factor influencing learning strategy. This exploratory research confirms Laurillard's finding for 10 of the 12 small classroom study group subjects: a serialist-like tool, the BBC AIV, tends to produce a serialist-like outcome (despite some learners' stated preferences for holist-like learning strategies).

The preference data is summarised in Column 2 of Figure 26 and abstracted into a single letter designating holist-like or serialist-like preferences in Column 3. Data about learning behaviour was collected in the form of records of the Teachback slides. The words in the captions of the slideshows were counted and were listed in Column 5 of Figure 26. Ranking students according to the Teachback slide extension items provided a linked ranking with preference data. For the purposes of comparison, these two sets of data are listed in Figure 26 together with one of two letters (A or D) indicating whether the extension items agree or disagree with slideshow word length as a predictor of preferences. Subjects' preferences were compared with two attributes of their behaviour: numbers of extension items and numbers of words in the Teachback slideshows. Extension items in Column 4 in Figure 26 were ranked from most (17) to least (0) extension items. The preference data did not exactly

Classroom Subjects	Sum of Preferences	Preference H = Holist S = Serialist	Numbers of Extension Items	Words in Teachback slides	Agree=A D=Disagree Extension and Preference
S8	58	s	17	395	D
S1	86	H	8	388	A
S4	63	h	4	74	A
S2	67	H	3	197	A
S10	57	s	2	182	A
S5	63	h	1	144	D
S7	59	s	1	71	D
S11	56	s	1	93	A
S12	53	S	1	64	A
S3	64	h	0	189	D
S6	63	h	0	210	D
S9	58	s	0	80	A

Figure 26. Ranked observed and predicted behaviours. The ordering of: 1) preferences; 2) words in the Teachback slides for classroom group of subjects; 3) strategy preference; 4) agreement between preferences and observed behaviour; is by subjects' extension items. Number of extension items predicted subjects' preference in 7 of 12 cases.

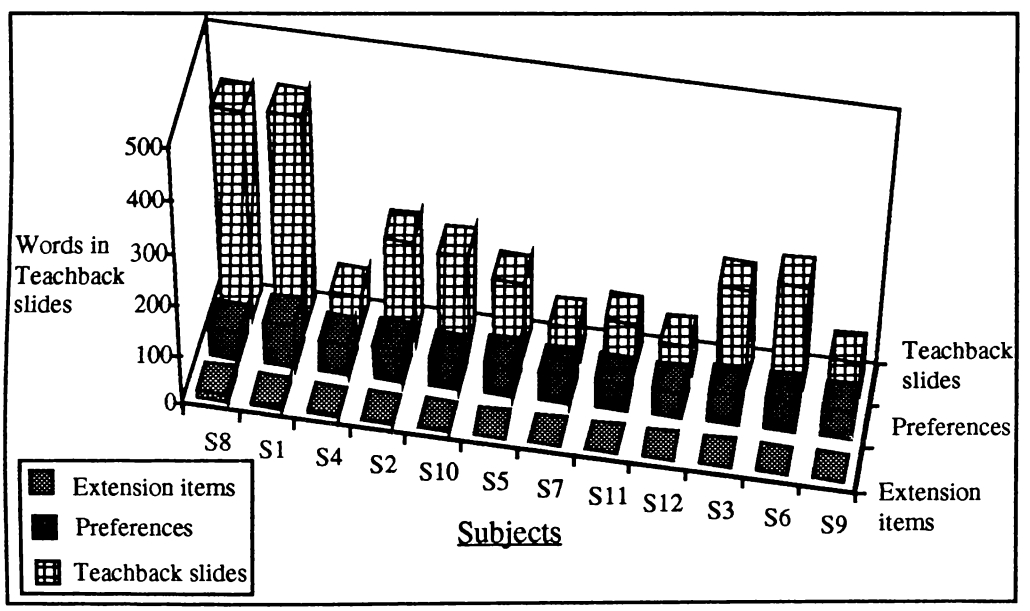

Figure 27. Graphical comparison of subjects' preferences and performance showed a general tendency of relatedness.

follow the ranking of the sum of Teachback extension items shown in Columns 2 and 4 in Figure 27. Subjects displayed three similarly sized sets of Teachback slideshow data: those whose Teachback material was between 60 and 100 words in length; those whose work was from 100 to 210 in length; and two people who produced the longest written contribution (about 380 words). Other than the incidental observation of grouping (which was not consistent with strategy preferences), no predictive relationships of statistical importance about the subgroups were established between length of Teachback and preferred strategy type. However, the number-of-extension-items 'attribute' predicted preferences for particular overall strategies in 7 of 12 cases. A comparison of these attributes in 3D is provided in Figure 27. The items to the left of the diagram are the most holist like in terms of extension items. These subjects also tended to produce the longest Teachback slideshows. However, the preference questionnaire responses did not provide the expected one-to-one correspondence of learning strategy preferences and learning outcomes in the form of either search patterns or Teachback slideshows.

Statistical analysis by Pearson's Product Moment Correlation is shown in Figure 28. The correlations between the three pairs of parameters for the group of 12 subjects reach statistical significance at the 5% level when r = 0.58. The r = 0.78 correlation between Numbers-of-extension-items and Words-in-the-Teachback slides was statistically significant, but of passing importance only. Extension items move beyond the data supplied by the BBC AIV and are therefore part of a wider base of the student's knowledge. It was not surprising that a person moving beyond what was supplied by BBC AIV would write more words than someone who uses what was supplied. The value of 0.61 was statistically significant and was important confirmation of a limited level of agreement between numbers of words in a Teachback sequence and a subject's preference for holist or serialist-like learning strategies. Analysis of individual performances and preferences drew to attention the problem of how to account for Subjects 1 and 8.

Accounting for Anomalies

Subject 1, listed first in Figure 17 and second in Figure 26 had a preference matched with performance and operated in an almost exclusively holist-like mode. This person said that her learning strategies made it very difficult for her to cope with serially orientated disciplines, such as school

	Numbers of extension items	Sum of preferences	Words in Teachback slides
Numbers of extension items	1.00		
Sum of preferences	0.23	1.00	
Words in Teachback slides	0.78	0.61	1.00

Figure 28. Comparison of correlation coefficients for observed and preferred behaviour. Numbers of words in Teachback slideshows and numbers of extension items provide a means to evaluate the predictions of learning strategy preferences derived from the questionnaire responses.

science. She did have an outstanding ability to perform well in both musical and literary work. The experience of participating in the research was one in which the she took a great deal of interest. However, despite many demonstrations of alternative approaches to learning, she made a deliberate choice to approach the computer system in a holist fashion. This subject spent much more out-of-class time using the BBC AIV than any of the other subjects before mastery was acquired of normal query procedures. No other evidence of difference in performance was noted in her logged data. This lack of learning strategy difference was attributed to the confining nature of the BBC AIV. Despite these problems this subject was able to come to terms with the computer system and produce an effective Teachback session on Transport and Communication in Britain. No predicted deficit in performance from mismatching was noted.

The anomalies between questionnaire performance and Teachback material are of more interest than the areas of agreement. In particular, Subject 8 showed a marked discrepancy on Teachback (holist-like) compared with learning preference (serialist-like). An examination of the Teachback script showed that the student presented the slideshow as a narrative account. The task engaged the holist-like 'person as tourist' who provided a rich account of family travel rather than the serialist-like account of a 'student carrying out an academic task'.

This particular outcome meant that it would be difficult to provide the data required for identifying which learning strategy was appropriate for any particular person on any particular occasion. If the strategy the person was using cannot be identified, then neither can an appropriate match with that strategy. Further, if the strategy the person uses was not consistent, then every session presents the same matching problem. The matching problem

may arise during a session at any time if the person changes strategy during the session. What applies to the matching problem also applies to the mismatching problem. These are positive results if the goal was to enlarge the strategy range a person can call upon, but do not enable algorithmic solutions -through computer software- to the matching problem.

In considering the empirical outcomes collected during students' searches of the database, it is emphasised that the media - the information and the user interface of the BBC AIV - come to the user as a finished product, complete and unalterable. There was no easy way the researcher could order or manipulate the media in the BBC AIV, such as was required to facilitate an individual grasp of a topic. This attribute meant that Pask's very strict epistemological criteria of complete knowledge specification could not be adhered to as he outlined (Pask, 1976c).

It was not until the subjects were able to get outside the constraints of the BBC AIV user interface that they had sufficient flexibility of expression to reflect their preferences in their learning/Teachback activities. The software extension called Versatile Teachback provided this flexibility. It was this software that subjects used to create their slideshows. While subjects could not alter the BBC AIV images, they could add, through Versatile Teachback, the captions which demonstrated both an individual grasp of the material and an individual strategy in communicating about the material.

In summary, recording learning activities and subsequently identifying the range of strategy types by comparing ranked preference data and subjects Teachback materials was achieved. From this comparison, indications were found of limited, but statistically significant, agreement between preference for particular learning strategies and actual behaviour. Significant problems emerged from this comparison which were: preferences were not a sufficiently reliable basis for algorithmic solution to the strategy identification problem; and, changes in learning strategy during a session could confound a match and turn it into a mismatch. Little is known about what might trigger such changes and therefore how to recognise them. Without this knowledge there is little possibility of algorithmically describing the problem in order to obtain a machine assisted solution. Chapter 5 discusses the research outcomes of Phase 1 in relation to the research problems particularly as they influence how the BBC AIV was seen as a teaching/learning environment. This chapter addresses the questions in Steps 4 and 5 of the Phase 2 research design.

CHAPTER 5

OUTCOMES: THE PHASE 2 RESEARCH DESIGN

Outline: The research question which provides the overall focus for this chapter is: **Can a computer be used as a surrogate for a human conversant in a conversation?** This question was resolved into the matching problem which emerged from the empirical research reported in Chapter 4. Difficulties involved in matching preferences with observed learning strategy identified in Phase 1, are examined as Step 4 in Section 1 of this chapter. Section 2 surveys developments in philosophy related to theoretical questions raised about the nature of the undecidability of the matching problem. The search for explanations to account for the undecidability problem in general lead to a wider review of philosophical studies and to ideas from developments in social sciences arising from the philosophical studies. These ideas are outlined in Section 3. Changes in geography, an integrative discipline, are considered within the framework of recent work in philosophy and social science in Section 4. Finally, in Section 5, some consequences of these findings are described.

PHASE 2

OUTCOMES FOR STEP 4

A Discussion of The Matching Problem

This chapter begins by returning to understandings developed from Conversation Theory. The research question addressed here was:

> **Can a computer be used to carry out the matching of preferences with the strategy used by the learner?**

Having established the existence of a wide range of differences in learning strategy from the questionnaire outcomes reported in the tables in

Chapter 4, consideration will be given in this chapter as to how to accommodate for this variety of preferences. However, if one of the aims of teaching is to enhance learning, then the outcomes described in Chapter 4 suggest that materials and learning experiences suited to the range of holist and serialist preferences must be provided. The nature of interactions in a two person group is explored in the next section.

In Conversation Theory, the interaction between two people in a learning context is understood to be a reciprocal sharing of information (Pask, 1976c). Pask states that the nature of this interaction can be specified and that the outcomes of a particular conversation can be made replicable and open to critical scrutiny. This scrutiny is essential if it is intended to match the learning material with the individual attributes of the learner. The research outcomes reported in Chapter 4 were collected on the assumption that it would be possible to confirm the other half of the 'conversation' in a computer, and by implication shed light on a person's learning processes. This goal has been accomplished to a limited extent with the integration of the BBC AIV and the software extensions described in Chapter 4. The limits of this accomplishment are that the confirmation is to the level of playing back a recording. This is equivalent to saying that a mirror replicates a person. There are obvious limitations in the mirror image which make the 'person' in the mirror a very unsatisfactory conversant. The particular problems associated with the BBC AIV as a conversant are discussed next.

There were significant problems that limit the extent to which even the extended BBC AIV could be adapted to meet real-time educational design criteria (Stankovic, 1989). There was, for example, an epistemological problem, as yet unresolved, described in Barbour, 1990a. This problem was a theoretical problem that confronts any person attempting to individualise the learning process by working with interactive programs in a computer-based learning environment. There were three parts to this problem. The first part was a conceptual problem, the second part was a problem related to decision criteria and the third was a problem of the logic of material organisation. These three parts of the problem involved in adapting the extended BBC AIV were considered in relation to the research of other people. Pask (1976c) and Laurillard (1987) were aware of the difficulties involved in the matching of material with learning strategies. Pask's view is dealt with first, followed by consideration of the view of Laurillard.

Conversation Theory predicts, and Pask's laboratory work showed, that a learner will make sound progress in the learning process when the material is matched with learning strategy (Pask, 1976c). Conversely, little progress will be made where the material is mismatched (Pask, 1976c; Laurillard, 1987). Pask claims to have established a laboratory research setting in which matching and mismatching of material and learner was achieved. He claimed that the tendency to adopt a particular strategy was an attribute that persisted over time and between tasks. He advanced cognitive fixity as a theoretical basis for the claim. Laurillard's work (1987) showed, however, that it was not possible to attribute a particular learning strategy to a person on a reliable basis because people were most likely to have many strategies to call on. Laurillard argued instead for attachment of strategy to the context in which the person was conversing. Her point of view was that strategy was tied to a person-in-a-context. My preference survey findings confirm Laurillard's view. Since people experience many contexts, it was likely that they could call on the strategy developed in any one of these contexts simply by recalling the context. This finding was not in overall agreement with Pask's work and alters his predictive claims for Conversation Theory about which Laurillard was generally in sympathy.

Having reviewed Pask and Laurillard's findings, the first part of the decision problem can be stated as the problem of determining at what point in time, conceptually, enough interaction has taken place **to decide which, of many possible learning strategies, was being used by a student on any one particular occasion.** Following such a determination, and a subsequent attempt at matching the system responses to the persons' learning strategy: **what were to be the criteria for successful matching?** Establishing decision criteria for successful matching encapsulates the second unsolved problem. Further, in order for real-time matching to occur, it must be empirically possible not only to identify the learner's current strategy, but also to **logically alter the form and presentation of material to match that particular person's learning strategy** (Barbour, 1991a). That this has yet to be achieved, was the third unsolved problem. Taken together, these three problems were crystallised into what is known as a 'decision problem'.

Pask's work showed that learning strategies can be determined over a period of time by human experts in a laboratory context. Carrying out the same type of analysis presents real difficulties in a classroom. These

difficulties have precluded carrying out aspects of the matching objective in my research. In part, this matching problem may be attributed to the closed and thus inaccessible data base of the BBC AIV. The world of Domesday, and any other ROM based system, comes pre-processed and unalterable in the ways that were required for a matched presentation. Interaction with the BBC AIV could only be carried out with the user interface that was provided. It was apparent from the undifferentiated monitoring records that subjects found this interface so constricting that not one of them was able to move outside the available serialist-like search strategies while they were learning.

It is also noted that all subjects were able to produce a slideshow. In terms of Pask's predictions, it should have been very difficult for holist learners to grasp sufficient material to construct a holistic view of the BBC AIV since they were able to see only a very small part of the total system. While serialists should have found the system much to their liking, the most engaging Teachback work was produced by two people with more holist than serialist preferences. This was an important outcome since it showed that subjects with different learning strategy preferences were able to work around the limitations of the BBC AIV interface design. An alternative explanation may be found in the very powerful global view provided by the BBC AIV 'Gallery' concept. With this concept users were able to move around inside a graphically generated 'virtual' Art Gallery. The Gallery contained a series of pictures displayed in a series of 'virtual rooms'. These pictures gave a visual overview and indicated to users that material was accessible in topic areas related to the theme of the picture. It was not established whether this visual function served to provide enough clues to the contents of the system for holists to function in their preferred mode. Subjects with holist-like preferences and subjects with serialist-like preferences both used the Gallery successfully.

This section has examined the origins of specific problems that arose out of the research. These problems were centrally related to the thesis question on providing individual learning experiences by use a computer to match material with learning strategies. The emerging question that developed during the research was: **Can a computer act as a conversant**? Investigation into this question begins with an evaluation of current developments in post-modern philosophy in the next section, Step 5.

PHASE 2

OUTCOMES FOR STEP 5

The research question addressed in this section is:

Can a computer act as a person in a conversation?

Outcomes from Step 4 showed that matching learning strategies and materials could not be achieved on the basis of an empirical matching of preferences and observed behaviour. Since matching was not possible based on empirical evidence, this outcome raised the issue of whether it was possible under any circumstances to employ a computer in the way suggested by the research question for Step 5 above. In the following sections this question is examined by exploring possible bases from which to establish a substantial foundation for programing a computer to act as a person in conversation. Step 5 is introduced by asking whether there is a cross-disciplinary philosophical base from which to begin the task of answering the Step 5 research question.

The Problem Context in Philosophy

Among the branches of philosophical investigation are two which were directly relevant to the issues raised in the research question. The first relates to the study of 'what is' and 'what can be said' about existent objects. This branch of philosophy is called 'ontology'. Questions about reality and what can be said about it, clearly fall into the category of ontological questions. The second branch of philosophy is concerned with 'how we come to know' and is called 'epistemology'. This section begins by taking a global view of recent interdisciplinary changes that have their developmental origins in philosophic deliberations over the nature of reality and how it is known. While this discussion positions my inquiry firmly within philosophy as it applies to geography as a social science, reference is made to computer science theory where appropriate.

A number of major changes in thought have recently been explored in philosophical circles. One of these, (changes in the nature of the way reality is viewed) is of particular importance for geographers who are concerned with studying reality at the scale of human beings. These changes have come about

as a result of new ways of thinking about reality and while they have their origins in the speculations of the Greeks, more recent commentary has suggested a radical review is needed of traditional perceptions of the 'real world' at the scale of human beings. Consideration of other scales, such as subatomic particles or the cosmos fall outside the scope of this discussion.

The critique of modernism - logical positivism - led by the 'later Wittgenstein' (1968) and consolidated by Rorty (1979), has contributed to renewed questioning of the basis by which claims are made to 'know the nature of reality' and the relationship of learning to that reality. These discussions have raised serious doubts as to the possibility of arbitrating between various 'claims to know'. In particular, it seems that there may be no meta-language to carry out this arbitration process. The implications of this statement for computer based systems are discussed in the next paragraph.

If the machine is, for the purposes of discussion, cast in the role of a conversant, then it might be expected that it has been programmed to make true statements. The machine would also need to be programmed to determine whether or not the statements it received were true. While the truth value of statements may be established within the vocabulary in which they are stated, there appears to be no necessary relationship between those statements and the reality to which they are to be applied (Rorty, 1989). It appears that the machine, as a conversant, must also be programmed with knowledge of the world and how to 'connect the world' with the statements under consideration. In philosophical studies, the lack of an acceptable process for determining truth, other than by agreement with other people, has meant that philosophers have come to see that there is no basis by which to determine which particular view of the many possible views, generated in a philosophical study, more closely approximates some ultimate 'truth' (Rorty, 1989).

This aspect of the problem of truth is also considered by Watzlawick who builds on the work of Morris and Carnap (in Watzawick, et al., 1968). He asserts that the behaviours associated with communication should be considered as *syntax, semantics and pragmatics.* It is Watzlawick's view that syntax refers to aspects of communication concerned with coding, channels, capacity, noise, redundancy and the statistical properties of language. He holds that syntax is the 'mathematical logic of language'. In contrast, he views semantic aspects of communications as involving the meaning of

message symbols. In this sense, he is of the view that the sender and the receiver must be in agreement on the significance of the signal before it is sent. He draws attention to the necessity of a shared 'semantic convention' and states that this is equivalent or analogous to a shared philosophy. These concepts of 'sharing' and 'agreement' are central to the main thrust of this chapter. In common with Watzlawick, the view of communication adopted here is that the important issue is the sender-receiver relation, as mediated by communication (Watzlawick, et al., 1968). Pragmatic meaning will be discussed next.

Applying the philosophical understanding that we have no language, no evaluation procedure or judgment that can stand independently of the people who use it, means that decisions involving judgement (pragmatics) become a matter for discussion. If no meta-criteria are available for deciding between two competing views then we do not know enough to enable a computer to be coded so that it can reach an agreement condition. It follows therefore, that pragmatic meaning is meaning decided by people in conversation. Conversation is the usually accepted mode of discussion between people. A conversation is 'talk' where talk is 'communicating ideas by spoken word' to a conversant 'a person well acquainted with the subject' (Fowler and Fowler, 1964). The issues involved in understanding 'conversations between people' are important because they may act as, or be used as, a model for understanding other interactions. Returning to the machine intended to contribute to conversation, it appears that the machine must now be programmed with the ability to reach agreement with people if it is to arbitrate on the pragmatic meanings of utterances it receives.

The Problem Context in Social Sciences

Goodwin and Heritage (1990) identify a disciplinary focus on the context of conversation, supported by face-to-face interaction, in sociological studies. A development out of this interest was the area of investigation called conversational analysis, or CA. As this work developed, it became associated in America with Harvard University and the syntheses of Talcott Parsons. A conceptual approach to human interaction dominated this work, moving away from empirical validation in an attempt to shift the focus of study to macro-scale analysis. The analysis of language and meaning became part of a distinct subject called 'linguistics' (Goodwin and Heritage, 1990).

