Hearing-Impaired Children, Initial Literacy and Computer Assisted Learning

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The kind permission is acknowledged of Grin Graphics, Jacksonville, Texas for free reproduction of all cartoons in the program.

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To my wonderful sons,

Nic and Dan
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Abstract

This thesis is concerned with the initial literacy of hearing-impaired children. The literature shows that hearing-impaired children are likely to leave school with reading ages vastly below their chronological ages. This research examined whether the essential area of language development can be enhanced through the use of computer assisted learning (CAL), and also sought to identify those factors that would make teachers of the deaf more positive towards using CAL in their classrooms.

It was found that teachers of the deaf were broadly sympathetic to the use of CAL as a teaching medium but were impeded by the lack of suitable software available, particularly in the essential subject area of language development. To compare the efficiency of CAL with live instruction, a CAL program dealing with an important area of syntax development, question formation, was designed and programmed, plus a workbook (for the live instruction) dealing with the same subject matter. A representative sample of 24 hearing-impaired children was selected and given a pre-test on question formation. The sample was then split into a 'live' group who received the workbook intervention and a CAL group. Each group was then given the post-test and their scores compared. The time each child spent studying the material presented by both the live and CAL interventions was noted and at the end of the instruction all children were asked which medium they preferred.

Data showed that there was no statistically significant difference between the results of those who learned through the live teaching and those who took the CAL program, except at the difficult level of transformation where the scores of the CAL group fell significantly. Those taking the CAL instruction, however, spent a significantly greater amount of time studying the program than their live counterparts and both the live and CAL groups showed overwhelming preference for CAL as a medium.

It is concluded that, while the results do not show any particular benefit for using CAL over live instruction, the time the hearing-impaired children were prepared to study it, and their strong preference for the medium, may have longer term benefits. The learning difficulties of this group (including possible short-term memory constraints) are especially pronounced. A medium that is enjoyed and which may provide repetition and reinforcement (within a visually stimulating interface) may have a stronger, longer term impact on learning and retention than was achieved in the relatively short timescales used as part of this research.
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<td>CAL</td>
<td>Computer assisted learning</td>
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<td>DES</td>
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<td>GCE</td>
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<td>LEA</td>
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<td>LMS</td>
<td>Local management of schools</td>
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<td>MEP</td>
<td>Microelectronics Education Programme</td>
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<td>NCC</td>
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<td>Pure tone average</td>
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CHAPTER 1

Introduction

This thesis looks at how hearing-impaired children of primary school age, can be successfully assisted in their acquisition of initial literacy\(^1\). Deaf children are one category of receivers of what has become known in recent years as special needs education, an area where the problems involved in teaching special needs children are often so acute and complex as to present a pedagogical challenge of considerable proportions. It was simply impractical, however, to look at ways of improving the educational performance of all special needs cases. Hearing-impaired children were therefore selected in preference to other handicapped groups because, unlike some children (for example those with behavioural problems), the nature of their disability is inevitably permanent.

When born congenitally deaf, or made deaf through accident or disease, a child's hearing is likely to deteriorate over time, not get better. Yet while the deaf are not the only group to which permanent disability applies, (the blind face similar hardships), the deaf, in some senses, seem especially disadvantaged. The ability to read, write and communicate is so important in an advanced, industrial society, yet this is precisely the area where the deaf have greatest difficulties. Conrad (1979), for example, found that the average reading age of deaf people on leaving school is 8.5, a desperately disappointing figure. Deaf people are further disadvantaged in that the nature and scale of their disability is not immediately obvious to those that they meet in their everyday encounters, with the result that they are not always accorded the respect and consideration they deserve. The sort of embarrassment and frustration the deaf suffer is well illustrated by Jones (1981):

\[\text{I am going shopping and I want a particular spare part for my electric kettle. I arrive at the counter and am confronted with an assistant. "Have you got the autoswitch for the Russell Hobbs electric kettle?" The poor shop assistant just walked sideways with an alarmed expression on her face. She aims for the supervisor and both have a little conversation. The supervisor puts on a large smile and walks towards me saying, "Is there anything I can do to help you?" I simply repeat what I had said to the assistant previously. The supervisor's face drops and says, "Pardon, I am sorry I don't understand you." I have to mime and ask for paper}\]

\(^{1}\) In this thesis the words 'hearing-impaired' and 'deaf' will be used interchangeably.
and pencil. Through the written message, I am happy to receive my spare part. (Jones, in Montgomery 1981, p. 104–105)

Clearly, if deaf people are to be integrated as full participants in society, education can play an important role in providing them with the skills and social confidence they need. As we shall see (Chapter 3), an important aspect, which at times can trigger a bitter debate, is whether this should take place in separate, special schools or in ordinary classrooms. The evidence for the pedagogic advantages of mainstreaming seems quite strong, and the social benefits even clearer. Parents too tend to support integration as it avoids the potentially stigmatising experience of segregated schooling.

Hearing-impaired children, however, face enormous difficulties when integrated into ordinary classrooms, not least of which are the communication barriers between the deaf children and their teachers and between deaf and hearing pupils. If the sole or primary method of communication in the classroom is speech then this is precisely the channel which the deaf find most problematic. Lipreading is not a solution, since, as will be discussed (Chapter 3), not all teachers adopt teaching strategies that facilitate lipreading. The hearing-impaired might be provided with a full-time tutor to ‘sign’ the content of the lesson to them, but this seems an impractical solution given the potential costs involved. Yet it is precisely the provision of resources such as this that is central to the successful integration of the deaf into the mainstream. Without the provision of additional resources, both ordinary classroom teachers and hearing children can have strong reservations about integrating special needs children. Ironically, we will show that the kinds of individualised learning programmes that are essential for teaching hearing-impaired children can also benefit the hearing members of the class. Indeed, it will be argued that the presence of handicapped children in the class can have positive advantages for their non-handicapped counterparts.

It seems unlikely, however, that there will be an abundance of such resources available, whether they be physical resources such as textbooks and equipment, or human resources such as specialist teachers. Governments have shown an ideological commitment for special needs education without having the conviction to invest in solutions to the problem. A major element of this thesis therefore is that a technology based solution such as computer assisted learning could provide the basis for part of the solution. Since the acquisition of literacy is such a central ingredient of so many other aspects of learning, it would seem logical to link this computer assisted learning resource to the acquisition of such basic literacy skills. Furthermore, since most deaf children now spend all, or at least part of, their academic day, working in the mainstream, the ability to understand and use these elements of basic literacy will help them to cope both with the challenges of the curriculum (especially the National Curriculum) and in their interactions with the hearing children around them.

It remains problematic, however, whether, in general, the computer is a relevant tool for teaching hearing-impaired children, and particularly whether it is capable of teaching aspects of initial literacy to them. The central theme of this project,
therefore, will be a comparison between the computer as a tool for teaching an aspect of initial literacy and an alternative teaching resource such as live tuition. The research will help to determine the extent to which the computer is effective in this area and what issues concerning software, hardware and teacher education need to be addressed to make its integration into the curriculum a success.
CHAPTER 2
Special Needs Education: Integration or Segregation?

1. INTRODUCTION

Before embarking on the project per se, it is necessary to clarify what is meant by special needs education and to explore the legislative provision that has been made for those that are categorised as having special needs. This Chapter, then, looks at the historical treatment of 'the handicapped', and takes a critical look at recent government changes to educational provision for special needs children and to the curriculum they study.

A special educational need can be said to exist when a disability (for example, physical, sensory, intellectual, emotional, social or any combination of these) affects learning to the extent that either access to the curriculum or the curriculum itself must be modified in some way. In the case of children with physical disabilities this may mean making changes to the physical layout of an educational establishment (access ramps, for example). For those with intellectual difficulties it may mean making modifications to the curriculum itself by reducing the range or cognitive level of subjects taught. For the pupil that it affects, special education, is:

\[
\text{that combination of curriculum, teaching, support and learning conditions necessary in order to meet the pupil's special educational needs in an appropriate and effective manner. It may form all or part of the pupil's curriculum, may be delivered individually or in association with others, and may form all or part of his school career. (Brennan 1985, p. 30-31)}
\]

It can be seen therefore, that special education is not a neat, precise category into which children can be slotted, but a complex combination of physical and emotional states requiring resources which the individual may require for some, much or indeed all of his/her educational life, depending, in principle at least, on the extent of his/her disability. This last qualification is added because whether a child receives special educational provision, and indeed, for how long, depends, in large part, on whether the child is classified as being in need of such provision. Classifying children into specific categories of handicap is a complex process in which scientific measurement may play a part, but so also will the judgements of trained professionals which must, at least in some measure, involve an element of subjectivity.
This Chapter then, takes a brief look at the history of special needs education from the 19th century (a period when it became highly institutionalised) up to the present day and also examines one of the most important investigations into special needs education this century – the Warnock Report (DES, 1978) and examines its impact. A more detailed history of special needs education is provided at Appendix 2. The Chapter then takes a critical look at current special needs provision, examines some of the issues of integrating the handicapped into mainstream education and how changes in resources, the curriculum and teaching approaches can be used to achieve it.

2. EDUCATION AND TREATMENT OF THE HANDICAPPED

The educational problems faced by children with handicaps only became obvious when large groups of children were drawn into the classroom with the development of mass compulsory education in the 19th century. Even then, however, the actual implementation of such education for the handicapped lagged behind that for 'normal' children. Most provision was through charitable organisations many of which seemed more intent on putting the handicapped to work than in educating them or improving their general condition. The state's first involvement in this area was through the Elementary Education (Blind and Deaf Children) Act of 1893, but, fairly typically, the main object of the Act was to make the blind and deaf more self-sufficient and, thus, to reduce their burden on the state. Although deaf children, for example, were now given education in state elementary schools, boys did not start school until the age of seven, and no provision at all was made for girls.

A move towards the segregation of handicapped children began with the 1914 Education (Defective and Epileptic Children) Act which made it compulsory for local education authorities to establish which children were 'defective' and to incorporate them into special, segregated schools. The 1921 Education Act also emphasised the need for the segregation of handicapped children into special schools, and began the process of categorising children into distinct groups, in this case: blind, deaf, defective (physical and mental) and epileptic.

This policy of segregation was, at least officially, relatively short-lived. The 1944 Education Act allowed for the less seriously handicapped to be educated in ordinary schools. In practice, however, the lack of resources provided to implement the Act meant that this process did not take place. Indeed, the number of special school places actually doubled from 12,000 in 1947 to 22,000 in 1955. From the 1960s, however, the pendulum began to move back towards integration. There was a general feeling that the segregating of handicapped pupils was an infringement of their human rights, and that the designation of someone as 'handicapped' was sometimes, to some extent, arbitrary. The 1976 Education Act, which was designed to enforce comprehensive education across the country, stipulated that children were to be assigned to special schools only if they could not be provided with efficient instruction in ordinary schools. The Conservative government, however, which came to power in 1979, did not implement this part of the Act on the grounds that it would be too expensive.
The main thrust towards integration came with the Warnock Report (DES, 1978). Essentially, the report attempted to redefine the definitions of handicap away from a deficit model (problems, disabilities, etc.) into a more positive model of the individual (capabilities, needs, etc.). Indeed, the very term 'special needs' grew out of the language of the report itself. The report also viewed the need for special help to be much broader than had previously been anticipated, with about one child in six at any one time needing such help, and one child in five needing special help at some time during their educational careers. To ensure that the improvement in provision for special needs children was achieved, a system for assessing and recording needs was proposed.

The 1981 Education Act which flowed from the Warnock Report abolished the former categories of handicap and replaced them with the generic concept of 'learning difficulty'. Those children with complex difficulties were to have these documented in a statement which, in turn, would trigger the provision of additional resources (staffing or equipment) for that child. Above all, the Act acknowledged, subject to certain qualifications, the principle of integration of special needs children into ordinary schools.

The workings of the Act, however, have been criticised by some researchers. Welton et al (1982), for example, have argued that the implementation of the Act has not been consistent in different areas. In some local education authorities, for example, the decision on whether special help was necessary was made by educational psychologists and in others by medical officers, often with different results. Galloway (1985) has also commented that the way in which the Act established the principle of integration 'subject to the provision of efficient education' of other children was an escape clause. Furthermore, as Norwich (1990) has pointed out, the implementation of the Act was not supported by additional government resources.

In practice, government statistics (DES, 1992) show that between 1984 and 1991 the number of children allocated to special schools fell from 105,800 to 94,500 – only an 11 per cent fall. In 1991, however, 148,300 children over the age of five were 'Statemented', with 53,800 of them attending ordinary schools or units within these schools. Thus, while the number of children attending special schools did not fall significantly, the large increase in Statemented children was met, largely, by ordinary school provision. While in 1984 only 15 per cent of special needs children were integrated into the mainstream, by 1991 this figure was 36 per cent – a significant increase, but not, given the publicity surrounding Warnock, a huge one.

3. INTEGRATION: THE POSSIBLE DREAM?

The central issue which needs addressing is the basis on which integration can take place. Lynas (1986), for example, argued that there are two different concepts of integration. With the assimilation/normalisation approach, attempts are made to make differences between the handicapped and 'normal' society less apparent, i.e. the handicapped are required to make adjustments so they can fit the norm. The other approach is mutual accommodation which also demands acceptance and
adaptation but there is less emphasis on 'making similar'; differences between groups are maintained and respective differences acknowledged. She recognised, however, that there are tensions within both of these policies, since the handicapped themselves may place more value on their own culture and group identity, rejecting the idea of assimilation and integration.

For Booth (1983b),

*Arguments for integration largely rest on the rights of all people to participate in their communities and on the experience of the negative effects that their exclusion has on their lives and those of others.*

(Booth 1983b, p. 6)

Once a moral choice has been made about whether children with disabilities should be integrated, the next stage is to determine which group, how many children and how it is to be achieve. He argued, perhaps controversially, that children can be educated in ordinary schools irrespective of their handicaps. Once a scheme is started he claimed that it is no more difficult to include children with severe mental and physical handicaps than those with mild ones. Separation from the mainstream only allows prejudice and mistaken ideas about the handicapped to persist. The key to this is the comprehensive school system which is open to all children (and adults) in a community. This idea of a comprehensive approach towards integration is at the core of the whole school policy towards education which developed in the mid-1980s. Roaf (1989) defined a whole school policy as one which is:

*clearly understood by the whole school community, whose purpose is to guide and determine the ethos of the school and to support attitudes and behaviour consistent with that ethos.* (Roaf 1989, p. 51)

The purpose of the whole school policy is to modify the school's ethos, organisation and management to the benefit of the children's education by raising consciousness and changing attitudes. Like Booth (1988), Roaf saw this issue as essentially one of human rights. Seen in this way, special needs is not just a segregated issue but one which interacts with gender, race and social class. It means that, as far as special needs are concerned, changing the attitudes of those involved in special needs teaching is put on an equal footing with the provision of resources.

Dean (1989), however, argued that for special needs education to be delivered by the whole school approach (indeed, for the needs of all children to be met), children must be cared for as individuals, their needs assessed and parents involved. The school should also have a special needs policy containing statements on the principles on which special needs education is based, arrangements for identifying and diagnosing problems, providing additional help, ensuring pupils develop independent learning skills, and the organisation of resources.

The whole school approach is in direct contrast to previous traditional approaches to special needs education. As Freeman (1988) pointed out, even the language and terminology of the two approaches is different with the whole school approach stressing 'all teachers' as opposed to 'specialists', the 'community' instead of 'experts',

[2-4]
'integration' as opposed to 'segregation' and 'rights' instead of 'needs'. She argued that the two traditions often compete for funds and often show little understanding of each other's viewpoints. Yet, rather confusingly, a school's policies may sometimes be based on both approaches. Thus a specialist school may have a formal policy of integration and maintain close links with ordinary schools in the community; conversely, ordinary schools may practice a segregationist policy within the school, restricting the access of handicapped pupils to the mainstream and giving some teachers an 'expert', special needs role. As Bines (1988) showed, while special needs teachers exist within the whole school to support subject teachers, the whole school approach assumes that all teachers take their share of responsibility for special needs (including curricula, teaching methods and organisational structures). This is a view supported by Ainscow and Florek (1989) who distinguished between what they regard as a pre-Warnock attitude to special needs which highlighted small groups with disabilities, to a post-Warnock approach with its stress on the needs of all children and the need to support all teachers in meeting the needs of all children.

Yet as we have already noted, Adams (1990) argued that it was opposition of ordinary school teachers themselves to integration that dampened the effect of the 1981 Education Act. They saw special needs children as just another burden in already under-resourced and overcrowded classrooms. At first sight, the research evidence confirms Adam's (1990) view. Thomas (1985), for example, examined the determinants of teachers' attitudes to integrating the intellectually handicapped into a sample of schools (both primary and secondary) in Tucson, Arizona (USA) and Devon, England. The intellectually handicapped were chosen for the study because they seemed to raise the most sensitive issues for teachers and the most disagreements about integration. The results showed that the balance of opinion was against integration in both Tucson and Devon, despite the existence of a long tradition of integration policies in the former.

Clearly, tradition and practical steps to implement policy cannot guarantee acceptance among those with day-to-day responsibility for its implementation. Yet the teaching profession in Tucson is significantly less opposed to integration than its Devon counterpart, indicating that such tradition, backed by extra resources and personnel, does influence attitudes over time. (Thomas 1985, pp. 260–261, my emphasis)

He also found that part of the problem of attitude change towards integration lies with the communication gap between the teaching profession and those outside the school who promote integration.

the notion of modelling, which implies that the adjustment of the handicapped child will be facilitated by the company of the non-handicapped, has not become part of the social stock of knowledge of regular class teachers. (Thomas 1985, pp. 261–262)

The implication of these finding may be the need not only to provide additional resources to ordinary classroom teachers but to provide them in a way which facilitates interaction (and hence modelling) with ordinary children. These issues will be taken up and examined in the next Chapter.
Research by Center (1987) in Australia found, in contrast to Thomas (1986), that most teachers (77% in a sample of over 4,000) were sympathetic to the notion of mainstreaming. Yet here again, their support was heavily dependent on the provision of adequate support services. Another interesting finding was:

*the greater tolerance expressed by teachers whose principals have instituted within school modifications to help cater for atypical students (e.g. provision of aides or parents as assistants in the regular classroom, reduction in class size, introduction of individualized programs, etc.)*  
(Center 1987, p.45)

Teachers were only positive to mainstreaming children whose characteristics are not likely to require extra instructional or management skills on the part of the teacher. It also appears that those with least teaching experience were likely to be more positive to mainstreaming than their more experienced colleagues, as were those with more pre-service, or in-service training. We have seen therefore, that the research of both Thomas (1985) and Center (1987) suggested that teacher attitudes towards integration are linked to the provision of additional resources. We have also seen that the attitude of teachers was critical to the lack of mainstreaming of handicapped children following the 1981 Education Act (DES, 1981). The question arises therefore about whether the supply of additional teaching resources would contribute towards changing this attitude and hence assisting integration.

It is because of the possible importance of providing teachers with additional teaching resources that the 1988 Education Act should be viewed with some concern. One aspect of the Act is the introduction of local management of schools (LMS), under which financial control of schools is taken away from local authorities and vested in the schools themselves. One result of this may be the loss of resources which centralisation of funding brings through economies of scale, and the ability to put extra resources into specific areas (such as special needs) through cross-subsidisation. As Lunt (1990) pointed out:

*LMS poses an immediate threat to the provision of centrally coordinated education support services by the LEA and may thereby drive individual schools towards a more piecemeal approach to supporting pupils which depends on an allocation of fractions of scarce resources to individual pupils.*  
(Lunt 1990, p. 42)

For example, schools may be unwilling to take pupils who do not bring with them extra resources from the LEA's aggregated schools budget which they have to share around schools. Thus education seems to be moving away from allocation on the basis of need, to provision on the basis of the limited budget available. This is the whole school approach turned on its head. While special schools themselves are excluded from LMS, the system would seem to do little to enhance the chances of integration within ordinary schools.

This does not necessarily mean that the principle of integration should be abandoned. One of the chief difficulties, however, seems to have been that many interested parties (government, the medical profession, teachers) have supported
integration as a principle, but there has been a lack of political will (and resulting resources) to put it into practice with any real effect. As we have seen, additional resources are a key component in making integration effective. But what kind of resources are required? Gagné (1992) insisted that instructional media (human instruction, paper-based materials, computer based training etc.) can only be selected on the basis of the learning objectives they are designed to deliver. These themselves flow from the nature of the instructional material (for example, intended learning outcomes such as verbal information, or intellectual skills such as problem solving) and therefore the curriculum. It is therefore to the curriculum that we shall now turn.

4. DESIGNING THE CURRICULUM FOR SPECIAL NEEDS

Kelly (1989) has pointed out that the curriculum is such a difficult concept to define that it might be safer not to attempt to define it too tightly. It is certainly much more than just the content or syllabus of a course. Kelly went on to suggest that any definition must address issues such as the intentions of planners, the procedures adopted for the implementation of these procedures, the 'hidden' learning that takes place that is not directly related to the course content or the intentions of teachers, and the actual experiences of learners within the learning situation. This section, therefore, is careful to address the subject matter which hearing-impaired children must learn, but also the issue of their social and emotional development and ethical issues concerned with their integration into mainstream education.

Ideally, special needs pupils will follow the same curriculum as the mainstream, but practicalities such as physical or mental impairment do not always make this possible. Curriculum design, therefore, needs to take into account the individual needs of pupils, the promotion of social interaction and moral development and the encouragement of integration with the mainstream curriculum. Those with severe needs may require specific and often individual objectives. But specific learning difficulties or behaviours that affect learning, may make the sequencing of objectives difficult. Therefore a continuous process must take place between setting objectives, observing pupil behaviour and re-setting objectives. Those with less severe special needs, however, may follow the objectives of the main curriculum.

Yet as Galloway (1989) pointed out, this is very much a child-focused approach to the curriculum which by implication assumes that these problems lie within the individual child. An alternative is the curriculum-centred approach; although it is recognised that no curriculum can be taught effectively without recognising the needs of individual children, this approach concentrates on the use of resources and teaching methods, thus:

special needs are conceptualised as a teaching problem, implying the teacher's need to find ways to make the curriculum accessible to the child. The child-focused approach, on the other hand, conceptualises special needs as a learning problem, implying the children's need for help because of their inability to cope with the curriculum.

(Galloway 1989, p112)
(Ways of modifying teaching approaches to improve the instruction of special needs children are dealt with in the next section below). According to Galloway (1989) both Her Majesty's Inspectorate and DES favour the curriculum-centred approach and are concerned at the often narrow curriculum provision for special needs children. An important implication of this approach is that it should be delivered in the mainstream with the stress on what special needs children have in common with other children and the emphasis on achieving the same aim for all. But as Norwich (1990) showed, the severity of the problems that special needs children face means that they may have to fulfil different goals or objectives to meet this aim. He presented a matrix of different combinations of aims, goals, objectives and classroom methods, as shown in Table 2.1. So it can be seen that despite the hope that the aims for all children should be the same, in case 5 the aims have had to be altered, because the sheer severity of the problem made this desire unrealistic. Norwich, however, was not very precise about what he meant by aims. He commented that an educational aim might be to develop the abilities of all individuals — even those with severe difficulties. An example of a goal was the provision of alternative means of communication such as lipreading. The relationships between aims, goals and objectives, however, were left at rather an abstract level, and no attempt was made to defined the terms, and few examples offered to clarify their inter-relationship.