Goodwin and Heritage (1990, 285) stated that difficulties arose with the separation of the context in which meaning was created and the language with which it was created. Both the context, and the meaning of the words used in the context, were abstracted away in linguistic studies. Among the consequences of this view was that the outcomes of face-to-face conversation were seen as less adequate instances of some underlying ideal basis of human interaction. Chomsky was cited by Goodwin and Heritage (1990, 111) as arguing that actual linguistic utterances were such poor instances of the potential of language that the ideal instances, as described by theory, were more worthy of investigation. Chomsky's justification for this position was that more progress has been made by working with the formalism for describing language than with the use of language by language speakers. This dictum has influenced much of the work of cognitive science (Haugeland, 1989), as is seen in the frequent reference to Chomsky's works in the associated literature.

A break with this tradition was recorded in Goodwin and Heritage (1990, 285) as being initiated by Garfinkel in his PhD thesis (1952) and subsequently in his writings on ethnomethodology. Garfinkel took a view of conversation which argued for immediacy of interaction and joint meaning creation. His view was derived from the work of Schutz on the social construction of knowledge. The view held by Goodwin and Heritage (1990, 285) was that there was a convergence of Schutz' work with that of the later Wittgenstein and Rorty.

From the perspective of Garfinkel's work, which departs from 'mainstream' sociological and linguistic analysis, learning in a classroom can be seen as the outcome of:

> 'intersubjective understandings... actively achieved as the outcome of concrete interactive processes'
>
> Goodwin and Heritage, 1990, 286

Garfinkel's research was augmented by, and integrated with, work from scholars interested in context analysis. Areas of social interaction in face-to-face conversation were investigated to provide an analysis of how human interaction was produced and organised. As the research in the field grew, certain aspects of context analysis appeared to be more amenable to investigation. Among these are 'turn taking', 'roles' and the 'importance of

audience'. The shift in focus was to the study of conversational interaction as such, rather than the conversation content. Sociological studies initiated by Garfinkel focus on understanding the nature of social aspects of human interaction in conversation. However, sociological work has not focussed on the cognitive aspects of importance to educators. It is noted that the focus in sociological work was on the structure of the interaction rather than the content with, about, and through which people interact and learn. This work is important to the current study because Garfinkel's work may have led to the view represented here. That is, that pragmatic content is fundamental to understanding a conversation. The change in focus away from the content of person-to-person interactions in the quest for more worthy ideal interactions and the study of the structure of conversations has resulted in a neglect of work which might have pointed up the problems involved in the pragmatics of language.

The Problem Context in Geography

The loss of disciplinary authority in philosophy outlined above means that all claims to know within any discipline can be accorded equivalent status and tested for appropriateness to context rather than being accepted as an instance of some ultimate contextually independent truth. In geographical studies, the implications of these recent philosophical developments have meant that geographers have come to see that there is no a priori basis to determine the truth of a particular perspective. Further, there appears to be no a priori way to determine which particular view of the many views generated in a geographical study more closely approximates some ultimate truth within the various perspectives of geographers studying geography. This point is illustrated in Figure 29. The model is a pictorial representation of Dear's (1988) argument. In his paper, Dear (1988) points to the large number of so called 'geographies'. These geographies are represented in Figure 29 as a named ellipse, each representing a theory about geography and shown in the middle ground of the diagram. The theories are applied through the disciplinary focus, the lightly stippled ellipse. In Dear's view:

> 'Human geography is the study of the contemporaneity of social process in time and space.'
>
> Dear, 1988, 270

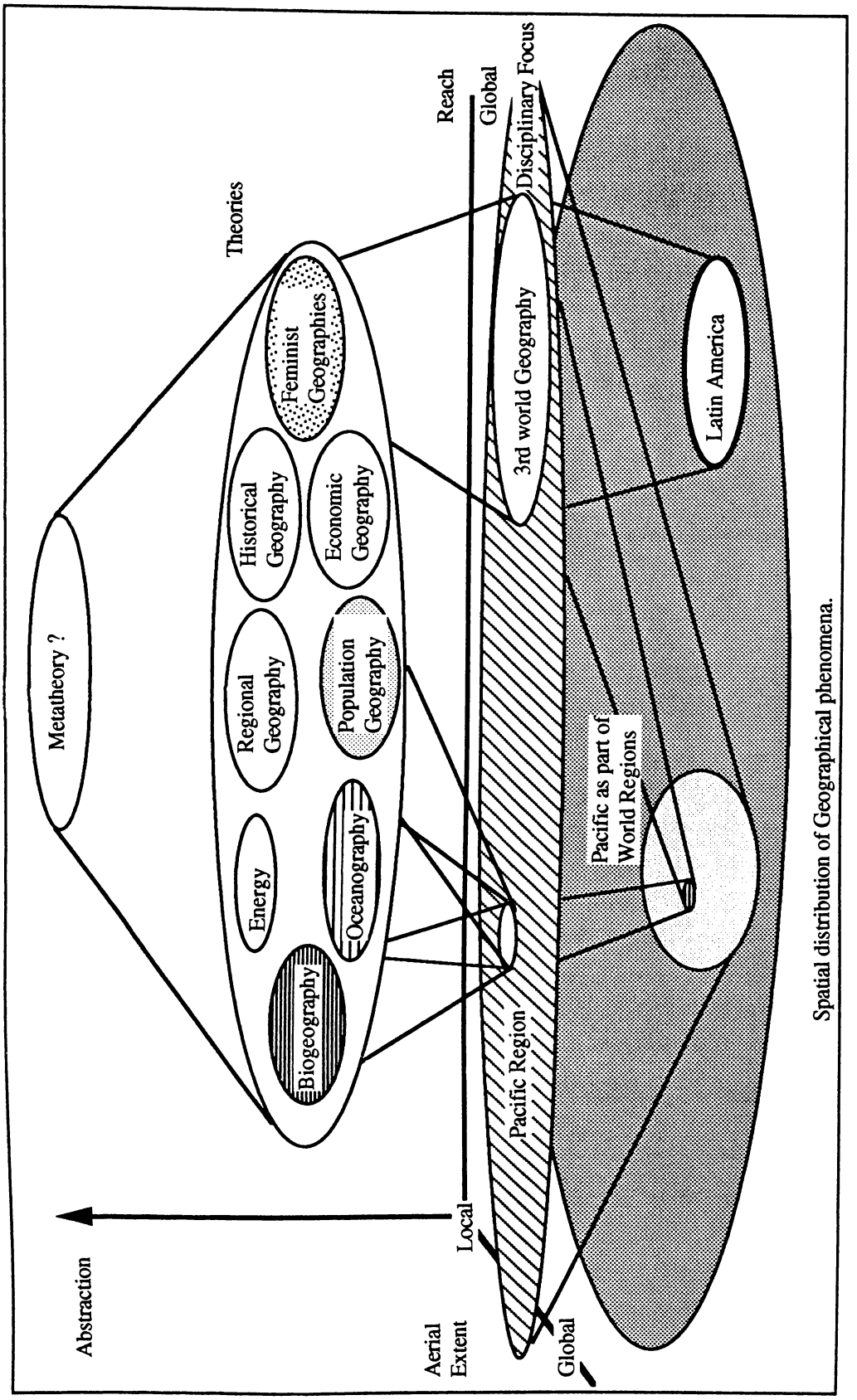

Figure 29. A model showing Dear's (1988) 'no metatheory' argument. The main point shown in this model is that no one metatheory provides a basis for deciding which framework of explanation (a 'Theory' in the diagram) is more acceptable than any other.

The darker ellipse represents the phenomena, humanly generated or otherwise, that are the 'objects' of empirical investigation. The horizontal 'reach' dimension, from local to global, refers to the numbers of subtopics encapsulated under a particular geography. The lateral aerial extent dimension refers to the four dimensional aspects of the discipline familiar to geographers as length, breadth, depth and time. The vertical dimension is intended to represent the abstraction of phenomena to disciplinary focus, to theoretical focus, and to the possibility of meta-theory. While Dear holds that the traditional endeavours of modernist geographers have been to find 'foundational' or 'ultimate' truths on which to ground interpretations of the discipline, he states that post-modernist thinking (Lyotard, in Dear, 1988, 265) is 'incredulous towards meta-narratives'.

The post-modernist holds out for a conversation from which no-one is excluded and no-one holds a privileged position. The fundamental issue for post-modernist thinkers is:

> 'on what basis can a claim be made for a privileged status of one theoretical viewpoint over another?'
>
> Dear, 1988, 256

Dear states that such questions are ***undecidable.*** It is my view that the explanation for this state of affairs lies in the number of translations required between different levels of analysis. A number of translations are required to link the world of thought with the world of phenomena. Translation from one vocabulary, used to describe the world of empirical phenomena, to another, a report of the nature of empirical phenomena, requires a third common vocabulary that adequately translates the other two. For discussions which involve clarification across theoretical frameworks, the translations are many times more complex. In each case, the translations include verifying that the statements made are confirmed at the phenomenal level. The fundamental issue at the 'meta' level is thus, that the complexity of the translation task is a result of a combinatorial explosion of possibilities for which there appears to be no realisable criteria for success. It appears that we have no criteria at the 'meta' level for deciding between theories other than checking them in conversation with other people also in contact with the phenomenal world.

Evaluation of Outcomes

The exploratory work, described in Phase 1, sought to confirm Pask's laboratory research in a computer environment in the classroom. The main findings confirm Pask's view that people differ in their preferences for particular learning strategies. The significant claim made by Pask for Conversation Theory was that through the application of understandings from the theory, **a computer could be programmed to act as a substitute for a human conversant.**

To assist in elucidating the nature of this claim, a description is provided of the tasks involved for a person. Briefly, because a more detailed description is provided below, this would require that a human conversant, among other things, match the strategy used by the student with appropriate materials, appropriately presented. Were it possible to describe these processes as they occur in a human, then it may be possible to mechanise the actions. Success here makes it conceivable that the answer to the question of How shall we enhance learning? could be 'by programming a computer to act in the same ways as a teacher does'. Turing (1950) also made this claim in a somewhat different form. The work reported here sets out to examine the assertion of both Pask and Turing that a computer can act in a way that is equivalent to a human conversant.

Intersubjectivity in Conversation.

The building blocks of conversation are the descriptions of relationships and procedures involved in concept (re)creation that are held in memory, and (re)created by memory activity. In brief, sensory stimuli are the data from which people form perceptions. Perceptions become communicable when awareness of their identity and replicability is shared through the exchange of noises and marks. This requires that they be expressed in language that is common to both people. Percept integration occurs when knowledge of the attributes of separable existing entities are seen as being shared and thus are the outcome of an interaction of one entity with another. Integrated perceptions for attributes having many possible exemplars or instances (such as all the entities which are blue in colour) are called concepts. Since communicated perceptions give linguistic expression to sense data, the

fundamental concept able to be derived from (early and late) sense data is that of existence; of distinguishable things (entities) in a sensory field.

Simply put, a person recognises that a particular set of attributes are the components of the sense data that together make up a thing. Or, perhaps more notoriously, this assemblage of materials, (wood, screws, and varnish) are the components that make up this particular object which has the function of seating one person. The verbal symbol (either expressed in noises or marks) for this object is 'chair'. The verbal symbol 'chair' has objectivity, as a concept, in two senses: the first that at least two people have agreed that the word shall refer to a particular object, and that this may be verified with reference to a particular existing object. Second, the word 'chair' as concept may be applied only to other existing objects that share the agreed attributes of the first referent. Thus the word 'chair' is not tied to a specific referent, such as the particular chair in the lounge, but also applies to functionally related objects in the kitchen, dining room and the lounge. The actual choice of noises to denote the object we call a chair is not important until those noises are tied by people to a particular object. Subsequently, the essential features of the concept are the meaning that people ascribe to the noises and marks that stand for the concept, and, at the next remove to the objects, the attributes of which are integrated to form the concept.

These agreed features are not subjective, that is they are not the product of a single person's whim. The labels for the object's features cannot be altered without doing damage to the elements of agreement from which the concept was formed, and without causing confusion within subsequent conversations. Part of the unspoken agenda of every conversation is the delineation by the participants of the intersecting linguistic worlds they share so that they may know what each person means by the words used in the conversation. At a further remove, the unspoken agenda of every conversation includes the continual (re)creation of the worlds as shared by the people in conversation. A machine acting as a human conversant would need to be programmed to accommodate for these interactions.

Talking About Truth or Convention

Pask holds (pers. comm., 1986) that there can be no conversation if there is no difference between the meanings that two people have about a

particular topic. Neither can anything new be learned by either of the participants since once agreement is reached on meaning there can be no further content on that topic in the conversation.

From this point of view, it is suggested that there is a range of concepts which have no phenomenal reality separable from the entities which exemplify or give them an existence. Concepts may be recalled by invoking the cognitive processes which recapitulate earlier sense data integration. In very simple terms, we give examples of instances of a concept by remembering and describing actual phenomena. We communicate the existence of these instances by talking about them and/or by pointing to actual examples of them. The single perceptible attribute that enables us to distinguish one thing from another is the awareness that each different thing exists. If an object exists in the common experience of two people, confirmation is found in sensory data which are a person's evidence for its existence.

The two attributes not able to be shared by two distinguishable objects at any one time are sameness of location and identity. In other words, each object has identity and this is known by people because it occupies exclusive space either in reality or in imagination. Thus, existence is verifiable in Conversation Theory because people can agree that things exist.

If two or more people agree that there is a match between the 'brain-events' that to each are the internal evidence of observed sense data as recognised and communicated by language, the referent for which is shared, then we may say that they share a common perception. The shared language and the processes by which it is created and communicated are the substance of Conversation Theory. Simply put, if we 'see' something and can communicate what we 'see' to someone else, then the thing we talk about exists for us. So far as is evident in the world around us there is no other way to substantiate any other claims to knowledge using Conversation Theory. All claims to know lying outside this framework are commonly described as the products of delusions or mysticism or special pleading. Consequently, there appear to be no existential statements about the phenomenal world, the truth of which can be known independently of the phenomenal world. It follows that there can be no statements about the material world the truth of which can be established 'by definition' and therefore without reference to the material world. If such a statement were acceptable it would be known as analytically true. From the above analysis it can be concluded that there are no analytically

true statements about the phenomenal world. What this assertion means in fact is that there is no necessary connection or logical connection between words and reality (Winograd and Flores, 1986, 51).

We create, more or less adequately, the descriptors and the concepts (conveyed by noises and marks) that provide the linguistic tools with which we apprehend whatever grasp of reality we have. It follows, therefore, that there do not appear to be any statements the contextual truth of which can be known a priori. It also follows that all contextual statements are open to empirical verification and falsification. Those statements that can be accepted in a conversational context are synthetic in nature. The analytic/synthetic dichotomy, with respect to the phenomenal world, is an illusion. Wittgenstein is attributed with saying: 'So you are saying that human agreement decides what is true and what is false?' (Wellmer, 1991). In a similar vein Turing (1950, 433) laments:

> If the meaning of the words 'computer' and 'think' are to be found by examining how they are commonly used it is difficult to escape the conclusion that the meaning and the answer to the question, can computers think is to be decided by Gallup poll. But this is absurd.

Unfortunately, it appears that language represented by sounds and marks only has the meaning given to it by people. So we have to say, absurd though it may seem, that meaning is decided by use. The phenomenal (and material) world is accepted as existing in Conversation Theory independent of particular people, and can be communicated about by people with a language. However, the meanings and importance that attach to things are the result of the cognitive and evaluative activities of people. In an analogous way, this is equivalent to the value attached to gold which has that value only because people have sought after the metal. Thus, while the referents of language have origins in the phenomenal world, the link between those referents and the phenomenal world is tenuous and the result of agreement among people rather than any necessary or direct and immutable relationship.

This is not to say that the language and concepts are vague and arbitrary of necessity, but rather that if the concepts used are defined vaguely or used vaguely then that is the direct result of the cognitive processes of the persons involved in the definition or the use. Language may be precise or not as people choose to make it. The process of determining whether language is vague or matched precisely to the topic of the conversation is established

during the act of conversing, which is a two-person case of Turing's Gallup poll. Equally important, and perhaps more problematic, is the realisation, confirmed in this application of Conversation Theory, that a precise definition of a concept may capture something of the material world or it may not. At best, what it will capture is the shared meanings held by people in a particular conversational context. Confirming or denying the accuracy and adequacy with which concepts reflect the nature of the material world requires clarifying what the people mean by the concept and then checking this with the actual phenomena of the material world.

This statement is not news to philosophers interested in phenomenology, but is frequently forgotten and trivialised by those wishing to argue that the nature of the world is somehow captured in the noises and marks we use to communicate about the world (Turing, 1950, Chomsky, 1968).

Haugeland (1989, 100) states that:

> formal tokens lead two lives ..[syntactic lives and semantic lives].. in which they [the tokens] have meanings and relations to the outside world.

This is the view held by people interested in artificial intelligence work (Haugeland, 1989). It is not compatible with the view of human conversation which confines the construction of meaning to human activity.

Aspects of Human Conversations

An outcome of this implication behind my view of Conversation Theory is that until agreement about shared meaning is reached in the conversation, there is no way of knowing whether the topic is actually understood- that is learned - by both people. Each person knows about aspects of the topic and must contribute this knowledge to the conversation. For example, for this discussion, we know already that the roles of the persons in a conversation are styled 'learner' and 'teacher'. The 'learner' will be used to refer to the person who has been involved with the topic for a shorter time and suppose therefore that the learner 'knows less' than the teacher. The teacher has the task of providing the information and making possible the procedures that are appropriate to the content and the context of the conversation, while the learner provides the feedback that enables the teacher to establish what has been learned and therefore what has still to be considered. There is an irony in

the common declaration that the learner knows less about the outcome of the teaching. Actually, the learner is the most knowledgeable about (and is the only authority on) what has been learned. It is this knowledge that is fundamental to the continuation of (and evaluation by both the participants in) the conversation. It is this knowledge that the teacher must acquire in order to assess the success or otherwise of the teaching process. In Chapter 2, Figure 10 showed the interpersonal interaction involved in two people reaching agreement. This model combined the earlier models shown in Figures 8 and 9. An analogous situation is shown in Figure 30 between two computers, and is the first indication of a limitation inherent in the computer. This is shown by the question marks indicating that something in the diagram is not known. (The question of agreement will be returned to later in this chapter.) In addition, when understanding is achieved, if there is no further concept introduced to converse about, the conversation will stop on that topic. In other words, conversation may continue until the point at which there is nothing further to agree about or one of the people realises that there is insufficient shared language to sustain the conversation and thus ceases to contribute about the topic.

The evaluative role is usually filled by the 'teacher' but may, by default, be initiated by the 'learner', as an outcome of inattention to the topic. For the purposes of this discussion, any interaction between the computer and the people using it, was viewed as a 'conversation'. The case being considered was the learning context involving a computer and a person. The computer, with a monitoring program, acts in part as a store for the conversation between the learner and whatever was provided by the person who created the learning materials. Recall that a conversation is an internal dialogue conducted in a single brain. The underlying point emphasised here is that the brain is the location of all conversations. The noises and marks created by others and received by the conversant are invested with meaning by each conversant. If it were the case that meaning was conveyed in the medium then it ought to have been evident in the disc records made of the interaction between the subjects and the BBC AIV Computer System.