Dean (1989) pointed out that special needs pupils may not have distant goals (such as examination success) so it is often best to concentrate on those areas in which they show an interest; for the less able pupil, it is best if these are short-term and attainable. Content should be related to the child's first hand experiences (which for some special needs children could be limited) with the need to provide opportunities for using and practising what is learned in situations which have significance for the pupils. Norwich (1990), however, argued that it is important to recognise that in designing a teaching programme, account must be taken of the fact that a variety of outcomes may be possible (not just those specified as objectives). Thus, if intended outcomes are cognitive then it should be borne in mind that other social/emotional outcomes may also occur. What is important is that a balance between planned and unpredictable outcomes needs to be struck.

**Table 2.1 Possible combinations of common and different aims, goals, objectives and classroom methods for special needs children**

<table>
<thead>
<tr>
<th>Case</th>
<th>Aims</th>
<th>Goals</th>
<th>Objectives</th>
<th>Classroom Methods</th>
</tr>
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<tbody>
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<td>C</td>
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<tr>
<td>2</td>
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</tr>
<tr>
<td>5</td>
<td>D</td>
<td>D</td>
<td>D</td>
<td>D</td>
</tr>
</tbody>
</table>

Note: C= Common to all; D= Different for some
(Source: Adapted from Norwich (1990) p.80)

[2-8]
The significance of the 'hidden curriculum' for special needs teaching should not be ignored. This is the relationship between pupils and teachers, between pupils, and between teachers which determine what pupils and teachers expect of each other and how they perceive each other. It can have important implications for special needs education. For example, the creation of special needs units within a school can give important informal 'messages' that somehow the children who attend them are different, i.e., retarded or defective. This can become self-fulfilling if the children who attend such units also take on the message. As Galloway (1985) argued, with any sort of streaming, the initial selection process becomes 'justified' by giving the streams different curricula; more is expected of the upper band (e.g., they tend to be given more homework) and so, in time, differences in the attainment begin to increase. It is thus imperative that when special needs children are set objectives that are different to the mainstream that these are not construed (by 'ordinary' children or the special needs children themselves) as in any way inferior to mainstream goals. One possible way of achieving this is to avoid the segregation of special needs children when they are working on their special curriculum. Indeed, if a way could be found of integrating mainstream objectives with special objectives so that both could be achieved simultaneously within the same instructional setting, then some of the dangers of the hidden curriculum could be avoided.

It could be argued that this is precisely what the National Curriculum, introduced under the Educational Reform Act (DES, 1988) was designed to achieve. The National Curriculum was established to ensure commonality of curriculum content for all children (with certain exceptions) within the UK state educational system. It is the exceptions, however, that are important. While the intention is that special needs children will participate in the National Curriculum it was recognised that there are practical limitations on the extent to which this can be achieved. Thus section 4 permits specific children to be excepted in respect of specific activities, e.g., handwriting for the non-sighted; Section 17 allows the Secretary of State to make provision where the National Curriculum may not apply or will be modified; Section 18 provides exceptions for all or part of the curriculum for those children with Statements; Section 19 allows individual headteachers, in consultation with governors to make individual pupils an exception for up to six months but specify what alternative the child is to receive in terms of a broad and balanced provision. Clearly, this means that there must be a tension between the goal of a genuine national curriculum for all, and the practicality of making it work in practice.

As Adams (1990) pointed out, because of the exceptions allowed, it means that some children will be working towards attainment targets that are different to the mainstream. While this is true, however, at least there is an obligation to ensure that all pupils have as much access to as much of the curriculum as possible (Dean, 1989); this in turn may increase both parent and teacher expectations of pupil performance which are often depressingly low for special needs children. Yet Ware (1990) remained somewhat sceptical about the implications of the National Curriculum arguing that it is simply unrealistic to believe that all special needs children can be prepared for adult life; some kind of modified curriculum is going to be necessary for many. The only advantage she sees for the wholesale,
The indiscriminate implementation of the National Curriculum is that it is the best safeguard against the marginalisation of pupils and their exclusion from the system.

The above discussion has looked at the objectives of the curriculum, but what about its content? This, of course, cannot be viewed independently of the objectives themselves. For example, a child who needs a radically altered curriculum because of the severity of her disabilities is hardly likely to benefit from the sort of content appropriate to 'normal' children. Hence Dean (1989) was perhaps being idealistic when she argued that the curriculum for all children should contain elements of:

- self-knowledge and personal development including knowledge of one's own strengths and weaknesses;
- the ability to live and work with others (hints here of 19th century special needs legislation?);
- communication skills such as giving and receiving messages and making judgements about what is appropriate in a situation;
- learning skills (making observations, asking questions, sorting, ordering, classifying, generalising, making and testing hypotheses and problem solving, evaluating evidence and demonstrating creativity).

Yet none of these are possible without the basis of reading and writing skills. As Warnock (DES, 1978) pointed out:

The development of language was considered to be a major requirement of the curriculum .... as a means of helping them to understand and express their feelings. It was considered by many to be a first priority for children with moderate and severe learning difficulties.

(Warnock 1978, p. 208)

The vital importance of this aspect for the deaf will be explained in the next Chapter.

Research carried out by Hodgson et al (1984) suggested that, in practice, special needs pupils follow one of five different types of curriculum:

- Mainstream: Usually the special needs pupils were selected for the mainstream curriculum on the basis of being able to cope with it. No changes or modifications were made to the curriculum.

- Mainstream with some modifications: Here the modification usually took the form of additional help being given in specific areas. For example, deaf children were given extra language work; often though, this could only be managed at the expense of other elements of the curriculum, e.g., the study of a foreign language.

- Mainstream with significant modifications: This depended on the needs of pupils and often meant periods of withdrawal especially for English and mathematics.
d) Special curriculum with additions: Only after individual needs had been met in terms of special provision was consideration given to what elements of the mainstream curriculum they could take.

e) Special curriculum: Here there was little or no integration with the mainstream curriculum.

Clearly, what is implied by this research is that there is no single approach to curriculum design, with the extent to which special needs pupils follow the mainstream curriculum depending, in large part, on the nature and extent of their disability. If integration is to be achieved, therefore, it must be in circumstances in which the curriculum needs of special needs children do not conflict so much with the mainstream as to alter the mainstream curriculum in any significant way. But whatever the content of the curriculum, another vital question is how it is to be delivered. Teaching approaches to special needs education will be examined next.

5. SPECIAL NEEDS TEACHING

One of the chief weaknesses of Warnock (1978) was its failure to provide any guidance or advice on how the teaching of special needs education can be improved. It has been left to others to address this issue. Brennan (1985) argued that it must be based on four factors:

a) individualisation, that is, meeting the individual and social needs of the pupil;

b) motivation, by involving the pupil in planning, goal setting and self-assessment;

c) generalisation, getting the pupil to use the skills/knowledge learnt in a variety of different settings;

d) reinforcement, overlearning in critical areas, especially of precise behavioural objectives.

For Leeson (1989), however, education has been too influenced by a behaviourist view of psychology which views intelligence as an innate capacity that is static, with knowledge seen as something that is external to the learner waiting to be discovered. Teaching then becomes the didactic transmission of facts with precise standards or norms to be met. By contrast, he cited the Lower Attaining Pupils Programme developed in Oxfordshire which set out to redefine concepts of ability and to expand and develop what counts for attainment in schools. Its main characteristics are:

a) an open classroom approach which enlists the active help of others in the community;

b) an emphasis on negotiated learning which explores attitudes, skills, concepts and experience through experiment and problem solving;

[2-11]
c) the promotion of the pupils' active participation and decision-making in their own learning;

d) the differentiation in teaching approaches which provides for individualised learning and responds sensitively to the needs of individual pupils.

The teaching/learning model for this is based on the cognitive education programme known as Instrumental Enrichment based on the work of Feuerstein (1979). The essence of this approach is not to teach specific subject matter but 'thinking about thinking'. Feuerstein (1979) argued that children become culturally deprived, i.e., lacking in particular experiences in development which are essential for learning about the world and their relation to it. The culture of the family and social groups is mediated (organised, selected, explained, filtered) through the intervention of parents and caring adults. When this breaks down we have a lack of Mediated Learning Experience. The purpose of Instrumental Enrichment is to restore the ability to learn from experience. This is not a skills training or deficit model but a meta-cognition approach at generalising the strategies and abilities from particular situations and being able to control one's own learning. Learning is seen as process-orientated with a focus on language to explore thinking, form concepts and assess understanding. Learning should make more use of concept-forming processes which means finding out at the start what pupils know and what they don't know. A methodology is required which encourages opinions, judgement-making, uses conflicting evidence and the exploration of ambiguity and uncertainty.

While this approach seems to supply some quite laudable goals it is questionable whether it is appropriate for all pupils. The acquisition of some higher level skills (problem solving, for example) assumes a certain level of cognitive development. This is not to uncritically accept Piaget's model, described by Brown and Desforges (1979) as structuralist in that it sees reasoning, language development and problem solving as being acquired by the child in a series of stages. It does seem, however, that cognitive ability must be at least partly dependent on the age of the child, and on their prior experience.

Ainscow (1989) also set out a number of approaches for improving the effectiveness of teachers in special needs education. Stating the purpose of a lesson is important since learning is about finding personal meanings from experience, while learners should be given variety and choice in what they do. While individual tasks can be important, she stresses the importance of co-operative learning which can increase academic outcomes, self-esteem, and personal development but can also free up the teacher for other tasks. Flexible and more imaginative approaches to teaching may have benefits for all pupils in the class. Research by Hodgson et al (1984) found that:

"teachers' efforts to rethink their mode of presentation for the sake of pupils with special needs benefited other pupils as well; their learning and grasp of topics were enhanced by a presentation style that was pedagogically better structured and was more sensitive to pupil feedback." (Hodgson et al 1984, p. 177)
What better recommendation for integration could there be than this? The study noted, however, that there were occasions when problems did occur, especially when repetition was required by the special needs pupils. The solution adopted was to do this after the class or to divide the class into groups and vary the repetition depending on the needs of the group. Some special needs pupils received inadequate amounts of interaction with the teacher (depending mostly on the teacher's awareness of individual pupil's problems) but also on the ability of the pupil to mask their own failure.

Unfortunately, these low-profile tactics seemed to work, particularly in large classes and the teachers who were not versed in special needs, and many pupils received less instructional time from teachers than they needed. (Hodgson et al 1984, p. 178)

Furthermore, many pupils, especially those with moderate learning difficulties, needed extrinsic reinforcement in large measure and for long periods; some teachers found this difficult and not something they expected to have to provide.

If these findings reflect a wider applicability, then this has some serious implications for special needs teaching. What is clearly required is a system of individualised instruction (but preferably one which allows for some interaction with others in the class) which can monitor student performance and provide constructive feedback, and reinforcement. Given that teachers are already under pressure from larger classes, this is unlikely to be provided by special needs teachers who are in short supply. One possible solution would be computer based training. Modular programs can be designed which allow individual pupils to explore different avenues of investigation, their performance can be monitored and constructive feedback provided while their successes can be noted and applauded to enhance motivation. Since the program can be produced with a specific group of special needs pupils in mind, it can be designed in accordance with the best instructional principles for that audience. But what of the costs of such a program, particularly with the introduction of Local Management of Schools with its implications for school budgets? This may not be such a problem since while the fixed costs of developing these programs can be high, the costs for individual instruction can be low, if spread over large numbers of pupils. If a generic teaching program can be designed to meet the needs of many pupils then costs may not be an insurmountable barrier. Certainly, the viability and advantages of computer based instruction have been noted by Dean (1989):

The computer revolution in education will make it possible to deal with children on an individual basis where this is appropriate to a degree which has not been possible before. A computer, given appropriate software (my emphasis), can identify what a child knows and does not know and match this to a programme which meets individual needs.

(Dean 1989, p. 201)

Brennan (1985) also supported the use of computers in special needs teaching but noted that basic, elementary programs predominate with an emphasis on repetition and reinforcement to the neglect of concept building, problem solving, and social
integration. He also noted the need to familiarise teachers with the medium and to eradicate their fears of using it.

6. CONCLUSION

We have seen that over the last two or three decades there has been tacit support for the integration of special needs children into the mainstream with Warnock (DES, 1978) epitomising the zenith of this movement. In practice, the practical manifestations of integration have been modest, due mainly to a lack of political will on the part of governments to implement the policy, and a corresponding lack of resources to make it effective. This has meant that teachers are reluctant to take special needs children, including deaf children, into ordinary classrooms, already stretched by large numbers and pressure on facilities.

The research question which arises therefore is whether the supply of additional resources will make these attitudes more positive and the fruits of integration more successful. But what kind of resources should these be? We have seen that it is essential that one requirement that additional resources should have is that they should be capable of delivering an individualised curriculum, that is, one in which the individual needs of all pupils is met. Ideally, it should be curriculum-centred, so attempting to deliver skills and attitudes rather than specific subject matter. It is suggested that computer assisted learning (CAL) may be the ideal medium to achieve these aims. Additional justifications for using CAL are provided in Chapters 3 and 4.

This Chapter has presented at least some of the arguments and problems concerned with the integration of special needs pupils. The emphasis will now turn more specifically to the integration of the deaf into ordinary schools.
CHAPTER 3

The Integration of Deaf Children into Ordinary Schools

1. INTRODUCTION

Although it was shown in Chapter 2 (and Appendix 2), that the integration of special needs children in general has been both slow and partial, in contrast, the integration of hearing-impaired children has been much more complete. A brief history of this integration is provided at Appendix 3.1. Today, over 90 per cent of deaf children attend ordinary classes for at least a portion of their school day (Markides, 1989). In one sense, therefore the deaf can be said to be almost fully integrated. This Chapter, however, will attempt to show that there is more to being integrated than merely sitting in a mainstream classroom. Arguments will be put forward as to why the deaf, probably more than any other category of special needs children, have special difficulties coping with the mainstream environment.

The Chapter will examine some definitions of what is meant by deafness or hearing-impairment. It will define, using some of the arguments from Chapter 2, what is meant by integration, how changes in integration policy have affected the deaf and what sorts of deaf children become integrated. Above all, it will examine some of the arguments raised in favour of integration including claims for greater academic attainment and better social adjustment. It will be recognised, however, that support for integration is by no means unanimous and will depend heavily on the political and philosophical view that is taken about the place of the deaf in society. Those who espouse the principles of 'equality of opportunity' tend to argue that the deaf should be taught the skills of oral communication so that they can function 'normally' in society. This 'normalisation' approach is opposed by those, many of them deaf people themselves, who see integration and oralism as a form of oppression and an attack on their own special deaf culture. In contrast, they see a value in deaf people having the opportunity to associate with each other, the main means of communication being sign language.

Accepting, however, that most deaf people will want or need to find work in a hearing society and will require the skills acquired through the educational system to achieve this, ways of making integration successful are examined. These include the need to change both teacher and hearing pupil attitudes towards the deaf, to aid the deaf in the mainstreamed class through the use of interpreters, and the need for additional resources. Suggestions are made for precisely what kind of extra resources could be used. Unfortunately, many of the studies and arguments concerning the deaf, some of

[3-1]
which are highlighted here, have concentrated on the relative merits of different forms of communication to the detriment of studies of the effectiveness of specific teaching strategies. Some research studies, looking at various aspect of integration strategies, will be examined and suggestions will be made for the development of alternative approaches.

2. DEFINITIONS OF DEAFNESS

The terms 'deaf', 'hearing impaired', 'partially hearing', 'stone deaf' are imprecise, and indeed, are often used interchangeably by people to mean simply loss of hearing. Deafness, however, is a complex phenomenon. Those, for example, who may be said to be 'stone deaf' may hear perfectly well if spoken to quietly and close to the ear, whereas if they are shouted at, they may find the sound intolerable and even painful. Others may suffer from tinnitus a condition in which the cochlea within the inner ear (see Appendix 3.2, Figure 2) generates a sound like a whistle or escaping steam which may be subtle or very loud, and which may be heard by the sufferer when there is little background noise.

In this study, the terms 'deafness' and 'hearing impairment' will be used interchangeably to describe hearing loss from mild to total deafness. They are terms, however, which have a number of characteristics, namely: degree of hearing impairment, age at onset of disability, the type of impairment and etiology of impairment. These areas are briefly discussed here and are examined in more detail at Appendix 3.1. Essentially, the degree of hearing-impairment will be defined, for this study, in line with definitions given by the British Association of Teachers of the Deaf (BATOD) namely:

Moderate: 41 - 70 dB of hearing loss
Severe: 71 - 95 dB
Profound in excess of 95 dB

These definitions are currently widely used in UK schools. To understand the impact of these degrees of deafness, faint speech normally registers about 40 dB, normal conversation about 60 dB and shouting at around 90 dB.

Type of hearing loss relates to the way in which the loss occurred and is usually related to the biological causes of the impairment. Age of onset is of particular importance to this study especially in relation to the acquisition of language. If deafness occurs before language acquisition, such language development can be seriously impaired. Etiology of impairment relates to the causes of deafness such as biological causes or accidents.
3. LEVELS OF DEAF INTEGRATION

3.1 What do we mean by integration?

The Warnock Report (DES, 1978) which was discussed in Chapter 2, argued that there are essentially three types of integration: social (full-time education in special classes or units with only social contact with ordinary schools); locational (with integration taking the form of physical proximity to the main school); and functional with an element of full-time education in ordinary classes with additional specialised help and support.

Of these three definitions it would seem that only the last offers integration in any real sense of the word. Social integration is important, but, if confined to only those periods when the hearing and deaf can come together socially, does not provide many learning opportunities for the deaf. Locational integration provides few benefits since, although the deaf and hearing communities may be close to each other, there is no reason to suppose that either community will have much opportunity to share either learning or social experiences. In neither case is there any provision made for shared instruction, for example, a common curriculum, or classes. For the purposes of this study therefore, integration will be taken to mean functional integration, that is, where the deaf are provided with at least an element of their education in mainstream classes. This, of course, may range from a small portion of their timetable to their entire school day.

Yet a number of writers question whether even functional integration can be counted as real integration. Jordan (1981), for instance, argued that, even with an interpreter in the classroom, mere physical proximity of the deaf to hearing pupils does not constitute integration. This can only be achieved by the development of the necessary support services and training of support personnel, good relations between the ordinary schools and deaf schools, more employment of the deaf in the public education system and the monitoring and evaluation of all deaf children. Scott (1981) agreed, arguing that just interpreting the spoken communication in the classroom provides a mechanical link between the hearing and the deaf which is not the same as integration. This can only occur if both sides wish it, in other words, where there is empathy and a willingness to communicate between the two groups. The ways in which such mutual understanding and tolerance can be developed will be dealt with in more detail later in section 5, below.

Merely placing a deaf child in the mainstream is certainly not a guarantee that the child will become integrated. Indeed, Holmes (1981) related his own personal alienating experience in a Scottish school where the small size of the town (population 90,000) meant that there were insufficient numbers of deaf pupils to ensure a representative group; age ranges fluctuated according to the incidence of deafness, particularly the recent history of rubella outbreaks. The result was that from the age of 13 onwards he became the oldest deaf boy in the school with the nearest deaf pupil 4 years his junior. He thus had no deaf playmates in the school which he found a very frustrating experience.
Hearing-Impaired Children and CAL

Integration of Deaf Children

This can be contrasted with Leeds education authority which is the only LEA in the UK to integrate all deaf people into mainstream schools and colleges. O'Grady (1991) showed that where Leeds seems to differ from the experience related by Holmes (1981) is the nature and scale of resources devoted to the integration policy. Between 1988 and 1991, for example, the education authority spent £15 million supporting integration, which included funds for additional help to the deaf in the use of spoken language, the employment of deaf adults experienced in the use of British Sign Language (BSL), and the funding of a Centre for the Deaf where they can experience and recreate their own culture. So integration is not seen as a means of making the deaf adapt to hearing society, but providing them with the means both to cope with hearing society and at the same time enjoy their own deaf social environment. As such, all, or significant amounts of their school time, will be spent alongside hearing pupils in mainstream settings, but with support from specialist teachers available for large amounts of the school day. Pickersgill (Arnold, 1992a) maintained that these should preferably be deaf teachers who provide a positive role model of deafness for both deaf and hearing children.

3.2 Recent developments in integration policy

While the 1944 Education Act laid the foundation for integration, Markides (1989) claimed that the ideology for its implementation can be traced back to the pioneering work of the Ewings at the University of Manchester who developed a programme of parent guidance, encouraged the use of residual hearing and supported the development of peripatetic services.

By the 1960s, on the Ewings own estimates, about 66% of the deaf in England and Wales were being educated in ordinary schools. Since then, the level of integration has increased although Markides (1989) acknowledged that exact figures are very difficult to come by. He estimated that there are about 35,000 hearing impaired children in the UK of whom about 80% are now educated in ordinary schools, 12% in special units attached to ordinary schools and only 8% in special schools. The BATOD (1989) survey puts the figure for the number of hearing-impaired higher at nearly 57,500, but this includes both school and pre-school children; within this sample, just over 7% are educated in special schools, a figure which seems consistent with Markides (1989), with nearly 90% in the mainstream.

Lynas (1986)1 claimed that this policy of integration was favoured by LEAs because welfare and community workers recognised the need to encourage the independence of handicapped people within society. This was not helped by the 'dependency culture' which, it was believed, segregation encouraged; furthermore, various pressure groups demanded integration. While Lynas (1986) does not state this, a more cynical view would be that, with post-1974 local government reorganisation and the financial problems of the recession, it became expensive to transport the deaf to schools in other LEAs or non-maintained schools. Integration, therefore, offered a cheaper alternative

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1 This is a seminal work containing many reference sources and will be referred to frequently throughout the rest of this Chapter.
which could be cloaked in progressive terms following Warnock (1978). The threat that falling school roles posed for both primary and secondary school budgets and staff head-counts, made headteachers increasingly sympathetic to taking additional deaf pupils.

Although, as was pointed out in Chapter 2, the proportion of special needs children attending segregated special schools actually increased in the 1960s and 1970s, this was not true for the deaf where more integration took place. Lynas (1986) claimed that a number of factors have enabled deaf children to cope more effectively in the mainstream environment. Firstly, earlier diagnosis and improved hearing aids have helped in language acquisition in the early years of life. Secondly, came the emergence of better parent guidance and tuition facilities for tuition of pre-school deaf children. Thirdly, 'natural' approaches to language acquisition were developed which emphasise a high input of everyday, colloquial language which is appropriate and functional to the situation, regardless of its syntactic accuracy. Behind all these factors lies a general disillusionment with the progress made by deaf children in their special schools. As Lynas (1986) commented:

*Integration, whilst perhaps not a sufficient condition for rehabilitation and normalisation, is increasingly coming to be perceived by many as a necessary one.* (Lynas 1986, p. 24)

It is a policy, however, which now has to be implemented within the context of the National Curriculum.

### 3.3 The implications of the National Curriculum

The National Curriculum is seen by its supporters as meeting the needs of all pupils including those with special needs:

*NCC wishes to reaffirm this principle of active participation by the complete range of pupils with SEN (including those with profound and multiple learning difficulties) whether they are in special, primary, middle or secondary schools, with or without statements.*

(National Curriculum Council Circular 5, para 3. Quoted in Webster 1990, p. 46)

Webster (1990) argued that both the DES's and NCC's policies imply that, with careful planning, in-service training and the use of the flexibility inherent in the National Curriculum, then the diverse range of educational and social needs of special needs children can be met. So all Attainment Targets and Programmes of Study must be followed, unless otherwise stated, by means of exceptional arrangements.