It was simply not possible to extract meaning from that disc record because it was in the form of bits, that is 'binary digits'. Furthermore, one of the subjects was a Portuguese-speaking Chilean. No evidence of cultural

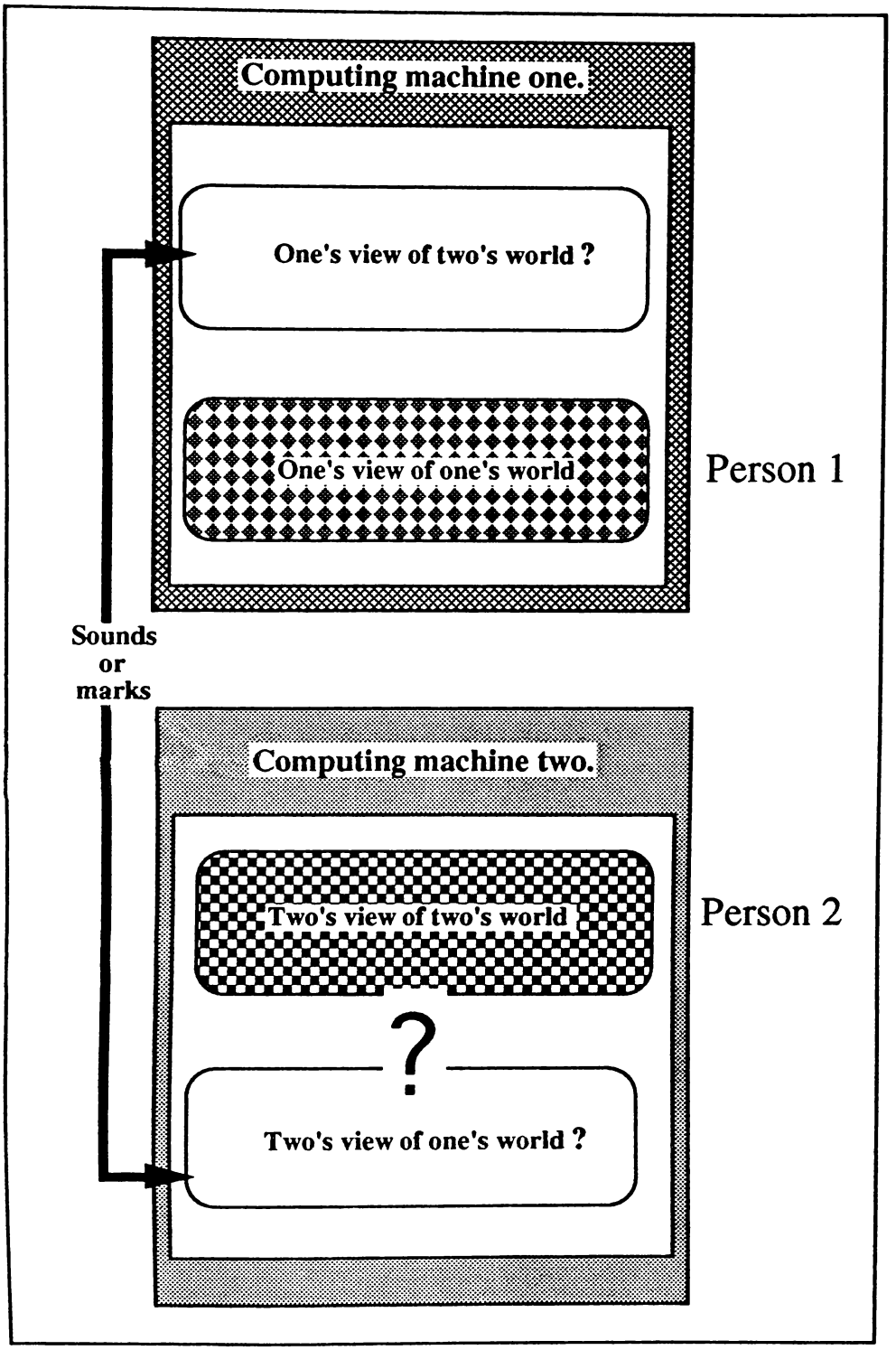

Figure 30. A Paskian view of a conversation between two people using two machines. The machine cannot be a third conversant **in the same way as a person.** This is because no pragmatic language agreement can be algorithmically created in the machine between the worlds of the people and the machine.

origin is found in the record of that person's person-computer interaction. This unremarkable finding places most of the claims made in the field of Artificial Intelligence for emulation of human intelligence under serious question (Haugeland, 1989).

An example is presented to elucidate this point. The meaning a person intended to convey by one mouse event cannot be distinguished from the meaning intended by another mouse event, such as a mouse click, where these are recorded in bit form. It follows, therefore, that meaning must be a consequence not of computer events, but of brain events. In order for the recorded 'bits' to be meaningful, additional code had to be written to translate binary data of the record into characters and then translate the characters into words. The marks, in which the words are produced, are then converted into sensory data by a person who is attending to them. Since people are able to give pragmatic meaning to mouse events and the marks which represent words, it follows that meaning is entirely a human creation.

It seems safe enough to state that meaning is created in one brain. For it to become part of the brain events of another person, implies an act of creation on the part of other person - the hearer. The interactions that people have with the computer may be viewed as one-sided conversations from the point of view of the observer. From the point of view of the user the conversation is an internal one in which a body of knowledge is built up from the data another person programmed into the computer. But, the analogy of what the computer contains has no more meaning than that seen in a mirror. Endowing a mirror with the capacity to create 'meaning' because it reflects a representation is simply an inappropriate use of metaphorical language.

Limits on What Computers Can Know

It has been argued that computers 'have the notion of semantics' or symbolic meaning (Haugeland, 1989). This is correct in so far as the defining characteristics of a 'Turing computer' are that it 'knows' what is meant by the command 'move the recording tape', and 'read the tape', 'write to the tape' and 'erase the tape'. The Turing machine recognises a limited set of symbols that can be written to and read from the tape. In total, these are the very low level 'state changes' that the Turing machine is capable of carrying out. These few items entirely describe the pragmatics of the meaning of what we claim the computer knows (Gandy, in Herken (ed) 1988, 81).

It will be shown in the next chapter (149 ff) that the computer cannot be programmed with an algorithm that will ensure the matching by the machine with the strategies used by the learner. The argument presented in support of this assertion is based on the insoluble nature of the decision-on-matching-problem. These understandings lead me to consider some theoretical and interdisciplinary aspects of Conversation Theory, the Halting Problem, and undecidability. These items are discussed in the next chapter.

In Phase 2 of the research design, two issues that emerged from Phase 1 research questions have been examined. The first issue, dealt with in this chapter as Step 4, concerned what could be learned from the literature about machine matching learning strategies and learning materials. In summary, the literature showed that knowledge is socially constructed. The second question, about having a machine act as a conversant, was addressed as Step 5 and is considered in a wider context in the next chapter.

CHAPTER 6

DISCUSSION

Outline: This chapter discusses the findings from examining the second emergent question, **Can a computer act as a conversant in a conversation?** which developed during the research. Section 1 outlines some theoretical limitations on Conversation Theory. Section 2 examines the question of a machine acting as a conversant. The issue of meta-vocabularies is reconsidered in Section 3. Agreement as a basis for concluding a conversation is examined in Section 4. A proof of the undecidability of machine conversation is provided in Section 5 together with an outline of the nature of decision problems. Section 6 examines the contingent nature of conversations and concludes with an introduction to Chapter 7 which examines the wider questions raised by the research.

Theoretical Limitations on Conversation Theory

The empirical data collected in the course of the research fills many computer discs, yet the outcomes that can be extracted from these records are brief when considered in relation to the research question. This brevity of report is a direct consequence of problems encountered in confirming Pask's contentions about his laboratory work in the classroom. Further work is required to ascertain whether this outcome was a consequence of the particular research environment or other factors.

The work resulting from **Phase 2** of this research is reported in Chapter 5 and re-examined here in relation to two theoretical aspects of Conversation Theory. The first aspect concerns issues of the limits of language in terms of ideas about representation, and constitutes a re-examination of Question 4. The second aspect concerns the limits of the application of computing power to problems and issues in human conversation, and constitutes a re-examination of Question 5.

Modified Question 4:

Can learning strategies be matched with a computer using a meta-vocabulary?

When dealing with human-computer interaction, as this thesis does, there are limitations on what may be accomplished. These are the direct consequence of the limits of language. It has been customary to view the process of communication as involving the transfer of representations from one person to another through the medium of language. The view adopted here follows Rorty's view (1989) in which the limits of language are declared at the outset so that expectations are clear to the conversants.

> Only when we do that (drop the idea of languages as representation) can we fully accept the argument I offered earlier - the argument that since truth is a property of sentences, since sentences are dependant for their existence upon vocabularies and since vocabularies are made by human beings, so are truths. For as long as we think that "the world" names something we ought to respect as well as cope with, something person-like in that it has a preferred description of itself, we shall insist that any philosophical account of truth save the "intuition" that truth is "out there".
>
> Rorty, 1989, 22

Rorty's position on the status of claims to know is that: 'Our certainty will be a matter of conversation between persons rather than an interaction with non human reality' (Rorty, 1979, 157). He is not alone in this view, drawing on the thinking of the later Wittgenstein (1968) and both Sellars (in Rorty, 1979) and Quine (in Rorty, 1979).

> I shall be arguing that their (Sellars and Quine) holism is a product of their commitment to the thesis that justification is not a matter of special relation between ideas (or words) and objects, but of conversation, of social practice.
>
> Rorty, 1979, 170

The assertion of a socially constructed reality is no more clearly stated than Rorty's view: 'The crucial premise of this argument is that we understand knowledge when we understand the social justification of belief' (Rorty 1979, 170). This particular view has immediate consequences for the activities of philosophers, for other disciplines, and for this research. He points out that:

> To drop the notion of philosophers as knowing something about knowing which nobody else knows so well would be to drop the notion that his voice always has an overriding claim on the attention of the other participants in the conversation.
>
> Rorty, 1979, 170

I propose adapting Rorty's proposition to the context of the status of the social justification for the reality studied in the discipline of geography in which it would read: To drop the notion of geographers as knowing something about geography (however it is defined) which nobody else knows so well would be to drop the notion that the geographer's voice always has an overriding claim on the attention of the other participants in the conversation.

Similarly, adapting Rorty's contention about the role of philosophers in relation to the role of geographers:

> The useful kibizting they can provide on various topics I just mentioned is made possible by their familiarity with the historical background of arguments on similar topics, and, most importantly, by the fact that arguments on such topics are punctuated by stale geographical (philosophical) cliches which the other participants have stumbled across in their reading, but about which professional geographers (philosophers) know the pros and cons by heart.
>
> adapted from Rorty, 1979, 393

Justification for this view is found in Rorty's treatment of Davidson's ideas on passing theories.

> Davidson sees him (Aristotle) as having hit upon a tool which happened to work better for certain purposes than any previous tool. Once we found out what could be done with a Galilean vocabulary, nobody was much interested in doing the things which used to be done with an Aristotelian vocabulary.
>
> Rorty, 1989, 19

The implications of such a view for current computer orientated research are, as Kuhn points out in the context of philosophy of science, that 'it is doubtful .... whether philosophy of science could construct an algorithm for choice among scientific theories' (Kuhn, 1962). Kuhn's doubt draws attention to a difficulty implicit in the algorithmic description of problems. 'There are limits to the types of problem that may be solved algorithmically'. If it is argued that : 'the problem is that the gap between the neutral language and the only languages useful in deciding the issue at hand is too great to be bridged by "meaning postulates"' (Rorty, 1979, 324), then it follows that the nature of the gap somehow prohibits or inhibits the process of meaning translation from one vocabulary to another. Or it may be that the exercise of finding an intermediary language is without point in the long run anyway, since such a language would be about the process of communicating rather than what the communicators were attempting to communicate. Thus, the issue of 'what is to be communicated' is what should be addressed rather than 'the criteria for deciding about the meta-language' in which it is evaluated.

This may be what Rorty has in mind when he advises: 'treat vocabularies as more like alternative tools than like bits of a jig saw puzzle' (Rorty, 1989, 11). It is suggested that the case is stronger in the context of computer mediated conversations than Rorty is representing it. I show below that it is simply not possible, in the strictest and most universal sense, to find an algorithmically decidable meta-vocabulary for a computer that would permit such a translation. This conclusion is based on a proof developed from the theory of algorithms and confirmed in the analogous context of consensus in distributed systems (Turek and Shasha, 1992).

An algorithm is a sequence of steps, using data as inputs to a process, which, when executed in a specified order by a person or computer, will bring about a desired solution state (an output) within a defined time span (Beardon, 1989). The class of problems that is algorithmically solvable is unique in that they can be executed on a specific type of digital computer called a "Universal Turing Machine". A great deal of work has been put into the identification of difficult instances of algorithmic problems. Among these is the problem of meta-vocabularies.

The Problem of Meta-vocabularies

The problem of a meta-vocabulary that would distinguish between competing scientific theories, takes two forms. One, such as Kuhn was talking about, takes the form of a language into which all other languages could be translated. The second, acting as some kind of super-vocabulary, such as Rorty was talking about, will be dealt with by analogy. It is suggested that such a meta-language is imagined to exist. We ask what attributes must it have in order to function in the desired ways. Such a meta-vocabulary would be part of a meta-language. The meta-language would have to accept input from the other two languages. The input would be in the form of rules for the syntax of the languages. The meta-language would need to be capable of determining whether the two sets of rules defined the same language or statements or programs. This is not a trivial task. I propose reducing the complexity of this task by considering it in relation to possible outcomes. In this context the specific question asked is: **Are the two possible sets of rules that describe the languages in question able to be described by the rules of the supposed meta-language?** Some preliminaries related to the Turing Test are required by way of introduction before an answer to the question is attempted.

The Conversing Computer

The issue of the role of the computer in a conversation involving a person has long been of interest to workers in computer science and the cognitive sciences. The so-called Turing Test is one of the earliest formal attempts to distinguish between possible and impossible person/computer interactions (Turing, 1950). In brief, the Turing Test sets up an experimental situation in which a person is connected to two other language processors, one of which is human, and the other is a computer. It is assumed that a very clever program could emulate a human to the extent that the person doing the interrogation could not distinguish between the computer and the human. There are those who believe that the Turing Test could not be passed by a computer under any circumstances (Dreyfus, 1979 and 1982). Others, particularly proponents of Artificial Intelligence (as defined in Beardon, 1989), argue that the problem will yield a solution in due course.

In Conversation Theory terms, for a computer to pass the Turing Test would require that all the complex modelling capability discussed in Chapter 2 be somehow built into the computer. That is a huge task, the knowledge component of which is currently being explored by Lenat (1983). In the context of the research carried out here a much smaller task was undertaken. The smaller task was to match two sets of data for equivalence. The first set of data is the students' responses to an interaction of the type that would result from querying a database. Three aspects are important:

1. the nature of the initial query, is it holist or serialist or mixed in type;
2. the type of data required by the student as a response (is it holist, serialist or mixed in type) and form of the marks and signs required as a response;
3. the vocabulary making up the marks and signs may be text or images (either still or moving) or employ any other means of conveying data.

The second part of the problem was to request Teachback from the student of the material that has been provided. Again, three aspects were important:

1. the form of the request for Teachback, is it holist, serialist or mixed;
2. the form of the response provide by the student, is it holist, serialist or mixed;
3. and finally, the form of the marks and signs offered by the student, are they holist, serialist or mixed.

These are complex tasks, but the fundamental issue involved in matching requests for replies in conversation is the nature of the outcome. Pask's Conversation Theory advises that the outcome of a conversation depends upon the **agreement condition**. The agreement condition specifically requires that one language processor to be able to confirm the marks and signs provided by another in such a way as to convince the other language processor that the two contributions are equivalent in meaning. For the purposes of this discussion I reduced the complexity of conversation to a single critical outcome: **the decision that an agreement has been reached on a shared understanding.**

The basis of this agreement will be a comparison of the material taught initially by one language processor with that taught back subsequently by another language processor. The criteria for agreement on shared understanding are likely to be simple for some contexts, but complex for others. A simple example would be an agreement over a comparison about the time of day recorded by two watches. A more complex example would be an agreement over a prognostication on the current state of the economy. The outcome of the conversation could be encapsulated in a single decision over whether an 'agreement' on understanding has been reached.

Writing an algorithm for establishing an agreement state between conversants is a puzzling sort of problem. For quite some time it appeared so straight forward that almost anyone should be able to set up the conditions given the specifications. Such specifications would have to include syntactic (rules for expression and word organisation, a grammar) and semantic agreement (the accepted meaning of the utterance in general), and criteria for agreement about the pragmatics of the language (what was meant on any one particular occasion). A possible structure for the specification of Pask's theoretical constructs that would facilitate this type of linguistic analysis is provided in Figure 31.

A literature search was carried out to locate prior examples of such specifications. However, it revealed very little on the concept of agreement. There is almost no literature on the concepts involved in generating computer agreement in the context of conversation in computing. It seemed that the problem was either new, was expressed in a different form, had some other unique features, or was considered unsolvable. There is a large literature on 'intractability' which deals with unsolvable problems. The seminal work in the field is by Book (1978). A coherent review is provided by Garey and Johnson (1979). More recent reviews and work on these concepts is found in Treinen (1990, in Nori and Madhavan, 1990) and in Herken (1988).

Syntactic Equivalence

Syntactic equivalence requires that two sets of rules are shown to define the same language. Harel (1987, 192) states that this task cannot be carried out by a computer that is, it is algorithmically unsolvable.

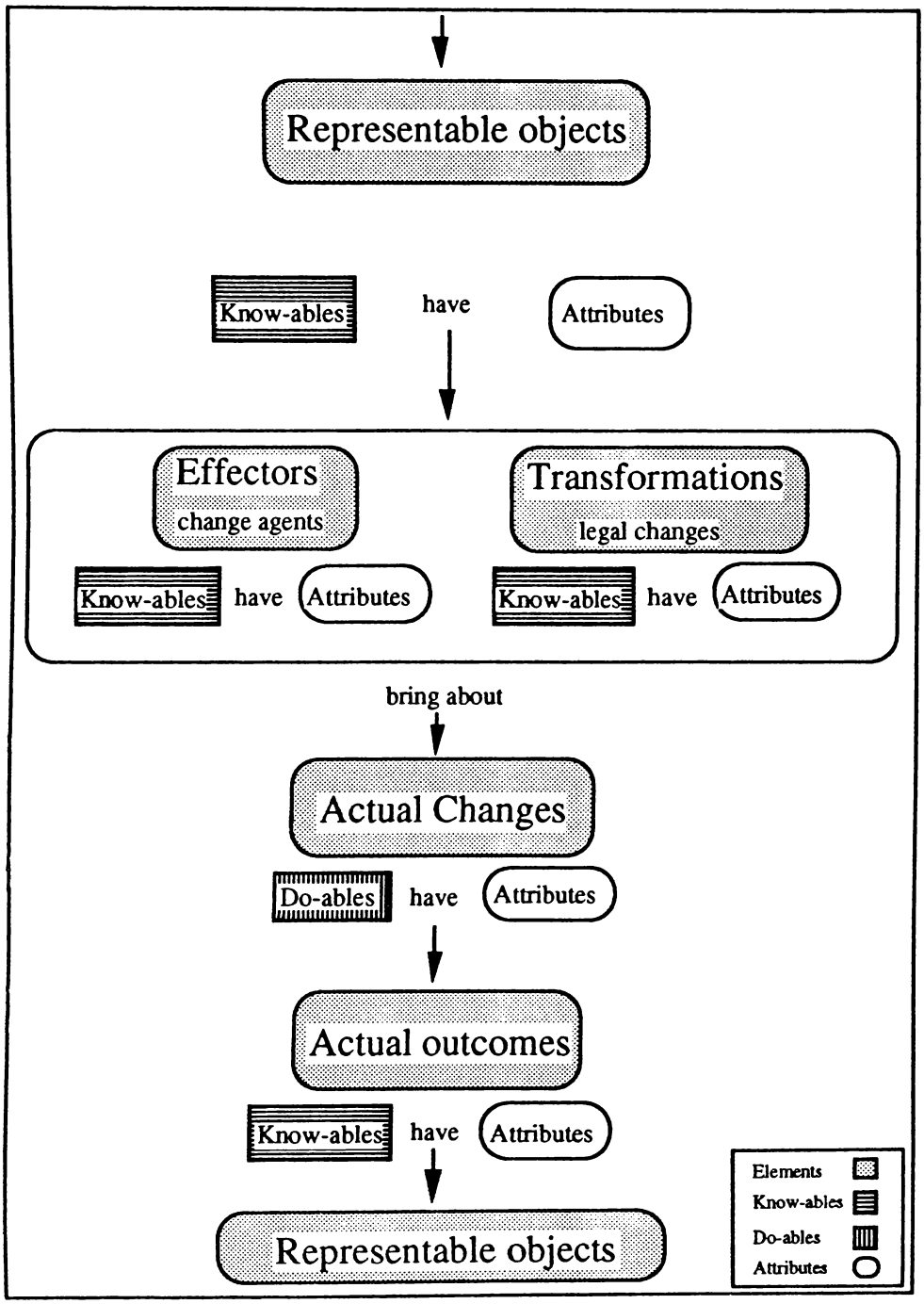

Figure 31. The five elements of 'what may be known'.
These are shown as two categories, know-ables and do-ables.

The particular context in which he demonstrates this is in relation to establishing whether or not two sets of rules for the syntax of two compilers (programs which convert humanly readable script into machine readable script) define the same language. This is an issue of importance in computing since success in establishing such an outcome would ensure that a new, supposedly faster compiler had all the attributes of the earlier version as well as the added speed.

The problem of syntactic equivalence can be reduced to one of undecidability by recasting it in terms of a binary decision. The question is: **'Can an algorithm be written which will detect the syntactic equivalence of two sets of rules as defining the same language?'**. The outcome of this question will be either "yes" or "no". We assume that such an equivalence algorithm can be written. We then explore the consequences of attempting to apply it in a similar way to the halting problem (Barbour 1991a). A diagrammatic representation of the Halting Problem is shown in Figure 32. Briefly, this problem asks is there an algorithm which will terminate on input X if it were to be run. If Prog P 'halts' then it is to return YES. If not, it is to return NO. The problem is algorithmically insoluble because while P may terminate on any input X and return YES, there is no way to decide how long to wait for a NO for any particular X. A sketch of the proof is presented in Figure 33. In this figure a program S is assumed to exist which solves the halting problem. S is provided with a copy of itself as input. Two further copies are made, each of which is run under 'assumed to halt' and 'assumed not to halt' conditions. The outcome of running both algorithms shows a contradiction in that the hypothetical program provides output only under the non-halting condition. Since all other steps follow the rules of program construction (are legal), it follows that the halting algorithm itself cannot exist.

The strategy of 'reduction to a known solution space' was also used to determine whether or not a computer is able to participate in a conversation with a human being in a way that would match that expected of person. A model analogous to the Halting Problem algorithm is illustrated in Figure 34. This model is used to show that two of Pask's claims for Conversation Theory are open to serious theoretical doubt.

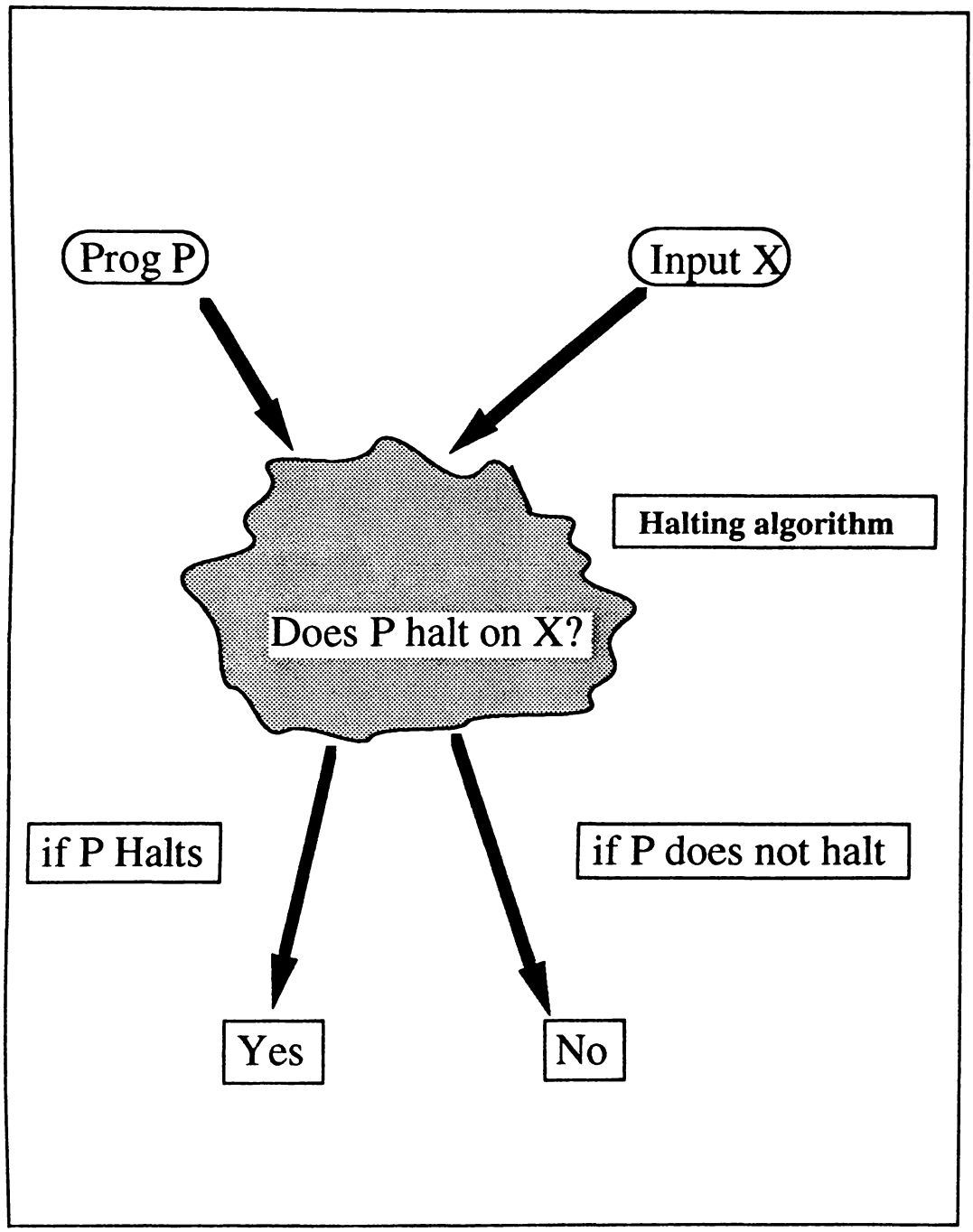

Figure 32 A summary of the 'halting problem'. In this diagram the question is asked of the 'Halting Algorithm' does Program P halt, given Input X (Harel, 1987 195). Output is required in the form of 'Yes' or 'No'.

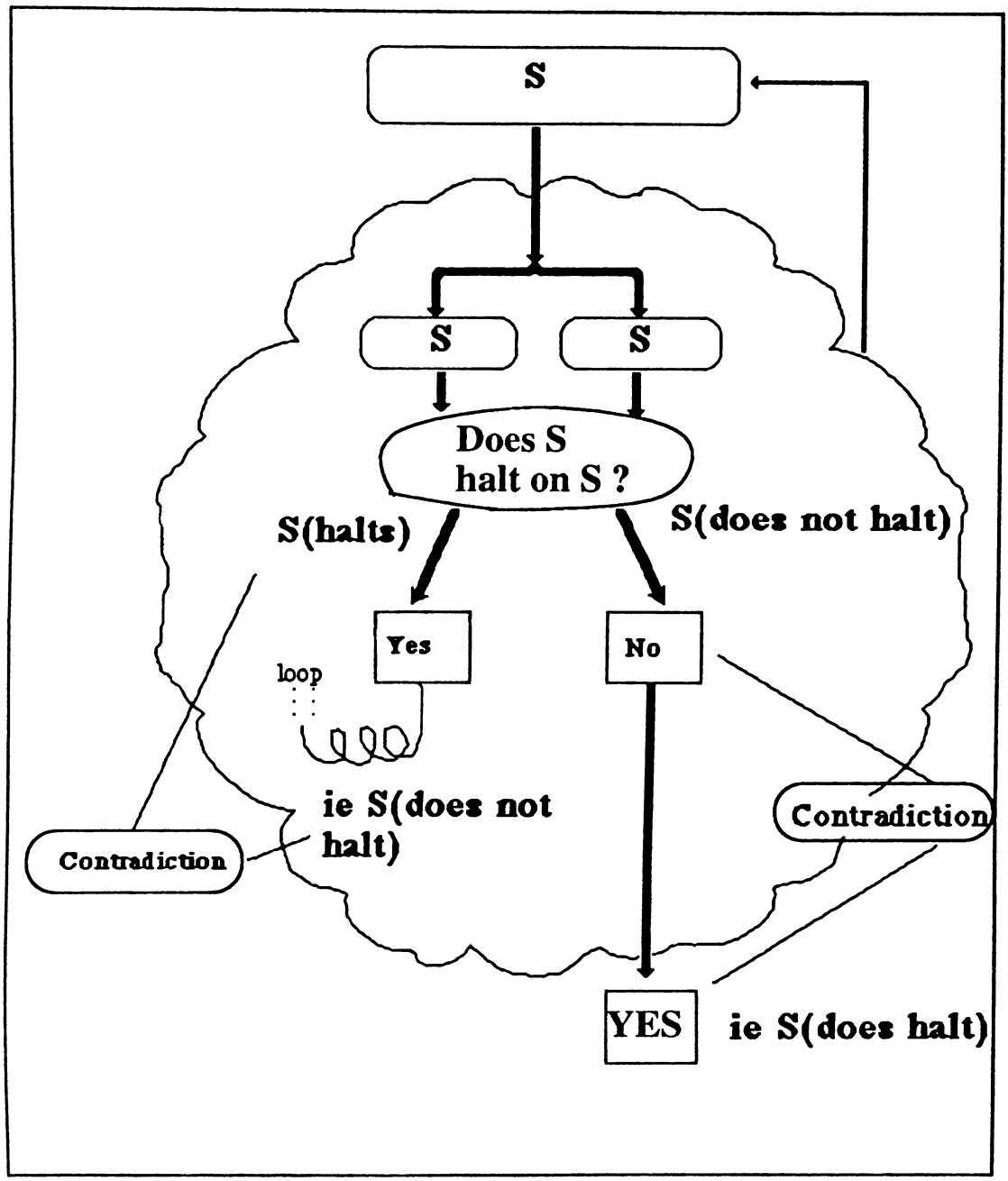

Figure 33. A sketch of a Halting problem proof by contradiction. It shows that the Halting algorithm cannot exist because if it were given itself as input then both the halting and non-halting outcomes are possible. It is this paradoxical outcome that shows that the Halting problem is undecidable (after Harel, 1987).

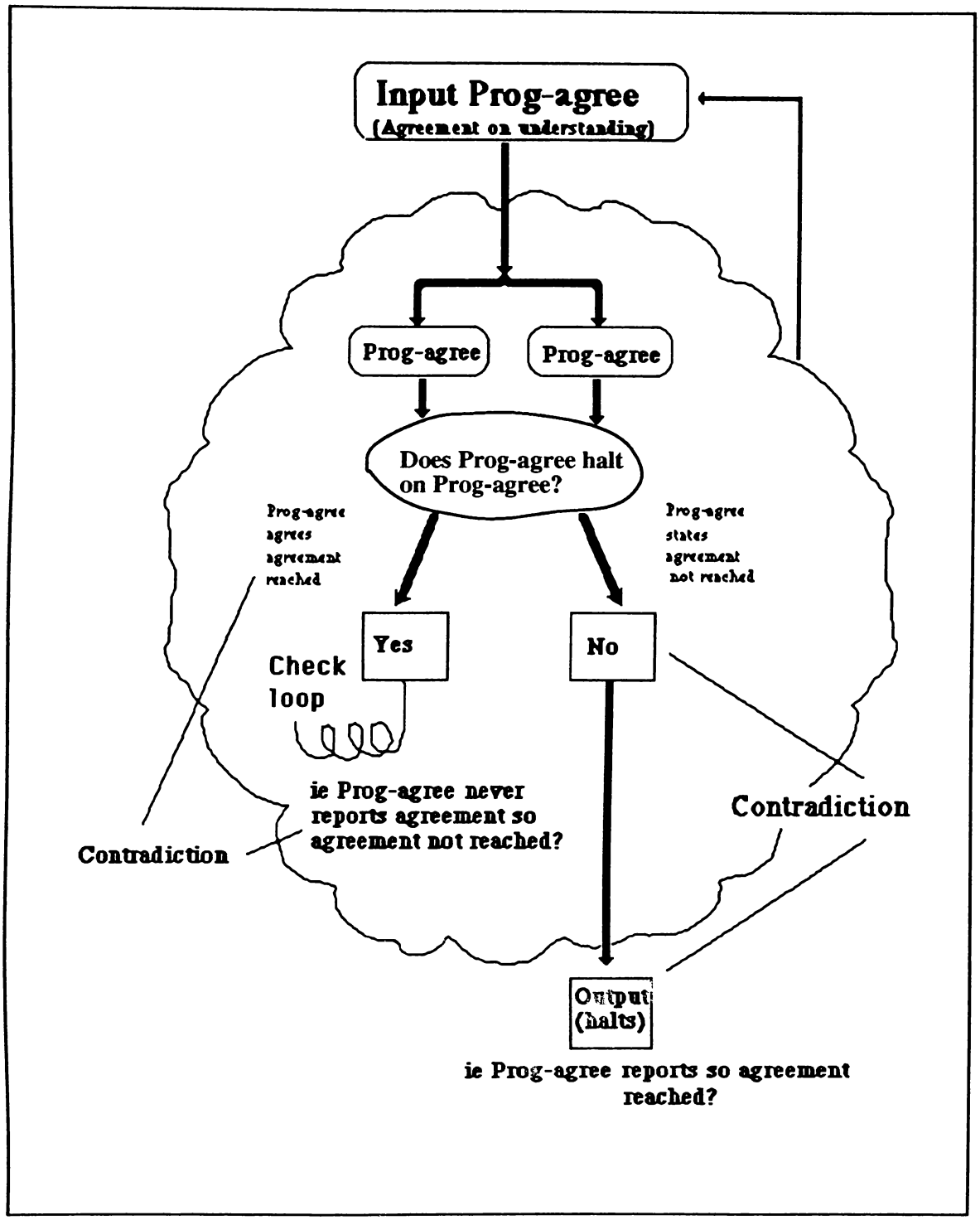

Figure 34. A sketch of a proof of the undecidability of the Agreement problem. This sketch follows the same argument as the Halting Problem Proof and shows up a similar paradox.

The first of Pask's claims is that the computer can provide a match between the person interacting with the computer and the organisation of the material that is provided by way of examples or instances which are in turn responses to questions. If responses to questions are viewed as sequences, Harel (1987, 191) shows that no matter how many characters are added to the sequence there is no way to establish that the resulting sequence is organised in the way that would yield a common word. Just providing the sequence, assuming it could be found, would not be enough to ensure that the response made sense or was correct for an inquirer.

The second aspect considered was whether Pask's contention that the computer could be a conversant was sustainable. Again, the argument presented to contest this view depends on the reduction of a very complex human interaction to a single outcome - an agreement on understanding. It is shown below that the required outcome is not reachable by algorithmic means.

The computer cannot be a conversant because it cannot 'agree' that what it 'knows' (either the semantic meaning or the pragmatic meaning) is equivalent to what a person knows (also either the semantic meaning or the pragmatic meaning).

The semantics of the languages that a computer can express are very limited. The computer cannot, for example, apply what is known to a new context. It does not create analogies. It has no concept of role (or perspective) or of change of role (or change of perspective). The computer can be made to be an outstanding mirror, but it is an impoverished teacher in Conversation Theory terms. Both the teacher and learner roles are required to sustain the central concepts of Conversation Theory. By far the most important requirement is to teachback what has been learned in a new context. This concept was illustrated in Figure 5, the last diagram. Meeting the teachback requirement necessitates the ability to embed knowledge in the world of common sense. The problem of embedding knowledge in the world of experience has yet to be solved. The nature of decision problems discussed in the next section is advanced as a possible explanation for current difficulties.

Decision Problems

Garey and Johnson (1979) describe a class of algorithmic problems called decision problems. There are only four possible states with respect to such problems. The first is the initial state or the undecided state, the second is the error state, or the undecidable state, the third and fourth are the outcome states of "yes" and "no". In the context of conversation, the last two answers are the interesting responses to the question "Has agreement been reached?"

Undecidability of Machine Agreement in Conversation

A discussion of the proof of the undecidability of the agreement problem is as follows. For this discussion it is assumed that the agreement problem can be solved (Figure 34). An algorithm - program - that can carry out the steps involved in the process is constructed. The program is called the Agreement Program. The program is run on a general purpose Turing machine, a computer. Two further copies of the program are made as input to the program. They are called 'CopyOne' and 'CopyTwo'. The Agreement Program only produces a 'yes output' if it can confirm that CopyOne halts. It produces a 'no output' if CopyTwo does not halt. Individually, these outputs will be interpreted as information about the Agreement Program. The Agreement Program 'observes' CopyOne and CopyTwo as they are executed.

The question is posed: If the Agreement Program is given two copies of itself, as data, will they halt? The output from the Agreement Program will be: Yes, to mean CopyOne has halted; or No, to mean CopyTwo has halted. The original Agreement Program continuously checks whether or not the Agreement Problem has been solved (Figure 34). If the Agreement Program produces a 'no' output, it means that the first contradiction has arisen. The program has reported 'no', from which we infer CopyTwo has halted. However, in relation to CopyOne, this output infers that the process of problem solving is still continuing.

The first of the two copies of the Agreement Program is now under the observation of the original program which is set to report whether the Agreement Program stops. It continuously checks to see if CopyOne has halted. A 'yes' should be produced, but the algorithm cannot confirm its own

status unless it has halted. This is the second of the two contradictions, 'nothing' means 'yes'. These contradictions mean that the Agreement Program cannot exist, because for it to do so requires it to be in contradiction with itself. It follows from this discussion that a computer cannot establish agreement in conversation with a human. The most straight forward introduction to the theory behind the undecidability problem is found in Harel (1987). Further discussions of the formalism or mathematics of the problem are provided in Beckman (1981).

An Analogy with Consensus

An analogous situation is found in distributed networks of computers. In that context, 'consensus' means a number of processors must 'agree on a decision based on initial states' (Turek and Shasha, 1992, 9). Fischer, Lynch and Paterson (1985, in Turek and Shasha, 1992) showed the impossibility of deterministic consensus among two or more processors in an asynchronous distributed system. 'Distributed' means two or more physically separate processors operating in an independent way, but linked by communication lines for the purposes of software and data sharing. An asynchronous system is one in which processor speeds (numbers of clock cycles per second) are not known. Conversely, a system is synchronous if all processors proceed at a predictable speed. Clearly, a system in which a person is interacting with a machine is an instance of one asynchronous processor (the person) in communication with a potentially synchronous machine. The potential synchronicity cannot be taken advantage of because the person's processing activity cannot be known with any kind of precision. Turek and Shasha (1992) further refine these conditions in a matrix shown in Figure 35. In this matrix *Message order* refers to the temporal sequence in which messages are passed. While it may be possible to order machine interactions, it is not possible to predict the ordering of human communications. The *Bounded/unbounded dimension* refers to the delay between messages. Again, bounding machine-message-passing is possible but is not necessarily the case with people. The *Broadcast dimension* refers to the possibility of sending messages to more than one processor in a network. In the conversational context this implies that more than one processor receives the data at one time. Human perceptual mechanisms are such that there is a high level of uncertainty attached to human message acquisition.

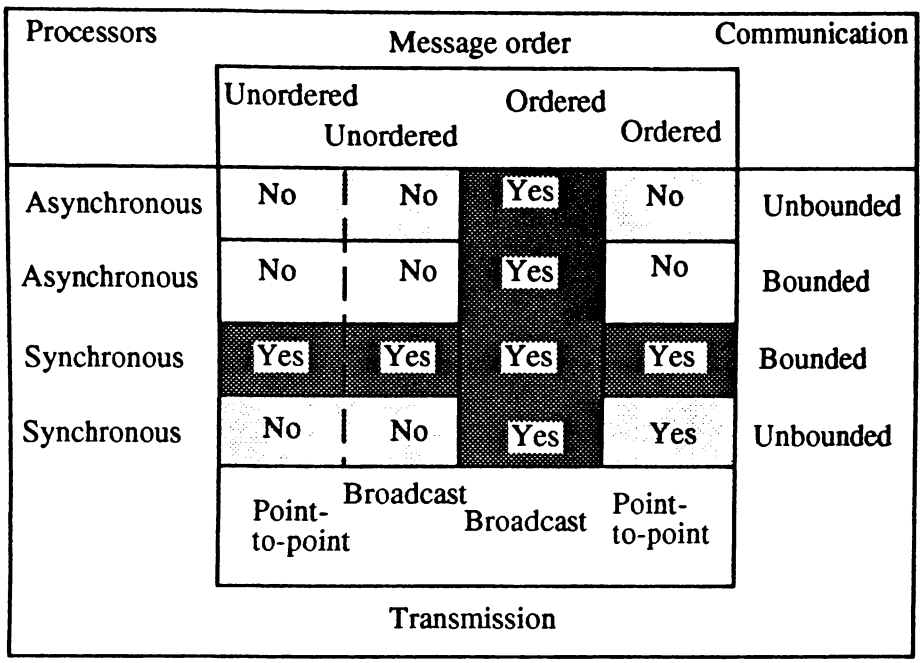

Figure 35. Conditions for consensus in a distributed system. The two shaded bands show when two or more processors can achieve consensus (Turek and Shasha, 1992, 10).

Looking at Figure 35 from a positive perspective suggests that person-machine conversation is possible under certain strict criteria. By far the most important criteria are synchronicity and ordering of interactions. Whether the rigidity of establishing synchronicity and ordering would constrain conversation beyond acceptability is not clear, for the evidence is not yet in. However, Figure 35 is suggestive of ways forward. The next section returns to empirical data and examines this in the light of philosophical aspects of Conversation Theory.

Discussion on the Contingent Nature of Conversation

Research findings, as reported in Chapter 4, show the outcomes of working with students in the classroom with a computer controlled learning environment, the extended BBC AIV. Recall that the BBC AIV is a slice of life from the British Isles in 1986, covering every imaginable aspect of things British. This system was extended to provide the medium for testing Pask's assertions about Conversation Theory. While the task for students was to demonstrate they could learn about and use the system, this was presented to them as secondary in importance to learning about a topic in the domain of British Geography. The computer was presented to students as a tool to

provide a wide variety of useful information through its very substantial database. This strategy permitted the computer to have a justified and pragmatic role in the classroom - it was another tool like a map or an encyclopaedia.

The problem is that given the same experience, people produced different demonstrations when asked to tell others about a topic using the system. This is the 'equifinality of cause' problem (Morris et al., 1988). Briefly, this states that similar 'causes' can have different effects and different causes can have the same effect. It is extraordinarily hard to disambiguate a single cause from multiple possible causes (Cates, 1985, 81).

The implication of equifinality of causes is that there was no basis for determining which, if any, of the productions of the student learners was 'correct' when there was no one criterion that recommended itself in the required a priori sense. The records of student learning were only trivially different and in addition, the steps employed (the strategies) to obtain these outcomes were also only trivially different.