One of the dangers of this approach is that special needs children and particularly the hearing-impaired, can become, in a sense, 'invisible' if they choose to remain silent and not draw attention to their disability. This may be particularly true for the severely or profoundly deaf if their language development (both vocabulary and pronunciation) is retarded. Statementing (see Chapter 2) would help to overcome this by drawing attention to the needs of each individual child with special needs. But the view of the
NCC is that very few children should require modifications or exemptions to the curriculum so statementing would not be needed, since a statement is only issued where the provision is additional to or different from that generally made in LEA schools in the area. Webster (1990) showed that where teachers of the deaf are available to visit all schools, the child in the mainstream who receives support will not be statemented (since the help is available to all schools in the area). Similarly, if additional help is taken from within the school's budget, a statement is not required.

The picture, however, is not entirely bleak. One of the benefits of the National Curriculum is its flexibility. Schools are required to teach the core and other foundation subjects 'for a reasonable time' to all pupils in Key Stages 1 to 3 (ages 5–14); within these stages there are 10 attainment levels, but a wide band of possible attainments which pupils should have achieved by specific ages. Indeed, the attainment levels at Key Stages 7, 11 and 14 overlap, enabling pupils to work according to their own abilities and needs at each stage (see Figure 3.1).

Deaf children may work at levels below that expected for their chronological ages, e.g., a hearing-impaired pupil aged 11 may work towards level 2 in AT2 (Reading). Working outside the levels designated for chronological age may be achieved by moving pupils up or down Key Stages to work with younger or older children; by teaching for part of their school time at levels outside ranges specified by Key Stages; teaching all the time outside the range.

Despite the advantages to the deaf which these flexible arrangements bring, concerns about the National Curriculum remain, particularly about the way in which knowledge is to be assessed. Webster (1990), for instance, was concerned about the validity of tests used because the deaf often tackle test materials in ways that are different to the hearing.

![Figure 3.1](3-6) Sequence of pupil achievement of levels in the National Curriculum between ages of 7 and 16. (Source: Webster, 1990, p. 48)
Standard Achievement Tests (SATs) will also take precedence over teacher assessment; yet formal tests are not always reliable tools, and there may be many circumstances when the informal judgements of experienced teachers may give a better indication about the problems and capabilities of individual children than standardised tests. The reporting of SATs results is also problematic for the deaf.

_The predictable consequence of the market economy for schools [is] to avoid having low attainers on roll; to make sure such pupils do not turn up when tests are done; to disapply the curriculum or assessment arrangements; or to fake the results._ (Webster 1990, p. 51)

He foresaw a situation arising where all pupils with special needs who are currently integrated into the ordinary classroom will be nominally placed on the roll of special schools so that test results are not seen to prejudice the mainstream school's position in the league table of examination results.

Sellers and Palmer (1992) also could see problems which the National Curriculum may bring, those children without statements (i.e., the majority of deaf pupils in ordinary schools) losing out. This is because access to the full curriculum would involve the schools in greater costs in terms of special resource provision. The authors were also concerned that headteachers now have the power to modify temporarily or disapply the National Curriculum for statemented children without consulting parents (although the latter do have the right of appeal to the governing body).

### 3.4 Who is selected for integration?

While the increasing integration of the deaf into mainstream education has been noted, what is also clear is that there are still some children segregated in special schools or units. The question of what criteria are used when children are selected for transfer to mainstream schools in the USA has been posed by Chess _et al_ (1984). Given a population of deaf children of normal intelligence, Chess _et al_ set out to investigate whether there are any special biases which operate to determine which children are selected for mainstreaming. A longitudinal study of 214 children was carried out from pre-school age through to adolescence. The researchers found that variables such as degree of deafness, sex or incidence of disorderly behaviour made no significant difference to whether children were selected for mainstreaming or a non-mainstream environment. The statistically significant variables were found to be ethnicity and socioeconomic class. Table 3.1 below, shows an over-preponderance of black and Hispanic pupils in non-mainstreamed classes and similarly, an over-representation of those in lower social classes; of course, in some cases non-white and lower social-economic class descriptions will have applied to one and the same pupils.
Table 3.1 Reported ethnic and social composition of mainstreamed and non-mainstreamed classes in the USA\(^2\) (Source: adapted from Chess et al, 1984, p 200)

<table>
<thead>
<tr>
<th></th>
<th>Mainstreamed (N=37)</th>
<th>Non-mainstreamed (N=46)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Ethnic group</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>White</td>
<td>97</td>
<td>61</td>
</tr>
<tr>
<td>Black</td>
<td>0</td>
<td>15</td>
</tr>
<tr>
<td>Hispanic</td>
<td>3</td>
<td>24</td>
</tr>
<tr>
<td><strong>Social Class</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Class 1 and 2</td>
<td>46</td>
<td>19</td>
</tr>
<tr>
<td>Class 4 and 5</td>
<td>14</td>
<td>48</td>
</tr>
</tbody>
</table>

Although Chess et al (1984) acknowledged that it is unwise to draw firm conclusions from these figures, she suggested that the high incidence of white, middle class pupils in mainstreamed classes is because the families of these children are highly aware of their legal rights. Not only this, they also have the education and resources to provide extra educational reinforcement for their children when needed, e.g., rigorous training in lipreading and vocal training from pre-school onwards which enables them to cope with, and be more suited to, the mainstream.

Lower socioeconomic class parents, although no less interested in their children, often failed to have the political know-how or financial ability to go beyond what was routinely offered. They also lacked the time and energy middle-class parents usually had to devote the general needs of their deaf children. (Chess 1984 et al, p. 200)

It would be interesting to know whether these findings could be replicated in the UK where the only similar study known in the general area of special needs is that of Coard (1974) who found a disproportionate number of Afro-Caribbean pupils in schools being categorised as 'educationally sub-normal'.

3.5 Levels of social integration

A specific element of integration which has been of interest to researchers is that of what MacLean (1983) has called 'psychosocial functioning', or social integration. In

\(^2\) Ethnicity determination was based on parental statement. Socioeconomic class used the 5-point scale of the Hollingshead Two-Factor Index (Hollingshead and Redlich).
reviewing the research literature to date, he noted that MacLean and Becker were concerned at the lack of substantive research in the area of psychosocial adjustment, especially since there seemed to be a pessimistic view that such adjustment was likely to be poor (Altshuler; Bowley and Gardiner). MacLean (1983) described how the issue of social integration has become tied up in two important arguments. One is about the relative merits of Total Communication involving manual sign language versus the merits of oral. The other is the debate between the advocates of mainstreaming against those who argue the merits of segregated education.

MacLean (1983) cited the work of Meadows and Schlesinger, who suggested that the incidence of emotionally disturbed deaf children is five times greater than estimates for the general population. MacLean (1983) himself formulated a more optimistic hypothesis that, within the context of a specific sub-group of hearing-impaired children (i.e., those living with their families, taught only by the oral method and in the mainstream), they would have no more problems of psychological adjustment than the hearing, given similar circumstances of life. Overall, his results bear out his optimism and he was able to conclude that the sub-group of hearing-impaired studied can function effectively in the hearing classroom environment.

In a UK study, Lynas (1986) also found a high degree of social integration. Only 4% of children in the deaf sample studied mixed only with deaf pupils in the school and there was no significant correlation between degree of hearing-loss and the number of hearing friends a deaf child had. The main variables which influenced the extent of the child's mixing were personality, and the extent to which the child was committed to 'normalisation'. The comments of a severely deaf secondary school pupil are instructive:

I want to stay with the hearing people all the time because I want more listen, you know, and talk properly. Better to get with hearing people.

(Alison, 13 years. Quoted in Lynas 1986, p. 212)

A study in New Zealand by Vandenberg, (Dale, 1984) found a contrasting picture. Here integration was far from successful with teachers ill-prepared and with very limited support from specialist teachers. Out of the study of 77 children over 20 of them said they had no close friend at home, while 5 had no friends at school. One of the most isolated cases said:

I play with no one in the playground. Mostly walk around, that's all....I lunch with no one at school. I try and make myself sit by myself and have a bit of peace and that's all I want at home. (Dale 1984, p. 55)

Clearly, given the conflicting evidence about the success of social integration, the issue of how deaf children can be successfully integrated into mainstream settings is a complex one. Yet it is also a very important issue, since if children do not feel secure within the school environment it is unlikely that they will realise their full educational potential. One of the supposed benefits of integration for the deaf is the opportunity to listen (as far as they are able) to hearing children speak, and to use these children as models. This is unlikely to occur if the deaf do not feel confident to mix socially with
their hearing peers. Some of the methods used to assist in the process of social integration are examined in section 5.

3.6 International comparisons

Research into the integration of the deaf has been conducted in a number of countries, and the pattern of integration policies which emerges is a varied one. Dale (1984) showed that countries such as (the former) West Germany, the Netherlands, the USA (up until 1972), and Belgium had a policy of almost total segregation. In contrast, Northern Italy had almost total integration, whilst in Denmark, and in the 1960s and 1970s, the UK, there was a significant degree of integration.

In the Developing Countries, Dale (1984) suggested that there are a large number of handicapped children attending their local ordinary school, but this is often only because their is no specialised help available. He argued that in India, however, in 1980 the government stated that it was to provide integrated education as a matter of policy, whilst in Kenya in the 1960s, units in ordinary schools were set up in preference to special schools, while in Mexico and Pakistan this policy is being considered.

We have seen that the process of integration is a general one, both in the sense that its incidence has increased over time, (at least in the case of the USA, and the UK), and that it has spread internationally. But what practical benefits does this policy bring for the deaf? This question is addressed in the next section.

4. THE PERCEIVED BENEFITS OF INTEGRATION

4.1 A review of the research

a) Academic attainment

In reviewing the research in this area, Lynas (1986) sounded a note of caution in that many of the studies were conducted in the USA where the curriculum, organisation of education and the cultural setting is different. Another problem is highlighted by Allen and Osborn (1984) who argued that one of the problems in assessing, say, the academic achievement levels of hearing impaired pupils against those who are segregated is that they constitute different populations, i.e., the integrated population have a greater tendency to have less severe hearing loss, to have lost hearing after the acquisition of language and to be more rated by their teachers as having intelligible speech. It can therefore be expected that integrated pupils will achieve at higher levels because they possess demographic and handicapping characteristics which have been shown to be related to higher achievement. The researchers therefore attempt to analyse the achievement levels of integrated pupils when these differences have been statistically controlled.

They found that even after this was done, integrated students showed higher achievement levels. For example, integrated students with profound hearing loss outperformed non-integrated students with profound hearing loss. But the research
also found that the beneficial effects of integration should be treated with some caution. Although integration status had a significant effect on reading and mathematics achievement, the actual proportion of achievement variance accounted for by integration status alone was very small. While integrated students performed better on standardised tests, ethnic status and additional handicap conditions are much stronger predictors of achievement.

With these reservations in mind, we can look at the research studies considered by Lynas (1986). Overall, the results of these studies were rather mixed with more recent studies tending to find in favour of integration. Lynas has noted that a study by Johnson (1963) found that a group of deaf children transferred to an ordinary school achieved poor results, largely due to insufficient specialist support and lack of teacher awareness of their problems. A study by Johnson (1962) also found disappointing progress by the hearing-impaired with those attending special schools even further behind in attainment of reading, arithmetic and speech. In contrast, research in the 1970s reported by Lynas (1986) tended to come up with more positive results. Dale (1978), for example, found that the deaf achieved better academic standards in less segregated environments (although specialist support was essential). Reich, Hambleton and Houldin (1977), in a Canadian study also found that integration can play a positive role. Research by Jensema and Trybus (1979) suggested that less segregated pupils score higher on vocabulary, reading comprehension, speech intelligibility, maths concepts and maths computation. The effectiveness of integration on academic attainment, however, is questioned by McCay Vernon (in Lynas, 1986), who claimed that, left to themselves, most deaf pupils cannot even tell what the teacher is saying.