Lack of criteria to distinguish correct strategies or correct outcomes meant no meta-framework could be established. Lack of a meta-framework meant that there was no way to ensure that sets of responses could be translated into a common set that would allow the two sets to be compared for equivalence of meaning - agreement. Establishing the conditions for this type pragmatic agreement is a much harder problem. It is well beyond the power of any possible digital computer algorithm. It is part of the set of problems called 'undecidable problems' the consequences of which are discussed in a following section.

A descriptive framework for assumed activities going on in the interaction between the computer and the learner is shown in Figure 36.

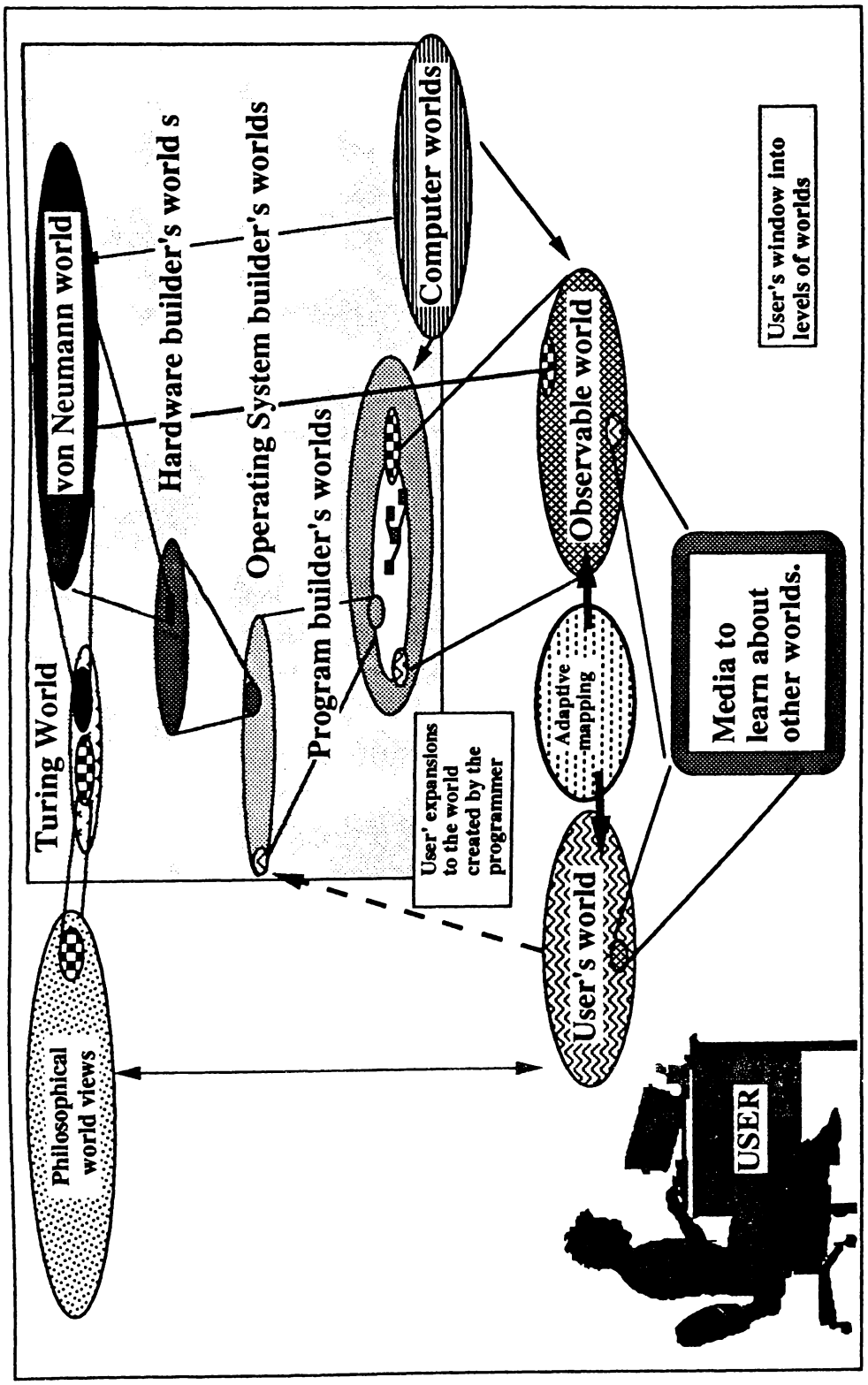

Figure 36. Windows into the world views of Computer Science and Users.

The main point is that the world views of the people involved in interacting with the computer affect what each may learn in ways that are not immediately apparent. The question arose first as to how agreement could be modelled at the level of the user and the observer. Second, what was required to account for the user's evident capacity to model and take advantage of the system's facilities? Third, how to account for different outcomes. A process orientation led to a model which I present as a metaphor for what was required for people to converse. In this sense the 'marks and noise' metaphor described below is presented as a useful tool with which to think about what goes on in conversations.

In the pursuit of geographic knowledge, the status of language has generally been seen as recording truths rather than acting as is proposed here (following Rorty (1989) citing Davidson) - as a more or less useful tool. Thus, language is construed here as being made up of vocabularies. A particular vocabulary is assessed, in this view, as being either more or less useful in comparison with other vocabularies.

Davidson's view, as presented by Rorty (1989), is that a language is best described by the concept of a 'passing theory'. That is, that the speakers of a language as a group hold an interconnected, but constantly changing and renewed set of vocabularies. The renewal process implies that some of the vocabulary is lost from lack of use, it 'passes' from use, hence the concept of a 'passing theory' of language. On this view it would be quite wrong to consider that vocabularies existed independent of their users. To do so would be, on Rorty's account, to 'worship the dead corpses of our ancestors' metaphors'. The realisation developed among philosophers that there appeared to be no way to step outside the various vocabularies we employ to find a meta-vocabulary that takes account of all possible vocabularies (Rorty, 1989).

In view of the discussion above on meta-theories, it was proposed that 'Truth' is a 'made' concept and does not exist independently of the sentences in which it is expressed. Consequently, it is proposed that 'Truth' is invented for the purpose of describing predictions and providing for control. It follows, then, that we have no representations of the world, but rather created descriptions which more or less cohere with what goes on in the world. Thus, truth is embedded in the rules that people employ to describe the world. There is no necessary truth to be found the sentences with which we agree to

ascribe an accepted coherence of marks and noises with some aspects of the world 'out there'. The phenomenal world does not depend on our sentences for its existence, but the social world certainly does. The problem may be summed up in the 'Problem of marks'.

Remember that if the symbol '-' can be: one for the Chinese, a link between complex words for English speakers and also, a spacer between words among others, then 'truth' is in relation to vocabularies, not in relation to marks in the world. As Rorty (1989) puts it: 'The world did not suddenly speak Newtonian shortly after Newton's view of the world became available'. Some, but not all people found Newton's vocabulary a more useful way of speaking about and predicting what goes on in the world. It can therefore be concluded that the languages that people use are made, not found, and that 'Truth' is a property of linguistic entities, not the phenomenal world. Vocabularies exist as tools that facilitate conversation. Many vocabularies empower conversation by facilitating the exchange of world views.

The way the phenomenal world is viewed philosophically is very much dependent on both disciplinary focus and theoretical positions. This statement implies a logical circularity commonly called a paradox (Boom, 1991). 'Paradox', in this context, is the name given to a logical contradiction following consistent deductions from correct premises. It is this type of logical circularity that leads to the conclusion that the issue of a meta-theory-to-decide-among-theories is undecidable (Rorty, 1989, xv). What is really intriguing is that the usual strategy for resolving a paradox is to recognise that it is generated by self reference (Watzlawick et al., 1968, 193). A move outside the frame of reference is most often the only way to recognise and resolve a paradox.

Suppose a move is made out of the language of statements that can be confirmed in the empirical world. This next level of language is called the meta-language. At the level of meta-language we can examine the next lower level statements and comment on them. However, we cannot comment or decide among competing ways to talk about lower level statements because as Russell (in Watzlawick et al., 1968, 192) puts it in the Theory of Logical Types, 'whatever involves all of a collection must not be one of the collection.' It appears Russell's injunction encapsulates what is paradoxical about decisions on the truth status of meta-languages and what is paradoxical

about the algorithmic undecidability of the agreement problem. 'Agreement' is not decidable because the algorithm is asked to decide about an attribute of itself! Paraphrasing Russell 'whatever is involved in the algorithmic resolution of a problem cannot be what the algorithm is to determine'.

It does seem that some rather unusual characteristics are attached to these paradoxical aspects of both 'the truth' and 'meta-views'. Thus, it is concluded that the paradoxical relationship between meta-theory and truth removes the possibility of recourse to a programmed arbiter to determine the 'truth' of the person's or another machine's contribution to a conversation as is shown in Figure 35. An aspect of 'truth' that is fundamental to Pask's Conversation Theory is that matching strategies is an essential part of his search for improved learning experiences. It has been shown that claims to machine match pragmatic meanings in a 'true way' that also describes reality, independent of people, implies a paradox. This paradox has been identified as an instance described by Russell's Logical Theory of types (in Watzlawick et al., 1968) and, as discussed above, cannot be resolved algorithmically.

It seems that the self referential aspects of agreement are what causes the problem. The question needs to be asked, What particular aspects of human decision making enable people to resolve the paradox? Conversation Theory suggests that one person may hold many centres of interest, or roles, or perspectives, or act as 'persons in a context' and may move among them as is appropriate. Most people are not aware of these 'persons in a context' because we describe ourselves as singular integrated personalities. Only under extreme duress are the experiences that make up a persona evident as distinctive manifestations of different personalities in a single person (Chase, 1987).

It is suggested in Chase (1987) that for each persona or centre of experience there is a vocabulary that supports and enables the articulation of the world as seen from within that perspective. It can be suggested, therefore, that agreement is reached between some of the many hidden persons-in-a-context that make up each human individual. Most people appear to create agreement by a process of inner conversation which enables confrontation between different 'perspectives'. Of course this suggestion merely pushes the self referential aspects of the agreement problem a little further away into the unexplored territory of mental models, but I can offer nothing better at this stage. Conversation Theory is suggested as an appropriate and useful

metaphor for thinking about what is involved in these issues. It has also been productive as a basis for considering aspects of the agreement problem in learning contexts.

Closure on Conversations

Contingency of conversation implies that there is no way to step outside of a conversation, or from conversations, to find a meta-conversation that takes account of, and allows unequivocal adjudication between all possible competing vocabularies in any conversation. The question is not, Has a truth been expressed in the conversation? but rather, Have the participants been successful in expressing and communicating their views of the world and hearing what the other participant has to say of a different world? Conversation Theory requires a shift from an outcome, which assumes that there is a outcome independent of a particular person, to the process, where the conversation is seen as an active construction by each of the conversants. This would be a precursor to an appreciation of an outcome of a quite different non-competitive nature, an agreement on what has been heard. In the constructivist view, introduced in Chapter 2, the outcome of conversations may therefore be a 'reality that is personally negotiated so that each inquirer will perceive a different world' (Pope and Gilbert, 1983). A conversational **agreement between individuals** will be negotiated for a specific purpose, the temporal duration of which will vary (Pope and Gilbert, 1983).

Chapter 6 has discussed problems that arose in the attempt during the research to use a computer as a conversant. Philosophical issues have been raised and exemplified in this chapter. Chapter 7 outlines the significance of the research and suggests further work.

CHAPTER 7

SUMMARY AND CONCLUSIONS

Outline: This thesis has examined five questions. The final chapter reviews the implications of the findings derived from attempting to answer these questions in Section 1. Section 2 deals with the implications of the findings for: Computer Science, Cognitive Science, Education and teachers, Geography, Geography teachers and Geography students. Sections 3 outlines suggestions for further work. Section 4 completes the study and offers concluding statements.

Judgement on the Research Questions

This research was prompted by a desire to provide for individual difference in the classroom. Pask's work on individual differences in learning strategies provided a framework within which to examine the larger question of whether learning could be enhanced by using a computer to accommodate for individual differences. Three steps were taken in which three initial questions were examined:

STEP 1: Research Question 1

Can the range of different preferences for approaching common learning tasks be detected using a questionnaire?

The research findings derived from the whole school survey suggest that the answer to this question is: **yes.**

STEP 2: Research Question 2

Can differences in learning strategies be identified in the records of students' learning?

The research findings extracted from an examination of the students' attempts to Teachback what they learned about the BBC AIV indicate clear evidence that **yes,** differences in learning strategies are detectable.

STEP 3: Research Question 3

What conclusions can be derived from a comparison of preferences with observed behaviour?

Consideration of this question showed that at the sixth form group level there was **partial support** for Ford's contention of using preference data as a basis for indicating likely learning strategies. Findings from this study also supported Laurillard's position. She argued for a range of strategies adopted by the learner depending on what 'person in a context' was elicited by the task. The main finding was that even a small sixth form group may be expected to have within it individuals who prefer widely different approaches to learning.

To meet the goal of accommodating for differences in learning strategies, provision must be made for all preferences in approaches to learning on all occasions. In juxtaposition to this finding is the outcome of the Teachback process which showed that, given the opportunity, even an unlikely serialist learning resource, such as the BBC AIV, can be extended to enable holist learning strategies to be exemplified. This finding supports Pask's (1980) view that independent learners can reconstruct material to suit their preferred learning strategies.

The emergent aspects of the research became evident when the question of matching subjects' preferences in learning strategies with appropriate materials was considered. This type of matching implies that the range of possible preferences is known and that the students' current learning strategy preferences are identifiable. Matching also implies that the resource material and teaching strategy range is known, and that the process of matching these is understood. In this type of exploratory research these questions were approached from a theoretical perspective.

STEP 4: Research Question 4

Can a computer be used to match learning materials with the preferred strategy used by the learner?

The review of the literature revealed work from Computer Science studies which indicated that this question leads to major theoretical problems. Among these problems was a significant limitation caused by the impossibility of matching the syntax of vocabularies (Harel, 1987). The answer to Question 4 is therefore **no,** a computer cannot be used to execute an algorithm which will match learning strategies with learning materials even at the simplest level of syntax.

STEP 5: Research Question 5

Can a computer be used as a conversant in a conversation?

This question was addressed by examining the nature of conversation as outlined in Pask's Conversation Theory, and applying understandings recently developed in post-modernist philosophy to the research question. The question was shown to be complex, but was reduced to a single outcome - that of agreement. It was also shown that agreement cannot be algorithmically encoded because the issue of agreement is algorithmically undecidable (Figure 37). Thus, to the last research question a clear and significant **no** was provided.

Implications of the Research Findings

This research has taken laboratory work into the normal classroom setting. The tools constructed from existing and new computer software were used in conjunction with the BBC AIV. The next sections examine the wider implications of the research findings for the on-going activities in a number of disciplines.

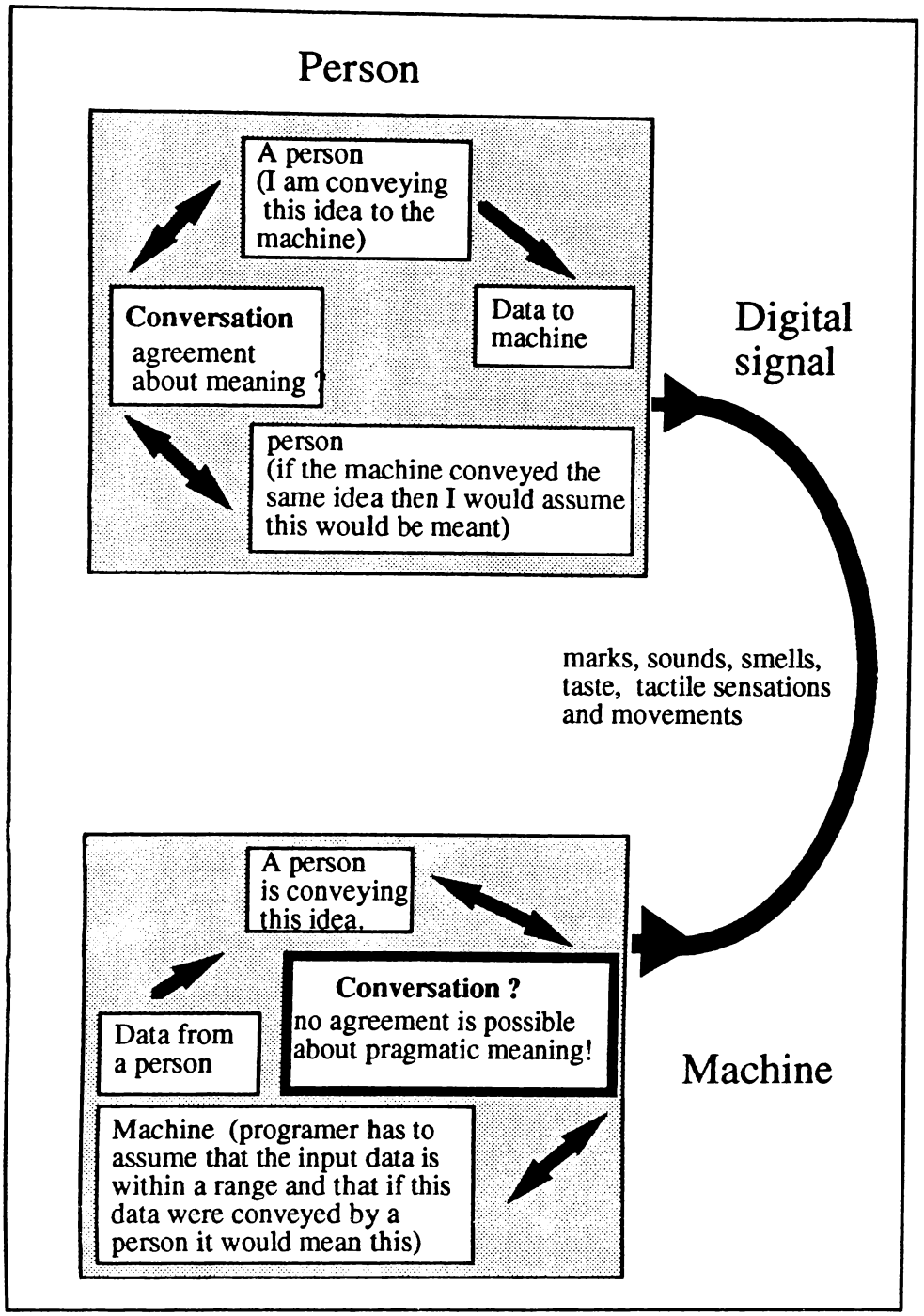

Figure 37. The limits of the machine as a conversant. These are identified and the normally unstated assumptions about pragmatic meaning are drawn to attention. Pragmatic meaning is created in a single brain as an outcome of an internal conversation between two 'persons in a context'.

Implications for Computer Science:

In the context of human conversation, responsibility for the outcome of a conversation clearly lies with the participants. If it were possible for a computer to be programmed to undertake the processes involved in reaching agreement, then the responsibility could be devolved to the computer. The theoretical investigations discussed in Chapter 4 and summarised above, show, however, that there are logical and conceptual constraints to the applicability of Conversation Theory. The problem of generating agreement lies outside of algorithmic solution. It is, as was pointed out, technically speaking, undecidable. It was shown that testing the claim that Conversation Theory is applicable to digital computers can be reduced to a decision problem. The question of agreement can only be approximated in an algorithm. Such approximation may be studied by using heuristic techniques based on statistical methods, mainly probability theory.

Thus, computers cannot in principle, provide a rationale for agreement. This means that the responsibility for the outcomes of an interaction with a computer lies with people **and always will.** These findings also provide a major challenge to proponents of the thesis that machines will one day be intelligent in the way that people are. The evidence presented here shows that if agreement over a shared understanding is taken as a surrogate of human intelligence then the digital machine will never be intelligent in the way people may be. Machines may be 'very smart' in many ways, but it appears that conversational intelligence will not be realised in any form that is analogous with human behaviour on the basis of the algorithmic solution of conversation problems.

Implications for Cognitive Science:

Pask's work has attracted international attention. According to Pask (pers. comm. 1986), 'grasping the nature of Conversation Theory requires taking on a large amount of intellectual baggage' and 'this is rather more than most people are prepared to consider'. However, my examination of Pask's work is supported by recent developments in philosophy and geography. Rorty's work shows, with Dear, that there are no meta-criteria to determine which of any particular view, or theory, or method, or body of knowledge is to be accepted among all possible competing views. For Rorty, as with Pask, the question of acceptability is established through a process of agreement. The interaction, for Rorty, is a conversation. Pask's laboratory work led to

the building of a body of constructs describing this interaction and is now called Conversation Theory.

Implications for Teachers:

This research shows that differences in learning strategies are evident in both questionnaire responses and the records of student Teachback material. This is an important finding which confirms Pask's (1975) laboratory results. The questionnaire responses confirm Ford's (1985) contention that differences in learning strategy can be detected by a preference survey. However, the Teachback records indicated that while some subjects actually did what the preference survey predicted they would, at least one student's record showed a complete reversal. Both Ford's research and the research reported here found subjects who did not fit tidily the predicted patterns. It follows from this evidence that the assumption of a one to one match of preference with performance is not upheld. Preference survey data appear to be predictive only at the group level. Thus, the contention of *polar* learning strategies is not supported. This is unfortunate since support for this proposition would be significant for education because polar learning strategies could be a basis for grouping students. The groups could then be taught using matched materials and teaching/learning strategies (Barbour, Heather and May, 1982; Strube, 1989).

Even more significant would be the finding that matching the media with learning strategy enhances learning, or conversely, that mismatching inhibits learning as Pask's Conversation Theory predicts. The computer matching of holist and serialist material was not, however, achieved in this research. This is explained by the undecidable nature of the problem of constructing an algorithm that indicates when agreement on matching had been reached. Pask avoided this problem by specifying the nature of the material to be learned very precisely and by employing people to decide when agreement with subjects had been reached. Winograd (1988) also adopted this stratagem and he sums up his position as 'Let people do the interpretation of natural language, and let the program deal with the explicit declarations of structure' (Winograd, 1988, 631).

The ability to illustrate an extreme serialist or holist strategy in an interactive context captures an aspect of human behaviour that has to date been particularly elusive. The Teachback records, when examined in relation to preference data, indicate a qualitative correspondence worthy of further

investigation for much larger sample groups. Pask's theory purports to account for the nature of such interactions and predicts a range of possible outcomes. It may apply in any context in which people wish to communicate and of these contexts, education is perhaps the most important for the survival and growth of culture.

Implications for Geography Teachers:

The geography teachers' problem of deciding which of many geographies is acceptable cannot be determined with recourse to an independent arbiter (Livingstone, 1990, 370). Geography is a discipline which employs tools and techniques from many other disciplines. Geographers, while taking advantage of progress in other disciplines, must also make themselves aware of the limitations of new tools. For practicing Geographers, the findings imply that care should be taken to ensure that geographical communications are acceptable to both holist and serialist thinkers. For teachers this implies a 'need to reflect on the way we instruct/encourage other individuals to use computers and the constructs both we and they (students) may attach to that computer use' (Chalmers and Forer, 1987,153). Further, teachers may need to consider making provision to ensure that people who confine themselves to a single learning strategy are guided away from the learning pathologies of 'globetrotting' and 'improvidence'.

Implications for Learners:

Through interacting with other peoples' use of the learning environment, students can be expected to increase their understanding of their own learning strengths and weaknesses. Pask predicts that only people who are able to adopt both serialist and holist learning strategies will be successful independent learners. My view is that all the learners investigated in the small sample group achieved qualitatively different levels of versatility and that the subjects were developing independence in learning. The range of responses to the preference questionnaire could encourage teachers to consider alternate strategies for people with particular biases in learning strategy, and also encourage them to adopt more flexible approaches to teaching.

Implications for Geographers:

The investigation into the problem of evaluating various geographical world views as to adequacy, or correspondence with reality, was also shown to be unanswerable. This issue is encapsulated in the question of meta-views.

Evidence presented showed that the issue of meta-views includes the issue of criteria for assessing those views. It was shown that the criteria for assessing meta-views cannot reside within the meta-view. Criteria for assessing views are generated at the next level above the meta-view.

The next level above a meta-view does not recommend a language or a vocabulary for assessing the fit of particular views with reality. Furthermore, the abstraction involved in the meta-meta-view is three removes from the reality to which it is to be applied. It is at the level of ordinary discourse that agreement on the meaning attached to noises and marks is reached in conversation. This distancing aspect and the number and difficulty of the translations involved in moving from a meta-meta-view to a world view inhibits agreement on issues related to the philosophical difficulties involved in delimiting any meta-view. The fundamental issue concerns the truth value of the statements made in the meta-view in relation to their correspondence with the competing geographical world views on which the meta-view is to arbitrate.

Harvey on 'Postmodernity' says the end of modernity is signalled by the 'rejection of meta-narratives' (large scale theoretical interpretations purportedly of universal application) (Harvey, 1989, 9, and Cosgrove, 1990). Rorty's view is that the issue of finding any meta-language is a lost cause and that the more immediate problem is one of 'keeping the conversations going'. This perspective of 'keeping conversations going' seems an appropriate position to adopt at this point of an investigation into the limits of Conversation Theory.

Further Work

Research is required on providing a generic data logging software package for each of the major computer and software environments. Some approximations to this concept are available in, for example, Ransdell's Real-Time Replay (Ransdell, 1990). However, it would be more desirable to record both the input to applications and the responses from them (Gettys and Berglan, 1989). Experience gained in the present research shows that this very difficult task can be achieved when the application software is specifically designed to permit a high level of integration with the analysis software (Ransdell, 1990). The current generation of commercial software 'hides' application responses to users' input to such an extent that it is often not

possible to monitor what the application is doing. This means that data logging applications will have to be specifically created outside of the commercial arena for software engineering.

While there is no general solution to the problem of algorithmically matching person-computer-person interaction, research is needed into the limits of what is able to be achieved heuristically. Heuristic solutions may emerge for subsets of the matching problem (Winograd, 1988 and Witten et al., 1991). It may be that when a conversation is conducted within a world in which the syntax is known and the semantics predetermined that the undecidable aspects of agreement can be 'worked around' as has been attempted with The Coordinator (Winograd, 1988).

Lack of software solutions to the general problem of how to assess students' work means that the assessment of student interaction with a computer is very much the teacher's problem. It is clear that appropriate reporting of the students' learning activities could materially assist the teacher in interpreting records of students' progress. Any work in this direction would greatly advance our present state of knowledge, particularly of the learning process. Such mechanised advice would need to carry a clear caveat about the responsibility for interpretation lying with the teacher to prevent excessive reliance on the system.

This exploratory research suggests:

- That identifying students with extremes in learning strategy could be accomplished using the modified version of Ford's questionnaire. This step could be a basis for initiating programs of work directed towards developing remedial programs for those with learning pathologies.

- That students need as many chances as possible to have sustained personal dialogues in a variety of forms to extend their repertoires of learning strategies.

- That these dialogues should both match and mismatch strategy with the tasks so that students grasp the type of strategy that is appropriate for particular tasks.

- That teachers need training in recognising appropriate learning strategies. They need training also in guiding students to choose the most appropriate learning strategy for particular tasks.

- That interacting with a computer may facilitate the training of teachers and the education of children by capturing evidence, from interactions, of differences in learning strategy.

- That while a computer cannot act in the same way as a human conversant it may have an educational role supporting data collection and processing about the human interactions involved in learning.

A further possible research area that came to attention is worth proposing in conclusion to the research. It is represented in diagrammatic form in Figure 38. This diagram shows, metaphorically, the interrelationships between a variety of world views. It shows that software, in this case the BBC AIV, provides a window into other worlds. It also suggests how those other worlds are constrained by the views on which they are predicated. There is little or no work on the boundaries of the worlds represented in the diagram. There is little or no work on the ways in which each world is cognised by the others or whether other perspectives are, or could be more 'appropriate' or 'productive'.

There is a need for further work into the complexity of interactions not only between groups, but also within groups. Such is the inherent complexity of within group communication that it is hardly surprising that 'many-person' communications often result in disagreement. For example, one person in the group who adopts a different view could make the achievement of consensus very difficult. Lack of agreement could also come about because at least one person adopts a different communication strategy, or prefers material presented in a different medium (Figure 38). Research is urgently needed in these boundary areas within and between disciplines because the computer, as a tool, is becoming the major medium influencing the way people deal with the world and with one another.

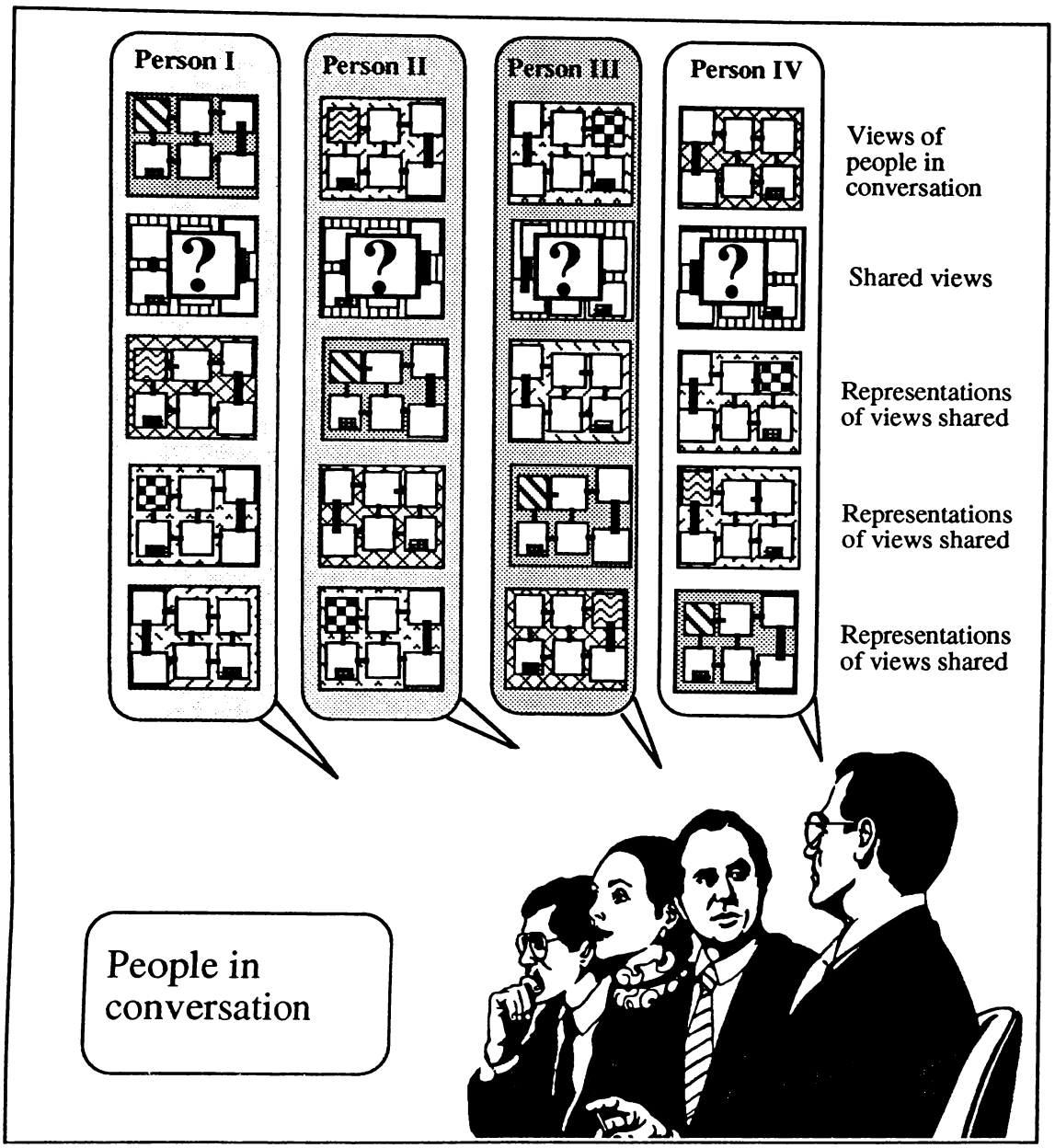

Figure 38. The potential for conversational confusion. A model of the increased complexity that can occur when communication strategies differ or when modes of communication differ. As shown in Figure 9 page 47 for one person, in a group situation each person in this illustration generates a model of the views of each of the other people. The complexity is such that it is not surprising that 'many-person' communications result in disagreement. For example, one person in the group who adopts a different view could make the achievement of consensus very difficult. Lack of agreement could also come about because one or more people adopt a different communication strategy or prefer material presented in a different medium.

APPENDIX A

Whole school Group Questionnaire Data.

Population Group (n=195) responses to Questionnaire items (n=20).

Gender	Age	Questions																				Sum	Pref
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20		
f	17	2	4	5	5	5	4	5	5	4	5	4	5	4	4	4	2	5	5	5	4	86	H
m	40	5	3	5	5	5	5	3	5	5	1	5	5	5	5	3	5	5	5	1	3	84	H
m	25	5	5	3	5	5	5	3	3	1	5	3	5	5	5	5	5	5	3	3	5	84	H
m	12	1	5	5	5	5	5	2	5	1	4	2	5	5	5	5	5	5	4	5	2	81	H
f	12	2	5	3	3	1	5	1	3	5	3	5	1	5	1	5	5	3	3	3	1	81	H
m	16	5	5	1	5	3	5	3	5	5	5	3	5	5	1	5	5	1	5	3	5	80	H
m	15	1	5	1	5	5	3	3	5	5	3	5	3	5	5	5	1	5	5	5	5	80	H
m	12	1	4	5	5	5	5	2	1	1	4	5	5	5	5	5	5	5	4	2	5	79	H
m	48	1	5	1	5	5	3	5	5	1	5	5	5	5	1	5	5	3	1	5	5	76	H
m	40	1	5	5	5	3	1	5	5	1	3	5	3	5	5	5	5	3	3	5	3	76	H
m	15	5	3	5	5	5	3	3	5	5	5	1	3	1	3	1	5	5	5	3	5	76	H
m	14	5	3	1	5	1	5	5	1	5	5	5	1	5	5	5	5	1	5	3	5	76	H
f	13	1	5	5	4	2	4	3	3	5	3	5	3	5	3	4	3	5	4	3	5	75	H
f	40	2	2	5	5	3	5	5	1	3	5	3	3	5	3	5	5	5	3	3	3	74	H
f	16	5	4	5	4	1	2	4	3	4	2	5	2	5	2	4	5	5	4	3	5	74	H
f	15	5	1	5	5	5	4	3	3	5	5	3	5	4	2	4	5	4	1	3	2	74	H
f	12	5	5	1	1	1	5	5	5	5	1	5	5	1	5	1	5	5	5	5	3	74	H
f	12	5	5	1	1	1	5	5	5	5	1	5	5	1	5	1	5	5	5	5	3	74	H
m	50	1	5	5	5	3	5	1	1	5	1	5	5	5	1	5	5	3	5	1	5	72	H
m	17	1	5	1	5	1	5	3	5	5	5	3	3	5	3	5	3	3	3	3	5	72	H
m	16	5	1	5	3	5	5	1	3	5	5	5	3	3	1	1	5	5	3	3	5	72	H
f	15	4	3	4	4	2	3	5	4	3	4	3	5	4	2	4	3	3	4	3	5	72	H
m	15	5	5	5	5	1	1	3	5	1	5	5	5	1	3	5	3	1	5	3	5	72	H
m	15	5	1	5	3	5	5	1	3	5	5	5	3	3	1	1	5	5	3	3	5	72	H
m	45	1	5	5	1	5	5	3	3	1	1	5	5	5	1	5	5	5	3	3	3	70	H
m	38	1	5	1	1	5	3	5	5	1	5	5	5	3	5	5	5	1	1	3	5	70	H
m	16	3	3	5	5	5	5	3	5	5	3	1	5	5	3	5	5	1	1	1	1	70	H
m	14	5	5	5	5	3	5	3	1	1	1	3	1	5	5	3	5	5	5	3	1	70	H
m	13	3	5	5	5	5	5	1	3	1	1	5	1	5	5	5	1	5	3	5	1	70	H
m	13	1	1	5	5	1	1	3	5	5	5	5	5	5	5	5	5	1	1	1	5	70	H
f	15	4	4	3	4	5	3	1	4	5	4	5	2	5	3	2	4	1	2	3	5	69	H
f	14	5	5	5	2	2	5	2	4	4	3	1	3	5	1	3	5	1	5	3	5	69	H
m	40	1	5	5	5	1	5	3	5	1	3	5	1	5	1	5	5	5	1	1	5	68	H
f	40	4	1	4	5	5	3	4	3	1	4	4	3	3	3	5	5	3	2	2	4	68	H
m	16	1	1	5	5	3	1	1	3	3	3	5	5	3	5	3	1	5	5	5	5	68	H
m	16	1	5	5	1	5	5	1	5	5	5	5	1	1	1	1	5	5	5	5	1	68	H
m	15	5	5	1	1	5	3	3	5	3	1	1	5	5	3	5	5	1	5	5	1	68	H
m	15	5	5	5	1	5	5	1	5	5	1	1	1	5	5	1	5	5	1	5	1	68	H
m	15	1	5	5	1	3	3	5	5	1	1	5	3	5	1	5	3	5	5	1	5	68	H
m	15	1	5	5	1	5	5	1	5	5	1	1	5	5	5	5	1	1	5	1	5	68	H
m	15	5	1	5	1	1	5	1	5	1	5	5	5	5	5	1	5	1	5	5	1	68	H
m	15	1	1	5	3	5	5	3	3	5	5	1	1	5	5	3	1	5	1	5	5	68	H
m	12	1	5	5	2	4	5	1	4	2	5	4	4	2	5	2	3	2	5	2	5	68	H
m	12	1	3	5	2	2	2	2	3	2	5	5	4	4	4	4	5	2	5	3	5	68	H
f	12	2	5	5	4	5	1	5	2	4	4	4	2	5	2	2	2	2	3	3	3	68	H
f	17	2	4	5	3	4	3	2	3	1	5	2	5	3	3	2	4	5	3	3	5	67	H
f	15	2	3	4	2	4	4	4	4	4	2	3	4	4	2	4	2	5	3	3	4	67	H
f	14	5	4	4	4	1	3	1	5	1	4	1	5	4	2	4	4	5	5	4	1	67	H
f	12	1	4	4	2	5	4	3	2	4	3	5	5	4	2	3	4	4	2	4	2	67	H
f	12	1	3	1	4	3	2	3	4	4	3	3	4	5	3	5	3	3	3	2	5	67	H

f	17	1	5	2	4	3	4	3	5	2	4	3	2	4	5	2	3	4	2	4	4	66	H
m	15	5	5	1	1	3	3	3	5	3	3	5	3	3	3	3	3	3	3	3	5	66	H
m	15	1	3	1	5	3	3	3	3	3	1	5	5	5	3	3	5	3	5	1	5	66	H
m	15	3	5	1	5	3	5	1	5	1	3	3	3	5	3	3	5	1	3	3	5	66	H
f	15	3	1	1	5	2	3	1	4	3	5	5	1	5	1	5	5	5	1	5	5	66	H
m	14	5	3	5	5	1	5	1	5	1	1	5	5	5	5	1	1	5	1	1	5	66	H
f	12	1	4	4	2	5	4	3	2	4	3	5	5	4	2	3	4	4	2	4	1	66	H
f	30	3	2	3	3	5	2	2	3	3	3	4	5	3	4	4	3	3	3	4	3	65	H
f	12	2	5	5	4	5	1	5	2	4	4	4	2	5	2	2	2	2	3	3	3	65	H
f	12	1	5	1	3	5	3	3	1	3	5	5	2	1	5	3	5	5	3	3	3	65	H
f	12	1	5	1	3	5	3	3	1	3	5	5	2	1	5	3	5	5	3	3	3	65	H
m	16	3	3	5	1	3	1	5	3	5	5	1	5	3	3	5	3	1	3	3	3	64	h
f	16	3	4	5	2	2	3	4	4	2	2	5	5	3	3	4	2	2	1	3	5	64	h
m	16	1	1	1	3	1	5	3	5	5	3	1	5	5	1	5	5	1	5	5	3	64	h
f	15	3	4	5	3	3	2	3	3	2	5	3	5	4	3	3	3	4	3	2	1	64	h
f	15	3	5	2	3	3	3	1	2	4	3	1	3	5	3	3	4	5	4	3	4	64	h
f	15	3	4	3	5	4	4	2	2	3	4	2	5	3	4	3	4	2	4	1	2	64	h
m	14	1	5	1	3	1	5	3	1	1	5	1	1	5	5	5	5	5	1	5	5	64	h
m	14	1	5	5	5	5	5	5	3	1	1	1	1	5	5	3	5	5	1	1	1	64	h
m	14	1	5	5	1	1	1	5	5	1	5	1	1	5	1	5	5	1	5	5	5	64	h
f	14	1	5	5	5	2	5	1	2	1	5	1	5	5	1	3	1	5	3	3	5	64	h
f	14	1	4	5	3	5	4	3	1	2	2	1	5	3	4	2	4	4	3	3	5	64	h
m	13	1	3	5	1	3	3	1	3	3	5	5	5	5	3	5	1	3	3	5	1	64	h
f	12	1	3	1	4	3	2	3	4	4	3	3	4	5	3	5	3	3	3	2	5	64	h
f	36	2	3	4	5	3	2	4	4	4	3	3	3	3	3	3	2	3	3	3	3	63	h
f	16	5	2	5	5	5	4	2	5	1	1	5	5	1	3	3	1	5	1	3	1	63	h
f	16	4	4	3	4	1	5	1	2	2	5	5	5	1	3	1	4	3	1	4	5	63	h
f	15	5	4	5	2	3	4	3	3	2	3	2	4	3	4	4	5	1	1	2	3	63	h
f	15	1	5	3	5	3	2	3	5	3	2	1	5	4	5	3	3	4	2	3	1	63	h
f	15	5	5	1	5	2	5	1	4	4	3	2	2	1	2	4	2	1	5	4	5	63	h
f	14	1	4	5	1	1	3	5	1	5	1	3	5	3	1	5	5	5	5	1	3	63	h
f	13	5	5	5	2	3	5	3	4	2	3	1	3	1	5	3	3	1	3	3	3	63	h
f	12	2	5	3	3	1	5	1	3	5	3	5	1	5	1	5	5	3	3	3	1	63	h
m	12	1	4	5	2	4	5	3	4	4	1	5	4	5	1	3	1	3	2	1	5	63	h
m	18	1	5	3	1	1	5	5	1	5	5	3	5	5	3	5	3	3	1	1	1	62	h
m	17	1	5	1	1	1	3	3	5	5	1	3	1	5	5	5	5	1	5	5	1	62	h
m	16	1	1	5	5	1	5	1	1	1	5	3	5	1	5	1	5	5	5	5	1	62	h
m	16	1	5	1	3	5	5	5	3	1	5	1	3	5	5	1	5	1	1	5	1	62	h
m	15	1	5	3	3	5	5	3	1	1	5	5	1	3	3	1	5	5	1	3	3	62	h
m	15	1	5	5	1	3	1	5	3	5	3	1	5	3	3	1	5	5	3	3	1	62	h
m	15	3	5	3	5	5	3	3	3	1	3	5	3	5	3	3	3	1	1	3	1	62	h
m	15	3	5	1	1	1	1	3	5	5	1	5	5	3	5	1	5	3	3	3	3	62	h
m	15	1	5	5	1	1	3	1	1	1	5	3	3	5	5	5	3	1	3	5	5	62	h
f	15	3	4	5	5	1	4	2	4	2	1	3	5	1	4	4	2	4	2	5	1	62	h
m	14	1	1	3	5	1	3	3	3	5	3	3	1	3	1	3	3	5	5	5	5	62	h
m	14	1	5	5	3	5	3	1	3	5	5	1	5	1	5	1	1	5	5	1	1	62	h
f	14	4	5	4	5	1	4	2	3	2	4	2	5	5	2	5	2	1	2	2	2	62	h
f	13	1	1	4	5	1	2	2	3	5	4	3	1	5	4	3	4	3	5	3	3	62	h
f	13	1	4	5	2	1	4	3	2	2	5	5	5	1	3	4	1	5	1	3	5	62	h
f	12	1	4	4	5	1	3	1	5	1	5	5	1	1	4	4	2	2	3	3	4	62	h
f	40	1	2	4	5	4	1	1	5	1	1	4	4	5	1	5	5	1	1	5	5	61	h