The first major survey to assess the level of academic achievement of the deaf in UK schools was carried out by Conrad (1979) based on the academic and linguistic performance of a sample of 15–16 year olds in England and Wales. The results were depressing and shocked even Conrad himself, showing that even after 10 years of oral education, most pupils never attained a reading age greater than 9; speech intelligibility was also poor particularly amongst the profoundly deaf. These findings, however, have been challenged by others, notably Lynas (1986), who found in a study of 38 hearing-impaired children that their attainments, at least in certain categories, matched those of hearing children. Table 3.2 shows that 31% attained between 1 and 4 passes which compares favourably with the hearing, of whom only 27% obtained this number of passes. The figures do show, though, that none of the deaf achieved more than 5 GCE 'O' level passes, and proportionately more attained no graded result at all.

Lynas (1986) concluded that while these results do not confirm those of Conrad (1979) in that these results are not well below those achieved by the school population as a whole, they do show a need for positive discrimination to fulfil the educational potential of the deaf.
Table 3.2 A Comparison of Formal Academic Attainment at Age 16 Years of 38 Hearing-Impaired Pupils who Featured in the Study with National Attainments for All Pupils

<table>
<thead>
<tr>
<th></th>
<th>5 or more GCE levels</th>
<th>1–4 GCE 'O' levels or CSE grade 1</th>
<th>1 or more CSE other grades</th>
<th>No graded results</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Attainment of school pupils in England 1981/2 a</strong></td>
<td>28.4%</td>
<td>27.4%</td>
<td>35.6%</td>
<td>9.6%</td>
</tr>
<tr>
<td><strong>Attainment of 38 hearing-impaired pupils 1979–84 who featured in the study</strong></td>
<td>–</td>
<td>31.5%</td>
<td>39.9%</td>
<td>29.6%</td>
</tr>
</tbody>
</table>

Source: a. DES 1984 (Source of Table: Lynas, 1986, p. 204)

b) Social and emotional adjustment

Lynas (1986) compared her own research with that of previous studies. Katz, Mathias and Merrill (1974), for example, found that the hearing-impaired do not necessarily feel more 'normal' in an ordinary school setting because they may suffer experiences which remind them of their disability. This view is supported by Reich et al (1977) who believed that placement in an ordinary school can foster poor self-concepts unless pupils see themselves as coping as effectively as their hearing peers. Both Johnson (1962) and Fisher (1965) came to the conclusion that poor adjustment may be caused by a lack of understanding on the part of hearing people such as teachers and fellow pupils. While not disagreeing with the results of the studies quoted, Lynas (1986) nevertheless concluded that:

*less than satisfactory social and emotional adjustment is a price that often has to be paid for greater academic achievements.*

(Lynas 1986, p. 37)

This statement, however, raises a number of concerns. Firstly, even if some children manage to achieve 'normal' academic standards within a social and emotional environment which they find hostile, it must be asked what they *could* achieve if this atmosphere was truly supportive. Secondly, it needs to be asked why the hearing, both teachers and pupils, are not fully supportive to the deaf in the classroom, and what, if anything, can be done about it (see section 5).

Research by Antia (1982) compared the social integration patterns of hearing and hearing-impaired children in integrated classes and between the hearing-impaired in special classes. The results were depressing, with the hearing-impaired spending little time interacting with their hearing peers. Furthermore, the total amount of interaction between the hearing-impaired and their peers remained the same in both the integrated
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and special classes. Antia (1982) posited two possible explanations for this. First, the instructional environment of the special class may have discouraged interaction between students. Second, the hearing-impaired students may have lacked 'social' communication skills such as the ability to initiate and maintain conversations. The study also found that the hearing-impaired also spent a large amount of time interacting with their teachers, suggesting a possible over-dependence on the latter. The author suggested that teachers should encourage more interaction between hearing-impaired children to develop social communication skills as a way of overcoming this dependence.

4.2 The search for 'normality'

Lynas (1986) found that the deaf themselves supported integration because it is seen as a way of promoting 'normality'.

*I like being in a normal school 'cos you're treated like a normal person.*

(Paul aged 17 years, quoted in Lynas 1986, p. 165)

A particular element of this normality is the ordinary school's speech and language environment. In contrast, she found that special schools were thought to be disadvantageous because they encouraged the use of simplified English or sign language. Ordinary schools, though, allowed for social integration with 'ordinary' pupils beyond the parameters of the deaf group, and prepared the deaf better for life beyond the school. Lynas (1986) found that the deaf in her sample:

*want to talk as normally as possible, understand the speech of normally hearing people, achieve as near normal as possible academic standards and become socialised into the ways of normally hearing society.* (Lynas 1986, p.169)

This does not mean that the deaf are in any sense ashamed of being deaf or that they lack a feeling of identity with their group. What they do want is integration into the dominant group in society – the hearing – and therefore some of the opportunities that it brings. Significantly, most of the pupils in Lynas' (1986) sample spent between 60% and 90% of their time in ordinary classrooms, with the remainder of the time in special classes with a teacher of the deaf. Most enjoyed the special classes because they felt they helped them with their ordinary classwork; but these special classes were criticised because of the potential stigma attached to them, the sense of over-surveillance from teachers within them and because it was felt that the classes separated the children from their hearing friends.

4.3 The benefits of 'modelling'

One of the advantages stated for integration by its supporters is that the deaf can 'model' themselves on their hearing colleagues. Dale (1984), for example, argued that when integrated, the hearing-impaired can observe a wide variety of 'ordinary' children closely and can see that both intellectually and socially they are equal in perhaps all situations except those involving oral language skills. There are a number
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of problems, however, with this position. While accepting and supporting the view that there is no a priori evidence that the intellectual capabilities of the deaf are anything but normally distributed, this is not necessarily the picture received by the deaf themselves. Formal testing in mainstream situations relies heavily on reading and writing skills in which the deaf are relatively weak. It is difficult for deaf pupils to maintain a positive self-image when, for many, their literacy skills are clearly seen to be less advanced than their hearing counterparts. This therefore reinforces the case for providing additional resources to help the hearing-impaired in achieving greater mastery of basic literacy skills. This issue will be addressed in more detail in Chapter 5.

Another aspect of modelling is the acquisition of spoken language through the oral environment of the ordinary classroom. Harrison (1986) saw this as the product of interaction between deaf children and their teacher, but also with their fellow hearing pupils. Lynas (1986), however, was more cautious about whether hearing children provide good language models. They tend to adopt strange postures when talking, e.g., holding the head sideways; they rarely face other children when talking, indeed will often 'converse' when running around; their speech is indistinct (mumbling, talking behind their teeth, giggling, etc.); they do not obey the 'one speaker at a time' rule and their talk may contain many incomplete and grammatically incorrect utterances; they will often communicate with the deaf using non-verbal strategies such as hand gestures. At a junior level, they are able to make modifications to their spoken language that are more directly related to both the communication and linguistic needs of the deaf, but Lynas (1986) concluded that the exact contribution they make to the language acquisition of the deaf is still unclear. It is at the secondary school level that the hearing make more effort to modify their communications but by this stage the problems of social integration for the deaf become more acute. It is worth noting that in a study by Anti (1982) the deaf used less oral communication in the integrated classes than in special classes, suggesting that integration itself does not necessarily lead to more oralism.

4.4 The benefits of integration: a counter-view

Views about the benefits of integration are not universally supported. Dale (1986), whilst not necessarily agreeing with these opinions, outlined the arguments for segregated day and residential schools as opposed to integrated ones. The argument is that in residential schools there are experienced staff who understand the problems that deaf children face. Within this environment, all children have a handicap to some degree so they are more likely to feel at ease. In the running of the school only handicapped children are available, so, if any child it to be given any responsibilities, it is bound to be a handicapped child, a situation less likely to occur in an ordinary school. Furthermore, class sizes are likely to be smaller than those in ordinary schools, with more individual treatment and homogenous groupings for teaching.

This view is supported by the Scottish Workshop with the Deaf (Montgomery, 1981), who argued that special schools themselves are agents of integration (into society), where hearing professionals can learn to communicate with the deaf and where the deaf can learn self-esteem. It is argued that in Scotland the special schools are
amongst the most open in the country with deaf children making frequent visits to ordinary schools and taking visits from such schools. In this way, integration is seen as being on equal terms instead, the authors argue, a form of interaction designed only to make the hearing feel comfortable. A more detailed analysis of the perceived disadvantages of integration is given at Appendix 3.3.

5. APPROACHES TO ASSISTING INTEGRATION

5.1 Where are the Teaching Strategies?

Much of the literature on the deaf concentrates on the issues of segregation versus integration or the debate about the relative merits of oralism, signing and Total Communication. In a sense, this is not entirely surprising since, as Arnold (1984) pointed out, these philosophies are based on deeply held assumptions about the nature of human disability, language, and literacy. These are issues of great significance because they affect the extent to which children can function effectively in school and also the extent to which they are employable in later life. It seems, however, that, partly due to the ferocity of these debates, relatively little has been done to investigate practical strategies for instructing the deaf. This view has been supported by Lindsay and Dickinson (1987) who argued that:

*Within the field of the hearing-impaired there is a lack of research studies which address the operation of optimal integration strategies. Within education generally there has been an inappropriate focus on the wrong question. It is important now both to ask the right questions, and to examine processes whereby children with hearing-impairment can be helped.* (Lindsay and Dickinson 1987, p. 6)

This is a major concern since the problems associated with instructing the deaf are immense.

These problems have been known about for some time, a government report (HMSO, 1963) noting in an ordinary classroom setting, the deaf need a good background of general knowledge and a wide vocabulary in order to understand the full meaning of a lesson. One unexpected difficulty the research found was the inefficiency of hearing-aids under normal class or laboratory conditions. Almost without exception, teachers did not understand the problems their children faced, e.g., lipreading was regarded as a skill inherently possessed by the deaf. Teachers also seemed unaware of the need to use a known vocabulary and the need to face deaf children when speaking to them. It is depressing to note that nearly thirty years later a study by Sellers and Palmer (1992) found that mainstream teachers with deaf children in their classes are deeply concerned about their lack of knowledge about the deaf.

*We need more advice, to know what to ask for. I really needed some induction before receiving a hearing-impaired child, nothing elaborate, just some notes even, but pointers for classroom management, what to expect and so on.* (Sellers and Palmer 1992, p. 36)
This lack of preparation of mainstream teachers who accept hearing-impaired children into their classes has been partially supported by the work of Reese (1995). In a survey of roughly 50 teachers, 30 reported receiving some help (advice on technical and academic matters, classroom management, etc.), but by implication, the other 20 received little or no help. Of those receiving help, 20 reported that the amount of help had been satisfactory. This implies, therefore, that roughly two-thirds of the teachers in this sample had received either no assistance or were dissatisfied with what advice they had been given. In a later survey, the number of teachers expressing concern about having hearing-impaired children in their classes had fallen from 22 to 18, not a very large fall. It is perhaps significant that 19 respondents reported having to spend extra time with the hearing-impaired pupils, mostly at the expense of the rest of the class. 75% of the respondents in the sample reported that they expected some help in the classroom.