f	15	4	2	1	2	5	5	2	4	3	5	3	5	4	4	1	2	2	4	2	1	61	h
f	15	2	5	5	2	2	4	2	2	1	3	2	4	5	4	4	5	2	3	3	1	61	h
f	13	3	4	4	3	1	3	3	4	1	5	3	2	3	4	3	3	5	1	5	1	61	h
m	12	3	4	5	2	4	1	4	4	2	2	1	5	4	4	4	4	2	2	2	2	61	h
m	12	1	1	5	2	4	1	2	5	2	2	5	5	4	1	2	5	5	4	1	4	61	h
m	18	1	5	5	1	1	5	1	5	1	5	5	5	1	5	1	1	1	1	5	5	60	N
m	17	3	5	5	3	3	5	3	3	5	5	1	3	3	1	1	3	3	1	3	1	60	N
m	17	1	5	5	5	1	5	1	5	1	5	5	3	3	1	1	5	3	1	3	1	60	N
f	16	3	5	4	5	1	4	2	4	3	3	3	1	3	1	1	4	3	4	3	3	60	N
m	15	5	5	1	1	5	5	3	1	1	5	3	3	1	3	5	3	3	3	3	1	60	N
f	15	1	4	2	4	2	3	3	3	2	4	3	4	4	5	3	4	2	2	2	3	60	N
f	15	3	5	2	3	3	3	2	3	2	3	4	3	3	3	4	4	3	2	2	3	60	N
m	15	1	1	3	1	5	1	5	1	5	5	1	5	5	1	5	5	1	1	3	5	60	N
f	15	1	4	3	1	4	3	2	2	4	4	5	1	5	2	5	5	1	1	3	4	60	N
f	12	1	4	5	2	5	4	2	2	3	1	5	3	4	4	2	4	3	3	2	1	60	N
f	12	4	1	2	4	4	3	2	3	1	2	4	2	2	3	3	4	2	4	5	5	60	N
f	12	1	4	5	2	5	4	2	2	3	1	5	3	4	4	2	4	3	3	2	1	60	N
f	12	4	1	2	4	4	3	2	3	1	2	4	2	2	3	3	4	2	4	5	5	60	N
f	17	4	4	2	4	4	4	1	4	2	2	2	2	4	4	1	2	2	2	4	5	59	s
f	16	2	2	5	4	5	4	4	2	1	2	1	5	4	2	2	5	1	2	4	2	59	s
f	16	5	4	5	1	5	1	4	4	3	1	4	1	1	1	2	5	1	1	5	5	59	s
f	16	5	5	3	4	3	1	4	3	2	3	3	1	5	5	1	5	1	1	3	1	59	s
f	14	2	5	3	3	4	3	2	4	2	4	2	5	4	2	3	2	2	2	4	1	59	s
f	12	1	4	4	5	1	3	1	5	1	5	5	1	1	4	4	2	2	3	3	4	59	s
f	12	1	5	3	4	3	2	2	3	2	3	3	4	5	3	3	2	2	3	2	4	59	s
f	12	1	5	3	4	3	2	2	3	2	3	3	4	5	3	3	2	2	3	2	4	59	s
f	40	4	4	4	4	3	3	3	4	1	3	3	1	4	1	3	3	2	3	1	4	58	s
m	18	1	5	1	1	5	5	3	3	1	5	1	3	1	3	3	5	3	3	5	1	58	s
m	17	1	5	3	5	3	1	3	1	1	3	3	1	5	3	5	5	1	1	3	5	58	s
m	17	1	5	5	1	5	1	1	5	5	5	1	3	5	3	1	1	3	1	3	3	58	s
f	16	2	5	4	5	1	4	2	3	1	4	2	2	3	5	1	5	1	1	3	4	58	s
m	16	5	5	1	1	5	3	5	1	1	1	1	5	5	1	3	5	3	1	5	1	58	s
m	16	1	5	5	5	3	5	5	1	1	1	1	1	5	5	5	1	3	1	3	1	58	s
f	16	1	1	5	1	5	3	3	3	1	5	2	2	1	5	1	1	5	5	4	4	58	s
f	15	2	5	5	4	3	4	5	2	1	1	3	2	5	1	3	3	1	1	3	4	58	s
m	15	1	5	1	1	5	5	5	1	5	1	1	5	5	3	1	5	5	1	1	1	58	s
f	15	5	4	1	1	1	5	1	1	1	5	5	5	1	1	5	1	1	5	4	5	58	s
m	14	3	5	1	1	3	1	5	5	1	5	1	5	5	1	5	1	1	3	3	3	58	s
m	14	1	1	5	5	5	3	3	1	5	5	1	5	5	3	1	1	1	1	5	1	58	s
f	14	1	1	5	2	1	2	5	1	5	1	1	1	1	5	4	5	2	5	5	5	58	s
f	18	2	4	5	1	1	4	2	4	2	4	2	5	4	4	2	4	4	1	1	1	57	s
f	13	1	4	5	2	5	4	2	2	2	4	5	2	2	3	2	2	1	4	2	3	57	s
f	13	2	3	4	3	2	3	2	2	2	3	3	4	3	3	4	2	3	4	3	2	57	s
m	12	1	4	4	2	1	2	3	1	2	3	5	4	3	1	5	2	4	3	5	2	57	s
f	12	2	4	4	1	2	2	3	2	1	4	2	4	4	3	2	3	2	4	1	4	57	s
m	16	1	1	5	5	5	1	5	3	1	3	3	1	5	3	3	5	3	1	1	1	56	s
f	15	2	2	4	3	3	3	2	2	2	4	2	5	3	5	5	1	2	1	3	2	56	s
m	15	1	5	5	1	1	1	1	5	5	5	1	5	1	5	1	5	1	1	1	5	56	s
m	15	5	5	1	1	1	1	3	3	1	3	5	1	5	3	5	5	1	1	1	5	56	s
m	15	5	1	5	1	5	1	1	1	5	5	1	5	5	5	1	1	1	5	1	1	56	s
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f	15	1	1	2	1	2	4	5	2	5	1	5	5	1	5	2	2	3	1	4	4	56	s
m	14	1	1	5	1	3	1	3	3	1	5	3	3	5	3	3	3	1	5	3	3	56	s
f	13	4	5	3	3	1	1	3	4	1	2	5	3	4	3	2	1	2	1	4	4	56	s
f	12	2	4	4	2	2	2	3	2	1	4	2	4	4	3	2	3	2	4	2	4	56	s
f	26	1	4	5	2	2	4	3	2	1	3	2	2	4	3	3	2	4	3	2	3	55	s
f	16	4	3	5	1	4	1	4	4	2	2	1	4	2	2	2	4	1	4	3	2	55	s
f	15	5	4	2	4	1	2	2	3	5	1	2	5	2	2	1	1	2	2	5	4	55	s
f	14	2	4	4	1	5	4	3	4	4	2	2	2	3	4	1	3	1	3	1	2	55	s
f	14	4	2	3	2	4	4	2	2	4	4	2	2	4	2	2	4	2	1	1	4	55	s
f	35	5	5	5	2	1	4	2	2	2	2	1	3	5	2	1	1	3	1	5	2	54	S
m	16	3	5	5	1	3	3	1	3	3	5	1	3	5	3	3	1	1	1	3	1	54	S
f	15	2	4	5	4	2	3	2	2	2	3	3	3	3	4	2	1	1	2	2	4	54	S
m	15	1	1	5	1	5	3	3	1	1	3	5	1	5	1	1	5	1	5	5	1	54	S
m	15	1	5	5	1	5	5	3	1	1	5	1	1	1	1	1	5	1	1	5	5	54	S
f	15	5	1	3	2	2	3	3	2	2	1	5	4	3	3	4	1	2	5	1	2	54	S
f	15	5	2	1	1	1	5	5	2	2	1	3	1	1	5	2	5	2	3	2	5	54	S
m	15	1	1	5	5	5	3	1	1	1	1	1	5	1	1	5	5	5	3	1	3	54	S
f	14	4	4	5	4	1	4	1	1	4	4	2	5	1	1	1	3	3	1	3	2	54	S
m	14	1	3	5	1	5	5	1	1	5	1	1	1	5	1	1	5	3	5	3	1	54	S
m	14	1	5	3	3	1	3	1	3	1	3	1	3	5	3	1	1	3	3	5	5	54	S
f	14	1	4	5	5	1	2	3	2	1	5	1	1	5	4	3	1	1	2	4	3	54	S
f	14	1	1	5	1	1	2	3	1	5	1	1	1	5	4	1	4	5	2	5	5	54	S
f	13	1	3	4	3	2	2	1	2	2	3	5	3	3	3	3	2	3	3	3	3	54	S
f	13	1	1	5	1	1	5	3	5	4	1	5	1	3	1	4	1	5	1	1	5	54	S
f	13	2	2	5	2	5	3	2	2	2	1	2	3	2	3	5	1	2	1	5	4	54	S
f	16	2	3	3	3	2	5	2	3	1	3	3	3	3	3	1	2	4	2	3	2	53	S
f	15	2	4	4	2	5	3	2	4	3	2	1	1	2	3	1	5	3	3	2	1	53	S
m	17	1	5	5	1	1	1	1	5	1	5	1	5	1	1	1	5	5	1	1	5	52	S
m	15	5	5	5	3	1	3	3	3	1	5	1	3	1	3	1	1	1	5	1	1	52	S
f	15	3	5	1	5	3	1	1	1	1	5	1	1	1	1	1	5	1	5	5	5	52	S
m	14	1	5	1	3	5	1	1	3	3	5	3	1	1	3	1	5	3	1	5	1	52	S
f	12	1	1	5	5	1	1	3	1	2	1	4	2	5	3	1	3	2	2	4	5	52	S
f	12	1	1	5	5	1	1	3	1	2	1	4	2	5	3	1	3	2	2	4	5	52	S
f	15	2	4	4	3	2	4	1	3	2	4	3	3	5	3	1	2	1	1	2	1	51	S
m	17	1	5	3	3	3	5	1	5	3	5	3	1	1	1	1	3	1	1	3	1	50	S
m	15	1	1	1	3	5	1	5	5	1	5	1	5	5	1	3	1	3	1	1	1	50	S
m	14	3	5	1	1	1	5	1	3	1	1	5	5	1	1	5	1	1	5	3	1	50	S
f	13	1	1	5	2	1	1	2	5	1	4	5	5	3	2	1	1	1	3	1	5	50	S
m	50	1	3	1	3	5	3	1	1	1	3	1	5	5	1	3	5	1	1	3	1	48	S
m	38	1	5	3	1	5	1	1	5	1	3	1	5	1	1	3	5	3	1	1	1	48	S
m	15	1	1	1	1	5	1	1	1	1	3	1	3	1	3	3	5	1	5	3	1	42	S
m	15	1	1	1	1	5	1	1	1	1	3	1	3	1	3	3	5	1	5	3	1	42	S
m	15	3	5	1	1	1	5	3	1	1	3	1	1	1	3	1	1	1	3	3	1	40	S
Question No		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20		
Sum of Prefs		452	722	711	585	594	639	514	604	508	642	597	650	690	586	588	671	548	548	603	610		

APPENDIX B

Teachback Slideshows for Sample Classroom Group

Subject One Annotated Teachback Slide notes.

Topic: WATER SPORTS in Britain

A Series of 13 slides about water related sporting activities.
A typical water sports centre in England
A polluted beach, not as nice as the manmade sports centre
A boat race in a sports centre
Sculling on the Thames river
Canoeing down a river
A canoe race down a river
Power boat racing
Formula one power boat racing
Water skiing, jump in foreground
A water skier
Windsurfing on an unpolluted beach
A surfie performing a slashback
An olympic diver on his way to a gold medal windsurfing at another unpolluted beach
(Extension material 1 item in a **serial-like** presentation.)

Subject Two Annotated Teachback Slide notes.

Topic: Population

The following production is an illustration of a number of ways in which people have planned for an increasing population.

When there is a limited amount of land available for building, Highrise buildings or Tower Blocks are planned and constructed to house many people.
An example of Highrise flat
This is an illustration of an Elderly People's Home under construction.
With an increasing population, Rest Homes are built to provide specialist
(across two slides)
care that is required for the retired.
This building used to be an old PoorHouse, it is now being used as a Rest Home.
In a largely populated area, transportation in individual vehicles would cause mass over-crowding. This problem is solved by the use of buses.
Since most people travel by car, multistorey car parking buildings are required.
People using Rail and Air transport use Taxis to get to thier final destination.
(Extension material: 1 item in **serialist-like** presentation)

Subject Three Annotated Teachback Slide notes.

Topic BRITISH HISTORIC PLACES

A brief look at some of the historic places I have visited in past years!
Stonehenge standing alone on theWiltshire planes near Salisbury
A close up view of the stones.
Stonehenge again from some distance away from the stones, probably near the underground tunnel. When visited it was a rather cold and blustery day.
Flatford Mill in East Anglia. The painting grounds of Constable. This was one of the many sights we saw while on our week stay in the area.
The Lavenham Guildhall, again in East Anglia. This building was the centre of British wool production for quite some time. Viewed from the square.
Melford Hall, in East Anglia. The day we were there the clouds were low, so a look at the countryside surrounding the hall was not very good.
Penrhyn Castle, Wales. This castle is only 2-3 hundred years old. Someone wanted a castle, but could not buy one so he made one! Good weather that day.
Wimpole Hall, in Cambridgeshire. This is seen without the scaffolding that was in place while we were there, thus making for better photographs.
Hadrians Wall, built to keep the Scot at home by the Brits. Later used by the romans. We visited this on the way back from our tour of Scotland.
Housesteads Fort on Hadrians Wall.
The forts were made by the romans as "halfway houses". Although some way from the road, it is worth the walk.
A birds eye view of the old fortified town of Colchester. The photo appears to be around the wrong way!
Polbadarn. This "castle" is seen just of a welsh road, which is used to get to an old slate mine.
Caernarfon Castle, on the coast of Wales, the "home" of the Princes of Wales.
York Minster before the disasterous fire that destroy part of the Minster. We saw this in the early 80's on a day trip from Manchester.
My family visited Ightham Mote while visiting "The Great Aunt". I stayed in the car and had a afternoon siesta! They said it was rather good.
Viewed the morning that we saw Ightham Mote. The trees in this photo of Knole House have suffered severe loses due to the big wind. Met a deer here.
Another Scotish sight. Holyrood Palace in Edinburgh. We visited this after a tour of Edinburgh and the Castle.
(Extension material 17 items in a **holist-like** presentation)

Subject Four Annotated Teachback Slide notes.

Topic Recreation

Children playing in a park.
A recreation area in a Park.

An outdoor concert in a Park.
Boating , Trentham.
Gardening, popular hobby.
Popular leisure activities at the beach. Building sand castles with Dad.
Potholing in the Yorks Dales. Skydiving.
Fishing on the Thames.
Family sport, harriers.
Squash, Susan Devoy and Lisa Opie.
Hockey action.
Outdoor Bowls, pasttime for elders.
(No extension items in a **serialist-like** presentation)

Subject Five Annotated Teachback Slide notes.

Topic: Geology

This is a series of slides showing some of the geological structures that can be found in Britain.
Fault lines
Great Glen fault
East Golds clay pit (faulting)
Fault in limestone and mudstone
Syncline in Pembrokeshire. This is caused by plate movement
Anticline in Cornwall
Erosion and weathering
River erosion of limestone
Frost action causing erosion, Cumbria
Wind erosion of millstone grit
Erosion caused by the action of waves
Natural arch, offshore island
Spheroidal weathering
Onion skin weathering
(No extension material in a **serialist-like** presentation)

Subject Six Annotated Teachback Slide notes.

Topic :London and South London

This is a set of slides created by ** about London.
The set also includes some about Essex which is to the south of London.
This slideshows a working water mill in a small village called Coggeshall which is just out of London.
This house is called Paycockes House (Coggeshall).It shows the standard of housing in the Essex area.
This is Colchester (Essex) you can see old buildings and a friendly community
This is a good example of the 1930's style of housing in greater London.
In this slide you can see some industrial premises.These were built in the early 17th century.
This old farmhouse in Willey,was built in the 15th century.As you can see here the house has built with timber beams.This church was built in the 13th century but is amazingly still in use today.

Here is an example of a cobble stone house, probably built in the early 1800's.
This house was built in 1985 . It is a big, modern spacious house.
(Two extension items in a **serialist-like** presentation)

Subject Seven Annotated Teachback Slide notes.

Topic: Transport and Communication

Transport and Communications in England have changed dramatically since the turn of the century, making improvements to everyday life.
One of the earliest forms of everyday transport was the horse drawn cart here we see a traditional Brewers dray probably in use during last century.
In the early days of mechanical transport, the cost would prevent ordinary people purchasing anything but the reliable bicycle.
With the arrival of the horse-drawn tram, short journeys within the towns were made cleaner and quicker for those with the available money.
The train made the workloads in many jobs lighter. For example, coal from the mines would no longer be hauled by hand up the steep mine shaft transformed into an efficient service which has been taken underground.
Comfort and speed are the requisites of todays busy lifestyles.
For the shorter journeys across cities the bus service has proved invaluable for those families without cars. (Keighley Bus Station, York.)
A black-cab taxi will cater for the exact needs of the passenger. Although the cost will be higher, the preset destination means less worry.
The Panther Solo is just one example of improved technology. The car, for those who can afford it, offers status and speed for the owner.
With the increase in industry has come an increase in the need for heavy transport. The Bedford range of trucks offer reliability and efficiency.
The car of the future has become the failure of the past. The Sinclair C5 was designed to be cheap, economical and popular. However, the idea never really took off because of the size of the vehicle. If the C5 was universally accepted, there would need to be total restructuring of the road system.
A ever growing population means more people must travel daily to work. The excellent train services in many areas offer these commuting facilities.
Bank Holiday traffic is unfortunately a result of cheaper prices on the most popular form of family transport - the car. As more and more people are able
(across two slides) to purchase their own, scenes such as these will become increasingly common. However, this is a small price to pay for the efficiency a car offers.Transport and Communications have made remarkable developments during the last century. It remains to be seen what the future will bring.
(14 extension items in a **holist-like** presentation)

Subject Eight Annotated Teachback Slide notes.