One form this help could take might be through the use of interpreters in the classroom. For Merrill (1981) this was not just a question of giving the deaf practical support, it 'confronts' the normally hearing children with a person who represents the real life situation of a deaf person in society. The children need to observe how this person functions in a hearing society, and they need to cope with this person so that they develop some understanding and respect for him. He argued that from awareness and understanding comes acceptance. O'Grady (1991) has also pointed to the success of using the deaf in integrated classrooms in the 'Leeds Model' of provision. It is likely that interpreters would help avoid some of the problems faced by the deaf in oral classrooms. Take, for instance, the testimony of Schreiber:

*The teacher asks a question. The child behind you or to the side gives an answer. It is wrong. The teacher then calls on you. Not having lipread the first wrong answer, you inadvertently make the same mistake. A little of this is all it takes to make you prefer the corner and a school career of the nodded head and the phoney acquiescence.*

(Schreiber, quoted in Montgomery 1981, p. 48)

Research by Gregory and Bishop (1989) highlighted the scale of these difficulties. The sample of 12 children selected suffered from a severe hearing loss (70 dB to 130 dB with a mean hearing loss of 95 dB) and were placed individually in mainstream schools. Specialist support was provided by visits by peripatetic teachers once or twice a week. As is customary, there was no signing support and only three of the children had any ancillary support in the classroom (and even these were part-time and non-specialists). Most teachers in the study had no experience of the deaf and received only limited preparation. The general educational philosophy towards the deaf was that, by being treated 'normally', this constituted giving them equal opportunities. With large classes, however, the teachers found it very difficult to give the deaf the individual support the teachers themselves realised they needed.

*I think he is going to need more extra help – the teacher has to ask herself what time you can spend with (child's name) when there are 29 other children in the class.* (Gregory and Bishop 1989, p. 3)
The study found that in one-to-one communications, teachers often had great difficulty understanding what the deaf child was saying. Perhaps not surprisingly, individual conversations with deaf children were harder, hearing children taking more initiatives in conversation than the deaf (p<.05) and contributed longer. The writers expressed concern that even within the deaf child's restricted conversation they often developed strategies to make it appear they knew more than they in fact did. Hence, they became very skilled at working out from the teacher's demeanour, or way in which the question was framed, whether they wanted the answer 'Yes' or 'No'; they also used the context of the question for guessing the type of reply needed.

On a more positive note, the study found that in group work, teachers addressed more comments to the deaf child, although the researchers admit that this may be because the teacher and hearing-impaired have difficulty understanding each other. But the deaf were less likely than hearing children to respond to questions addressed to the whole group (p<0.5) and failed significantly more often to respond to questions addressed to them by the teacher. The researchers concluded that the deaf have no straight forward access to 'normal' language and as a result did not have the competence to benefit from the wider curriculum (supposedly one of the main benefits of integration). Therefore exposure to the curriculum did not necessarily imply access to it:

*Equal opportunities with respect to curriculum do not depend on the presentation of the same material to everyone in the same form, but require that each child must be equally able to take up the opportunities.* (Gregory and Bishop 1989, p. 6)

But if teachers are already having to cope with overcrowded classrooms and with insufficient peripatetic support, what are the chances of providing the deaf with the sort of *individual instruction* they need (always assuming the teachers were aware of what these special needs were)? The results of this study strongly suggest the need for the availability of programmes of individualised instruction based on accepted principles of 'good practice' for teaching the deaf. Not only would this provide teachers with a useful resource, its design would enable the expertise of deaf teachers and researchers to be incorporated into the instructional design process, importing, as it were, this experience into the classroom itself.

### 5.2 Improving teaching styles

In her research, Lynas (1986) found that the instructional styles used by teachers often posed unexpected problems for the deaf. This was especially true in question and answer sessions where it was difficult for the hearing-impaired student to locate the source of respondent's replies. The deaf also disliked the lecture style of approach because it is difficult to concentrate on lipreading a lengthy monologue for long periods. The deaf had problems when asked to look at something, for example a map, and listen to an explanation at the same time. The speaking style of teachers could also pose difficulties since they tend to vary in clarity, loudness, accent, and lipreadability (especially men with beards!). Some teachers forget the importance of facing the deaf person and standing still while speaking so lipreading is made possible.
Teachers also vary in the sort of teaching style which deaf pupils find most useful, namely: summarising information, reformulating and editing it, and correcting contributions. All these allow for some repetition of the information which can be vital to the deaf picking up more of the meaning. Of course, in settings making use of individualised instruction, particularly where the learner is allowed or encouraged to review information, this is less of a problem.

The significance of one-to-one instruction is confirmed by Gjerdingen and Manning (1991) who described it as one of the elements of the highly successful Clarke Model of mainstream education. The Clarke School for the Deaf has a 100 year record of preparing deaf pupils for integration into ordinary schools. The authors argued that one of the difficulties the deaf face in ordinary classrooms is the fast pace of work which hinders them from learning the material well. Individual tutoring can be tailored to their own pace and at the same time be designed to be intellectually stimulating. In teaching, the use of outlining, repeating and paraphrasing have been found to be important. But for successful integration into the mainstream in English-speaking schools, English is absolutely essential including both reading and writing skills.

While not rejecting the importance of instructional group activity it seems that individualised instruction potentially has an important role to play. An individualised instructional programme, delivered by, say, a computer, might offer even more advantages, since, it can be designed to provide a variety of routes through the program to meet individual pupil needs, and the pace of instruction most suited to them. Furthermore, it can adopt the teaching styles the deaf find most useful especially those of summarising, reformulating ideas and providing feedback. With the best will in the world, teachers with classes of 30-40 children are unable to provide the sorts of individual attention that the hearing-impaired (or indeed, many children) require. A computer assisted learning (CAL) program is a patient tutor, never distracted by competing claims for attention and readily available at all times.

5.3 Changing teacher attitudes

Lynas (1986) reported that most studies find a relatively unfavourable teacher attitude towards the deaf which stems from their own insecurity and resentment arising from ignorance and inexperience. She referred to the work of Murphy, Dickstein and Dripps (1960), for example, who found that the hearing-impaired, the visually handicapped and delinquents were the lowest ranked in terms of 'desirability'. Acceptance is usually linked to knowledge of the handicap and more importantly, previous experience of working with the deaf (Haring, Stern and Cruickshank, 1958). Also important is an ideological commitment to integration and the provision of special facilities and additional resources (Cope and Anderson, 1977). On the other hand, teachers may display a positive attitude towards the integration of the deaf and still not be willing to accept them into the class. This willingness is considerably influenced by institutional variables such as class size (Bitter and Johnston, 1973), and the organisation of teaching. Indeed, this last point is crucial since other studies (Porter, 1975; Kindred, 1976) all stressed the need for the teacher to give the
handicapped child individualised and personalised teaching. Large classes, and a lack of additional resources, of course, mitigate against this.

The research of Lynas (1986) herself confirmed some of these findings. About half the teachers in her study were 'positive' about having any hearing-impaired pupils in their classes. Reasons for this varied from a belief in the contribution they could make towards helping the deaf, to the fact that the deaf seemed to display 'good pupil' behaviour. Some developed these positive views as a result of having the deaf in their class.

There seems, however, to have been little, if any, research done on the effect of providing additional resources in the classroom and its effect on teacher attitudes. This could be done as part of the process of evaluating the effectiveness of the CAL suggested in section 5.2. Hence, it would be possible to assess the impact of the program both on pupil performance on a specific learning area, and the support of teachers for the deaf in their classes.

5.4 Changing hearing pupil attitudes

It was shown in section 5 that various studies have highlighted the need to improve the social integration of the deaf in ordinary classrooms. There have been relatively few practical studies, however, of what strategies can be used to improve this situation. One exception to this dearth of activity is Greco et al (1983) who described a programme for developing in hearing pupils a greater understanding of the hearing-impaired, using the story of a deaf child and his family, delivered by trained volunteers and supplemented by various visual aids such as slides and picture books. The script included topics such as: What is sound?; What is hearing loss?; What are some causes of hearing problems? Unfortunately, the researchers do not report on the effects of this intervention.

A study which was evaluated, however, was undertaken by Vandell et al (1982). The researchers hypothesised that one of the major failures of interaction between hearing and deaf children at the preschool stage is the hearing child's failure to modify their initiations to take into account the deaf child's lack of hearing, and the hearing child's lack of responsiveness to deaf initiatives. An assumption was made that the hearing would modify the initiations and responses to the deaf during free play if they were: firstly, made more aware of the meaning of deafness; secondly, explicitly provided with techniques for interacting with deaf peers; and thirdly, given opportunities to practice these techniques with each other and with deaf peers, i.e., using more gestures, touches, signs and object-related social acts. The 'training' given the hearing children included:

a) being read stories about the deaf and deafness;

b) a visit by an audiologist to explain how the ear functions and how hearing loss occurs;

c) a lesson in sign language;
d) having their hearing restricted while playing 'Simon Says';

e) holding a tea party while not being allowed to hear or speak;

f) being asked to teach a deaf 'buddy' how to make different shapes out of clay;

g) being paired with a deaf buddy during free play activity.

Rather surprisingly, the results of this experiment were in total contrast to what the researchers had expected. Children in the treatment group (who had been through the sessions) interacted less often and for shorter durations than dyads involving hearing children in a control group, who also made more use of gestures, touches, approaches and coordinated initiations. The deaf treatment and control groups initiated similar numbers of interactions and their social acts were similar. The researchers concluded rather depressingly, that hearing and deaf children interacted more frequently and for longer periods with a partner of the same hearing status and that this pattern was not modified by intervention.

It is disappointing, but perhaps not entirely surprising, that the experiment produced contradictory results, since, any study which seems to focus on 'deafness as a problem', always runs the danger of reinforcing negative perceptions of the deaf (Antia, 1985). But even if it had been more successful, it is difficult to see what use the results would have been in determining appropriate interventions since so many different intervention variables were used. It would have seemed more sensible to have tested intervention strategies one at a time to tease out which, if any, had a positive impact. The researchers' conclusion does hold out some hope by pointing to two vital objectives for future research: the need to assess the impact of mainstreaming on academic and cognitive functions, and the critical task of getting hearing children to see a value to interacting with deaf peers.

Perhaps it is possible to achieve both of these aims simultaneously by taking the individualised programme of instruction (see section 5.2) which meets some of the cognitive needs of the deaf (and, hopefully, the hearing) and which allows the hearing and deaf to interact with each other (perhaps in dyads). Not only will this programme (hopefully) assist the cognitive functioning of both sets of children, but, by allowing and encouraging interaction, will enhance social understanding and integration. This will be because hearing children come to see the deaf as partners and intellectual equals, not as 'people with problems'.

The research of Lynas (1986) also raises some important issues about hearing pupil attitudes towards the deaf which need to be addressed by teaching strategies. She found that most hearing pupils displayed genuine concern and sympathy for their deaf peers and that, in general, they supported the idea of integration even if this meant teachers spending some additional time with the deaf. But if positive discrimination became too overt, then this support tended to evaporate. Given the concerns expressed by teachers themselves about the large amount of additional time the deaf tend to need (section 5.1), this again supports the need for additional resources in the classroom such as individual study programmes to supplement live teaching. These would help to give the deaf some of the extra tuition they need, and at the same time, would not be
seen by hearing pupils as drawing the teacher too much towards the deaf, something which, as Lynas (1986) noted, the deaf themselves are against. They dislike it because public attention only serves to emphasise their disability.

6. CONCLUSION

While the rights of hearing-impaired pupils to their own language and culture should be strongly supported, if they are not be become marginalised and disenfranchised from hearing society they must be given the skills to function in that society. One of the keys to this effective functioning is literacy. Yet it is precisely here that many deaf pupils have so many problems. While the research findings on the reading levels of the deaf (Conrad, 1979; Lynas, 1986) are inconclusive, the academic attainments of the deaf are, at best, mixed (see Table 3.2).

The National Curriculum offers an opportunity for the deaf to gain access to the whole school curriculum, but it is an opportunity loaded with risks. The educationally disadvantaged can only be expected to progress if the necessary additional resources are made available. Local Management of Schools, league tables of examination results and the costs of extra resources all suggest that the deaf will be seen as a burden. Already there are suggestions (Sellers and Palmer, 1990) that mainstream teachers feel unable to cope with the hearing-impaired children thrust upon them. This is partly because the teachers themselves feel inadequately trained for the job, but also because class sizes are large and difficult to cope with as it is.