Topic: Pollution

THIS IS THE RESULT OF AN OIL SLICK. IT COULD LEAD TO AN ECOLOGICAL DISASTER.
THIS IS THE POSSIBLE END RESULT OF OIL POLLUTION. DEAD SEA BIRDS.
THE MASSIVE CLEAN UP OPERATION AFTER AN OIL SLICK. THE CLEAN UP INVOLVES MANY TIME CONSUMING HOURS.
THIS IS A RESULT OF OUR THROW AWAY SOCIETY. RUBBISH IN THE ROCHDALE CANAL. ALSO A RESULT OF CARELESS PEOPLE. RUBBISH AND SCUM AT MORECOMBE BAY.
THE DEATH OF THESE FISH WAS CAUSED BY POLLUTION, POSSIBLY INDUSTRIAL WASTE HEAT.
THIS CAR CEMETERY IS LOCATED IN THE MIDDLE OF A SCENIC AREA IN ENGLAND. THIS IS ANOTHER FORM OF POLLUTION
TOXIC WASTE IS OFTEN STORED IN DRUMS OR CANNISTERS SIMILAR TO THIS. OFTEN THE CONTENTS CAUSE THE CONTAINER TO CORRODE.
AIR POLLUTION IS OFTEN CAUSED BY ACTIVITIES LIKE THIS. IT ALSO HAS HARMFUL EFFECTS ON MANY ENVIRONMENTAL FACTORS.
ACID RAIN IS ONE OF THE RESULTS OF AIR POLLUTION. THESE TWIGS SHOW THE DAMAGE THAT ACID RAIN CAN CAUSE.
NUCLEAR WASTE IS OFTEN STORED IN CONTAINERS LIKE THE ONES SHOWN HERE OFTEN THE WASTE IS BURIED UNDERGROUND.
THIS SLIDESHOWS SAND SAMPLING TO DETECT RADIO ACTIVITY. THIS IS A NECESSARY PART OF SOME PEOPLES OCCUPATION.
(3 extension in a **serialist-like** presentation)

Subject Nine Annotated Teachback Slide notes.

Topic: Some causes of unemployment

City Abattoir, Sheffield, day after closure, October 1982.
Factory closure and demolition.19184
Abandoned factories.Closing of factories causes Poverty because of Unemployment.
Here are some photographs showing some effects of unemployment.
Three men, probably unemployed, collecting seacoal on the beach.
Workers made redundant.
Homeless men, Fleet street, London.
Soup run, Waterloo, London (helping unemployed)
Hostel for Unemployed.
Scavenging on Rubbish tip
Queueing for the dole, London.
(1 extension item in a **serialist-like** presentation)

Subject Ten Annotated Teachback Slide notes.

Topic: Cars

THIS IS A CAR
ESTE ES UN AUTO
VAUXHALL CAVALIER 1985
MODELO VAUXHALL CAVALIER 1985
FORD ESCORT 1985
MODELO 1985 FORD ESCORT, EN CHILE
MINI METRO AND HELICOPTER 1985
MODELO MINI METRO Y HELICOPTERO 1985
EN CHILE
Ford Sierra Sedan 1985
Modelo Ford Sierra Sedan 1985
En Chile
Austin Maestro 1985
Modelo Austin Maestro 1985
Vauxhall Astra 1983
Modelo Vauxhall Astra 1983
En Chile
Volvo 1985
Modelo Volvo 1985 Hecho en Suecia
En Chile
Volkswagon Golf 1985 from Germany
Modelo Volswagen Golf '85 en Alemania
Nissan Pulsar '85 From Japan
Modelo Nissan Pulsar '85 en Japon
En Chile
Carpark at an airport.
Estacionamientos en Aeropuerto
(No extension items in a **serialist-like** presentation)

Subject Eleven Annotated Teachback Slide notes.

Topic New housing in Britian

Prices ranging from $81,000 to $750,000.
South Glamorgan. New house, two bedrooms. Cost = $81,000 or '26,950
South Glamorgan. Semi-detached four bedroomed house. Cost = $111,000 or 38,000 South Glamorgan. Modern detached four bedroomed house. Situated on private estate. Cost= $171,000 or 56,950.
Glasgow flat. Lower apartment cottage with double bedroom. Cost = $585,00
or 195,000. Glasgow - semi detached villa with three bedrooms. Cost = $120,000 or 40,000.
Surrey. Georgian style house built in 1925. Includes 5 bedrooms with three-quaters acre of land. Cost = $750,000 or 250,000.
Surrey flat. Double bedroom , modern ground floor. Cost = $11,700 or Guildford, Surrey. Four bedroomed detached house built in 1984. Cost = $297,000 or 98,500.
Waybridge, Surrey. Reproduction tudor house, six bedrooms and two-thirds
acre of land. Cost = $765,000 or 255,000.

Halifax. Four bedroomed detached house built in 1984. Cost = $102,000 or '34,000. West Midlands. Detached four bedroomed house. Cost = $156,000 or 51,950. Midlands. Four large double bedrooms.Very private with swimming pool. Cost = $750,000 or 250,000.
Midlands. Looking inside of the home. Lounge with fireplace with a 400 year old oak beam. Central heating. North Humberside. Modern Neo-Georgian detached house with four bedrooms. Cost = $132,000 or 43,750.
(No extension items in a **serialist-like** presentation)

Subject Twelve Annotated Teachback Slide notes.

Topic: Beaches

Summer beaches for tourists within England. V 1989.
Crowded English beach in mid summer
Some dude doing a wicked bomb in cornwell
Grandma and Grandpa just returned from Woodstock
Erosion barriers in Rottington
Heaps of people in Scarborough
boxing day trips
Sunbathers
Fishermen
Engish farm over looking the sea
Swimming pool
winter
A wickedly ragy beach party
A old guy proving that not all British people are WHITE
British pastime

(4 extension items in a **serialist-like** presentation)

APPENDIX C

Correlation Coefficients for the Whole School Group (n=195) from age 12 to 50.

MTB > correlate age, Q1 to Q20 for whole data set

	Age	Q1	Q2	Q3	Q4	Q5	Q6	Q7
Q1	-0.009							
Q2	0.071	0.060						
Q3	-0.006	-0.114	-0.104					
Q4	0.168	0.045	0.006	0.047				
Q5	0.150	-0.026	-0.112	0.002	-0.033			
Q6	0.068	0.175	0.171	-0.012	0.068	0.003		
Q7	0.082	0.057	0.039	-0.112	-0.059	0.062	-0.032	
Q8	0.127	0.140	0.156	-0.017	0.064	-0.085	0.014	-0.035
Q9	-0.107	0.072	-0.078	-0.026	-0.040	0.060	0.105	0.086
Q10	-0.060	-0.106	0.049	-0.030	0.057	0.013	-0.067	-0.122
Q11	0.051	0.033	-0.078	-0.035	0.097	-0.036	0.067	-0.032
Q12	0.102	0.076	-0.021	0.034	-0.063	0.101	-0.021	0.013
Q13	0.113	-0.114	-0.013	0.077	0.147	0.069	-0.065	0.149
Q14	-0.161	0.049	0.018	-0.017	-0.002	-0.003	0.044	0.097
Q15	0.169	-0.084	0.045	-0.127	0.141	0.005	-0.015	0.169
Q16	0.213	0.033	0.057	-0.152	0.022	0.093	0.011	0.133
Q17	0.050	-0.039	0.013	0.147	0.122	0.081	0.254	0.041
Q18	-0.136	0.094	-0.110	-0.059	-0.076	-0.035	0.008	-0.022
Q19	-0.092	-0.001	-0.027	-0.138	-0.004	-0.082	-0.026	-0.017
Q20	0.007	-0.034	-0.052	-0.003	0.129	-0.164	-0.125	-0.019
Sum	0.106	0.237	0.175	0.066	0.332	0.155	0.291	0.224

	Q8	Q9	Q10	Q11	Q12	Q13	Q14	Q15
Q9	0.029							
Q10	0.048	-0.107						
Q11	0.100	-0.043	-0.061					
Q12	0.136	0.025	0.027	0.073				
Q13	-0.004	0.070	-0.067	-0.026	0.004			
Q14	0.035	-0.043	0.000	-0.004	-0.019	-0.029		
Q15	0.036	-0.042	-0.016	0.168	0.151	0.249	-0.042	
Q16	0.020	0.101	-0.020	-0.049	-0.112	0.078	-0.040	0.014
Q17	0.023	0.148	-0.071	0.135	0.033	-0.065	0.058	-0.063
Q18	0.040	0.143	-0.010	0.088	0.078	-0.066	0.083	0.100
Q19	-0.043	-0.047	0.002	0.014	-0.161	-0.085	0.068	0.034
Q20	0.060	0.055	0.043	0.249	-0.041	0.007	-0.035	0.124
Sum	0.265	0.326	0.106	0.330	0.215	0.245	0.220	0.366

	Q16	Q17	Q18	Q19	Q20
Q17	0.053				
Q18	0.019	0.046			
Q19	-0.050	-0.012	0.071		
Q20	-0.034	0.017	0.064	0.010	
Sum	0.207	0.373	0.280	0.088	0.258

APPENDIX D

The Three Modified Ford Questionnaires.

Strictly Confidential.

Name: (Optional)
.....
Years in teaching:
0 to 5 ()
5 to 10 ()
10 to 20 ()
20 plus ()

Teaching /Learning Methods Questionnaire (Teachers Version)

Please answer the following questions by placing a **circle** on the number of the option that most closely matches how you teach.

NOTE: THERE ARE **NO** RIGHT OR WRONG OR BETTER OR WORSE ANSWERS.
The material in this questionnaire will be used to construct a profile about teachers and students in this school.
No person will be identifiable in the profile, or at any other stage from the material in these questionnaires.

*** Circle 1 if you agree with the left statement.
Circle 2 if you agree (with reservations) to the left option.
Circle 3 if you do not choose either option.
Circle 4 if you agree (with reservation) with the right option.
Circle 5 if you agree with the right statement.
Circle ALL THE OPTIONS if you choose both options.

Example:

When collecting my mail I tend to open the bills first.	1(2)3 4 5	When collecting my mail I tend to open the letters first.

Note: Please answer quickly... so as not to take up your valuable time.

1. When I am reading a novel or a fiction book I tend to turn over pages that do not interest me.	1 2 3 4 5	I read every page so that I do not miss anything.
2. When I am reading a text book I read only the bits that refer to what I want to know.	1 2 3 4 5	I read textbooks carefully page by page so as not to miss the ideas and facts in the book.
3. When I'm collecting information for a lesson or assignment for pupils I like to begin with as much information as possible at the start.	1 2 3 4 5	I prefer to locate info when I need it.
4. I like to look very carefully at one bit of resource material before I move to the next.	1 2 3 4 5	I like to move between a number of sources of material at the same time.

5. I like to have a clear picture of the whole topic or task in my brain while I am working on a task.	1 2 3 4 5	I like to divide topics up up into their parts and do each part in turn building up an overall picture bit by bit.
6. When I am researching for resource material I am generally looking for a single book or item.	1 2 3 4 5	I tend to spend a lot of time browsing in resource material and the library.
7. When I am preparing an exam I spend a lot of time putting material into a logical order so that I can see how all the questions fit together.	1 2 3 4 5	When I am preparing an exam I tend to test each topic in the order covered in the course outline.
8. When I am reading a book or other info source I skip about quite a lot dipping into the material to give students a clearer picture of the main ideas.	1 2 3 4 5	I prefer to get into detail as soon as possible because the meaning becomes clearer for pupils when I use this approach.
9. Generally I concentrate on only one or a few aspects of a topic at any one time.	1 2 3 4 5	Generally I teach about a number of different parts of the topic at the same time.
10. Once I present all the bits of a topic fitted together I put effort into teaching the details.	1 2 3 4 5	I like to teach generally how the bits in a topic all go together because the topic makes better sense when pupils can see why all the bits are important as the work. progresses.
11. When I prepare lessons I use any prepared resources/ material I can get my hands on	1 2 3 4 5	I prepare all my own work because I prefer to organise it to suit methods I find successful.
12. When I present material in a class context I usually tend to outline what material will be covered in the lesson first.	1 2 3 4 5	I let the content to be covered unfold as the lesson progresses.
13. I add interest to lessons by telling small stories or annecdotes to make the lesson more enjoyable.	1 2 3 4 5	I generally stick to the main points of the lesson and dont add extra information.
14. I spend a lot of time describing the main ideas in a topic.	1 2 3 4 5	I spend a lot of time showing the steps that that make up the ideas and processes in a topic.

15. I sometimes invent new ways of looking at topics in order to make the material easier to remember.	1 2 3 4 5	I use the examples given in the texts and other source material.
16. I use pictures and sketches to make the ideas in my subject easier to remember.	1 2 3 4 5	I find words the best way to convey the ideas in my subject.
17. My best subject is presented as a whole lot of smaller and separate subtopics.	1 2 3 4 5	My best subject is presented as connected aspects of the same subject.
18. My subject..... is best taught one aspect at a time. One principle, then the example, and so on.	1 2 3 4 5	My subject ..... is best taught by passing on principles first then examples next.
19. Thinking logically is more important than being creative in my subject.	1 2 3 4 5	Being creative is most important in my subject.
20. I like the material I work with to be well organised and clearly set out in texts notes and other source material.	1 2 3 4 5	I like to organise material for myself into the ways that make sense for me.

Thankyou for your help with this profile.

R.H. Barbour.
H.O.D. Geography.

Strictly Confidential.

Name: .....
eg: James Watt or Mary Lamb.
Age Range: 10 to 12. (X)

Teaching /Learning Questionnaire
(Form One and Two Pupil's Version)

Please **circle** the number of the statement that closely matches how you go about learning.

NOTE: THERE ARE **NO** RIGHT OR WRONG OR BETTER OR WORSE ANSWERS.
The material in this questionnaire will be used to construct a profile about teachers and students in this school.
No person will be identifiable in the profile, or at any other stage from the material in these questionnaires.

*** Circle 1 if you agree with the left statement.
Circle 2 if you agree (with some doubts) to the left option.
Circle 3 if you do not choose either option.
Circle 4 if you agree (with some doubts) with the right option.
Circle 5 if you agree with the right statement.
Circle ALL THE OPTIONS if you choose both left and right options.

Example:

When I get back my tests I tend to look for the ones I got right first.	1(2)3 4 5	When I get back my tests I tend to look for the ones I got wrong first.

Note: Please answer carefully and quickly... so as not to take up your valuable time.

1. When I am reading an SSR book I usually turn over the pages that do not interest me.	1 2 3 4 5	I read every page so that I do not miss anything.
2. When I am reading a text book I read only the bits that refer to what I want to know.	1 2 3 4 5	I read textbooks carefully page by page so as not to miss the ideas and facts in the book.
3. When I'm collecting information for a topic or assignment I like to begin with as much information as possible at the start.	1 2 3 4 5	I prefer to get facts when I need them.
4. I like to look very carefully at one bit of a book before I move to the next.	1 2 3 4 5	I like to look at a number of books of facts at the same time.
5. I like to have a clear picture of the whole topic or task in my mind while I am working on a task.	1 2 3 4 5	I like to divide topics up up into their parts and do each part in turn building up an overall picture of the topic bit by bit.

6. When I am looking for information I am generally looking for a single book or item.	1 2 3 4 5	I like to spend a lot of time skimming books in the library.
7. When I am preparing for a test I spend a lot of time putting notes into order so that I can make all the parts fit together.	1 2 3 4 5	When I am preparing for a test I tend to learn each topic in the order covered in the class.
8. When I am reading a book or other information I skip about quite a lot dipping into the material to get a clear picture of the main ideas.	1 2 3 4 5	I get into the details as soon as possible because the meaning becomes clearer for me better this way.
9. Generally I focus on only one or a few ideas of a topic at any one time.	1 2 3 4 5	Generally I learn about a number of different parts of the topic at the same time.
10. Once I get all the bits of a topic fitted together I put effort into learning the details.	1 2 3 4 5	I like to learn generally how the bits in a topic all go together because the topic makes better sense when I can see **why** all the bits are important.
11. I enjoy lessons where I am provided with material I need to learn the topic by the teacher.	1 2 3 4 5	I collect all my own material because I like to organise it to suit me.
12. I enjoy classes where the teacher makes an outline of the material that will be covered in the lesson first.	1 2 3 4 5	I enjoy classes where the information is given in bits as lesson progresses.
13. I enjoy classes and lessons when the teacher adds stories to make the lesson more interesting.	1 2 3 4 5	I enjoy classes when the the main points of the lesson are given without the extra stories.
14. I spend a lot of effort learning the main ideas in a topic.	1 2 3 4 5	I spend a lot of time learning the steps that that make up the main ideas in a topic.
15. I sometimes make-up new ways of looking at topics in order to make the material easier to remember.	1 2 3 4 5	I use the examples given in the texts and other source material to help remember.
16. I use pictures and sketches to make the ideas in in my work easier to remember.	1 2 3 4 5	I find words the best way to get the ideas to be learned.

17. I learn best when the work is presented as a whole lot of smaller and seperate bits.	1 2 3 4 5	I learn best when the work is presented as parts of the same bigger topic.
18. My best subject..... is learned one aspect at a time. One idea then the example, and so on.	1 2 3 4 5	My best subject ..... is learned by picking up main ideas first then doing the examples next.
19. Thinking logically is more important than new ideas in my best subject.	1 2 3 4 5	New ideas are most important in my best subject.
20. I like the material I work with to be well organised and clearly set out in texts, notes and other source material.	1 2 3 4 5	I like to organise material for myself into the ways that make sense for me.

Thankyou for your help with this profile.

R.H. Barbour.
H.O.D. Geography.

Strictly Confidential.

Name: .....
eg: James Watt or Mary Lamb.
Age Range: 12 to 14. ()
14 to 16. ()
over 16. ()

Teaching /Learning Questionnaire (Pupil's Version)

Please **circle** the number of the option that closely matches how you go about learning.

NOTE: THERE ARE **NO** RIGHT OR WRONG OR BETTER OR WORSE ANSWERS.
The material in this questionnaire will be used to construct a profile about teachers and students in this school.
No person will be identifiable in the profile, or at any other stage from the material in these questionnaires.

*** Circle 1 if you agree with the left statement.
Circle 2 if you agree (with some doubts) to the left option.
Circle 3 if you do not choose either option.
Circle 4 if you agree (with some doubts) with the right option.
Circle 5 if you agree with the right statement.
Circle ALL THE OPTIONS if you choose both statements.

Example:

When collecting my tests I tend to look for the ones I got right first.	1(2)3 4 5	When collecting my tests I tend to look for the ones I got wrong first.

Note: Please answer quickly... so as not to take up your valuable time.

1. When I am reading an SSR book I tend to turn over the pages that do not interest me.	1 2 3 4 5	I read every page so that I do not miss anything.
2. When I am reading a text book I read only the bits that refer to what I want to know.	1 2 3 4 5	I read textbooks carefully page by page so as not to miss the ideas and facts in the book.
3. When I'm collecting information for a topic or assignment I like to begin with as much information as possible at the start.	1 2 3 4 5	I prefer to locate info when I need it.
4. I like to look very carefully at one bit of a book before I move to the next.	1 2 3 4 5	I like to move among a number of sources of facts at the same time.
5. I like to have a clear picture of the whole topic or task in my mind while I am working on a task.	1 2 3 4 5	I like to divide topics up up into their parts and do each part in turn building up an overall picture bit by bit.

6. When I am researching for resource material I am generally looking for a single book or item.	1 2 3 4 5	I tend to spend a lot of time skimming books in the library.
7. When I am preparing for a test I spend a lot of time putting notes into order so that I can see how all the parts fit together.	1 2 3 4 5	When I am preparing for a test I tend to learn each topic in the order covered in the class.
8. When I am reading a book or other information I skip about quite a lot dipping into the material to get a clear picture of the main ideas.	1 2 3 4 5	I get into the details as soon as possible because the meaning becomes clearer for me when I use this approach.
9. Generally I concentrate on only one or a few aspects of a topic at any one time.	1 2 3 4 5	Generally I learn about a number of different parts of the topic at the same time.
10. Once I get all the bits of a topic fitted together I put effort into learning the details.	1 2 3 4 5	I like to learn generally how the bits in a topic all go together because the topic makes better sense when I can see **why** all the bits are important.
11. I enjoy lessons where I am provided with material I need to learn about the topic by the teacher.	1 2 3 4 5	I like collect all my own material because I like to organise it to suit my own thinking.
12. I enjoy classes where the teacher makes an outline of the material that will be covered in the lesson first.	1 2 3 4 5	I enjoy classes where the information is given in its as lesson progresses.
13. I enjoy classes and lessons when the teacher adds stories to make the lesson more interesting.	1 2 3 4 5	I enjoy classes when the the main points of the lesson are given without the extra stories.
14. I spend a lot of time learning the main ideas in a topic.	1 2 3 4 5	I spend a lot of time learning the steps that that make up the main ideas in a topic.
15. I sometimes make-up new ways of looking at topics in order to make the material easier to remember.	1 2 3 4 5	I use the examples given in the texts and other source material to help remember.
16. I use pictures and sketches to make the ideas in my work easier to remember.	1 2 3 4 5	I find words the best way to get the ideas to be learned

17. I learn best when the work is presented as a lot of smaller and seperate subtopics.	1 2 3 4 5	I learn best when the work is presented in a whole topic.
18. My best subject..... is learned one aspect at a time. One idea then the example, and so on.	1 2 3 4 5	My best subject ..... is learned by picking up main ideas first then looking at examples next.
19. Thinking logically is more important than new ideas in my best subject.	1 2 3 4 5	New ideas are most important in my best subject.
20. I like the material I work with to be well organised and clearly set out in texts, notes and other source material.	1 2 3 4 5	I like to organise material for myself into the ways that make sense for me.

Thankyou for your help with this profile.

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