The recommendation for more teacher-delivered individualised instruction for the deaf seems a wildly optimistic hope. Teachers, both mainstream and peripatetic, are already over-stretched and schools unwilling to bare the financial burden of taking on more staff. In this context, the delivery of individualised instruction through CAL seems feasible since, if it can be shown to be instructionally effective, the low delivery costs (if spread over large numbers of pupils) can be viable. This should not be interpreted as necessarily accepting the policies of either LMS or the National Curriculum. But it does offer, within the current financial climate, a strategic solution to a very real problem for the deaf. Unsupported, or inadequately supported within the mainstream, (many of them not deemed worthy of a Statement) the real danger is that these children will become 'invisible' and sink without trace.

Two issues now need addressing. How can the literacy standards of the hearing-impaired by improved, and what part can CAL play in this?
CHAPTER 4

The Acquisition of Initial Literacy by Deaf Children

1. INTRODUCTION

In modern, industrial society, learning to read is widely regarded as the most central objective of early schooling (Baker, 1989). Instruction in reading usually precedes instruction in writing, and the ability to read is viewed as essential for managing most of the academic tasks pupils face throughout their school lives. This emphasis on the importance of reading, and the consistency with which its acquisition is monitored, is reflected in the attention given to it by parents, schools, political parties and governments. In addition, decades of educational research have been devoted to studying the processes by which reading is acquired, and the effectiveness of alternative approaches to reading instruction. The research has engendered considerable debate about which methods for acquiring reading are the most effective. The debate can be broadly divided between two models: 'top–down', 'global' or 'whole language' and 'bottom–up', 'phonetic' or 'decoding'. Various positions are taken between these two extremes. It is a debate which has overflowed into a discussion as to which method is most suited to teaching hearing–impaired children.

Despite the arguments between these alternative approaches continuing for several decades, Stubbs (1980) has noted there is still no widely agreed definition of what constitutes reading or literacy. He suggested that the suspicion must therefore arise that the two terms are simply not definable. One reason for this might be that they refer to a cluster of rather different skills, and not to one single skill. As he pointed out, reading is partly a perpetual psychological skill involving eye–span and recognition of shapes; it is also partly a linguistic skill involving knowledge of sequential probability of words and letters; and it is also partly a social skill with particular social uses. Another problem in defining reading is that people use different reading skills in different conditions, for example, according to the difficulty of the reading material, and on their purpose in reading.

While many of these qualifications are relevant, it will be assumed here that reading, and especially initial literacy, is a process of relating written symbols (graphemes) to sound units (phonemes) to achieve meaning. Hence, it is at the same time, both a top–down and a bottom–up process. But whether a pupil uses one strategy or the other or which combination of both, will depend on pupils' skills in word and letter recognition, their ability to translate this recognition into relevant sounds (a significant challenge if the child is hearing–impaired) and above all to construct meaning from all of the above. In examining some the debates about the acquisition
of language and reading skills, their relevance to hearing-impaired children will be addressed.

2. THE ACQUISITION OF LANGUAGE

One of the elements which distinguishes man from the animal world is the way he communicates with language. Certainly, animals can communicate with each other, but, as Vygotsky (1962) has argued this is not so much communication as a 'spread of effect':

*A frightened goose suddenly aware of danger and rousing the whole flock with its cries does not tell the others what it has seen but rather contaminates them with its fear.* (Vygotsky 1962, p. 6)

Smith (1971) suggested that, even by the age of 12 months, the human child uses more language than a chimpanzee could ever learn; for the chimpanzee a sign has a one-to-one correspondence with its meaning, while the human infant is already communicating complex underlying thoughts through single-word utterances. Language allows man not only to communicate with others of the species but also to *think* in terms of abstract concepts - or as Vygotsky (1962) put it, higher forms of human intercourse are only possible because human thoughts reflect conceptualised actuality.

An important question, however, is how do humans actually acquire language? Are they naturally or genetically predisposed towards learning language, or is language socially learnt? Certainly, early theories tended to favour the first approach. Vygotsky (1962), for example, compared his work on the development of children's speech with that of behaviourist psychologists and with the work of Piaget. What is significant, is that all approaches stressed that children pass through a series of stages in learning language (see Table 4.1).

The main difference between Vygotsky (1962) and Piaget is that the latter believed that most pre-school children's talk is *egocentric*, while Vygotsky thought that egocentric speech is merely a transitional stage in the evolution from vocal to inner speech. For Vygotsky, speech development takes four stages:

<table>
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<tr>
<th>Theorist</th>
<th>Stages</th>
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<tbody>
<tr>
<td>Vygotsky</td>
<td>Social (\rightarrow) Egocentric (\rightarrow) Inner Speech</td>
</tr>
<tr>
<td>Behaviourists</td>
<td>Vocal speech (\rightarrow) Whisper (\rightarrow) Inner Speech</td>
</tr>
<tr>
<td>Piaget</td>
<td>Non-verbal autistic thought (\rightarrow) Egocentric thought (\rightarrow) Socialised speech/logical thinking</td>
</tr>
</tbody>
</table>
a) Primitive/natural consisting of preintellectual speech and preverbal thought.

b) Naive psychology where the child's experiences the physical properties of his own body and the objects around him. The child is able to make correct use of grammatical forms/structures before being able to fully understand their logical operations.

c) External signs and operations are used to aid internal problem, for example, the child counts on his/her fingers, or resorts to mnemonic aids, etc. Use is also made of egocentric speech.

d) Ingrowth stage where external operations are turned inwards and the child starts to count in his/her head and use logical memory. In other words, inner speech has developed.

For Vygotsky (1962), the development of thought is determined by the development of language. Essentially, the development of inner speech depends on outside factors, i.e., logic is a direct function of socialised speech:

*The child's intellectual growth is contingent on his mastering the social means of thought, that is, language.* (Vygotsky 1962, p. 51)

Because of this, the nature of the development of language changes from biological (in the early phases of development) to sociohistorical.

*Verbal thought is not an innate, natural form of behaviour but is determined by a historical-cultural process and has specific properties and laws that cannot be found in the natural forms of thought and speech.* (Vygotsky 1962, p. 51)

If Vygotsky is right, and thought is the product of socialised speech, then, given the retarded language development of many hearing-impaired people, this would suggest that their thought processes were also retarded, for which there is, clearly, no evidence. The development of language, therefore, may be just one aspect (albeit, for many people the crucial one) for the development of cognitive skills. Deaf people may use different cognitive means to achieve ends which are similar to those of hearing people.

An alternative model is provided by Halliday (1975), who suggested that a child who is learning his first language is learning how to mean. In the early stages, the child, strictly speaking, is not using a language as such, since language is normally defined as a tri-stratal system of semantics, grammar and phonology. In contrast, the child firstly develops a meaning-sound system consisting of a systematicity or constant relation between content and expression, and functionality, i.e., the use of sound to satisfy material needs. In this sense, Halliday (1975) was agreeing with Vygotsky (1962) that the development of language is rooted in social context:

*..... there is no system of content as such, in abstraction from the context of situation. There is only content with respect; that is, with respect to the functions that language serves in the life of the developing child.* (Halliday 1975, p. 15)
Halliday (1975) suggested that the child's language develops through three stages:

a) Phase I: Language is instrumental (satisfying material needs), regulatory (controlling the behaviour of others) and interactional (e.g., interacting with the mother). It is also heuristic with the use of questioning to gain an understanding of the environment. In using language, the child's message is interpreted by the adult and if it makes sense in terms of adult language, reinforced.

b) Phase II: (about 16½ months) This begins the transition to the adult language system. Vocabulary items may not all be pragmatic in function, for example, the use of words such as 'star' or 'bubble'. Words also occur in the context of observation, recall, and prediction. Their function is a learning function about the environment, i.e., a mathetic function, one that is both personal and heuristic. A pragmatic function develops at this stage as newly acquired words and structures are put to use. The pragmatic function leads into the interpersonal component of the adult system (the adult's own involvement in the speech situation – roles, attitudes, wishes, etc.), while the mathetic leads into the ideational component (the speaker's experience and interpretation of the world). At this stage, the child also learns grammatical structure (an intermediate form between content and expression), so is developing the basic tri-stratal organisation of adult language.

c) Phase III: This is the adult language system comprising two major components – ideational and interpersonal. These become mapped onto one another, with the result that language develops rich layers of meaning; thus, it becomes possible to mean more than one thing with the same word or phrase. One result of acquiring this is that children come to school with an accumulated store of information about the social structure, systems of knowledge and values that have been assimilated without formal instruction from adults which have been acquired through the process of learning language itself. Thus, according to Halliday (1975), the learning of language and culture are independent but also interconnected. Taking Halliday's (1975) analysis one could hypothesise that if language development is impaired, which is the case with most hearing-impaired children, then such knowledge will also necessarily be limited. Thus, deaf children may be doubly disadvantaged, in terms of language and in terms of knowledge of social norms and culture which language mediates.

As Moon (1988) has shown, these theories about the social context of language acquisition were challenged in the 1960s primarily by Chomsky who sought to explain language learning in terms of genetically transmitted grammatical predisposition which, he believed, is unique to humans. At one level, the experience of hearing-impaired people acts to support Chomsky's assertion since, even without the ability to hear spoken language, the deaf, at various levels of accuracy, are able to reproduce it. However, the lack of fluency and grammatical accuracy with which this is performed may, conversely, point to the significance of language development as a social phenomenon.
Indeed, Moon (1988) referred to research which suggested that language learning itself is not significantly different from other forms of learning, and that experiments with animals have shown that they too can be taught forms of sign language. He argued that by the 1970s, most theories were suggesting that language is acquired within an interpersonal context, particularly with parents. Children, as Halliday (1975) emphasised, thus become immersed in oral language in contexts which are purposeful and meaningful. So children learn to communicate by communicating, just as they learn to walk by walking itself. Yet the majority of deaf children live with parents who have hearing faculties, thus making the very act of communication between children and parents potentially problematic. The virtuous circle whereby children learn to communicate by the act of communication itself (including the vital ingredient of language), may not be so easily acquired by hearing-impaired children. It is not the case, however, that language learning is necessarily completely dependent on parental input. Smith (1971) suggested that children learn language by a process of ‘hypothesis testing’ to discover the rules of language. The child’s language is idiosyncratic and its progressive refinement into adult language follows an orderly sequence. Even by the age of 6 months, the babbling of infants from different countries becomes distinguishable, i.e., the baby has started to acquire rules for the production of sounds. As Smith (1971) has put it:

... it would be an over simplification to say that he has learned these sounds by imitating his parents. The baby acquires them the way a sculptor ‘acquires’ a statue — by disposing of surplus material that he originally had available for use if required. (Smith 1971, p. 52)

By the age of 18 months, the child has acquired a powerful set of syntactic rules and is using two or three word phrases: 'all gone milk', or 'see baby'. These can hardly be copied directly from parents since adults do not use these language structures. The primary role of the adult is to provide feedback — not in correcting an item of language, but in giving information so the child can verify a rule he/she has just applied. Smith (1971) argued that these same rule–discovery skills are also applied to reading.

3. HOW CHILDREN LEARN TO READ

3.1 The challenge of written text

It is probably true to say that most children are 'reading' their environment before they even meet formal reading instruction in the classroom. Not only, as we have seen, are most children aware of using the structures of adult language before they reach school, as Beardsley (1988) has shown, they are actively interpreting the whole environment which affects their daily lives. Thus, in the post office, they learn literacy by looking at television screens, asking questions of parents, noticing stamps, letters, booklets, etc. By the time they are formally introduced to literacy, they have acquired a:

..... shared knowledge of ... many cultural manifestations .. and from the ways in which their parents have interpreted literacy for them. (Beardsley, 1988, p. 90)
Television literacies like Thomas the Tank Engine create a culture which all children share, e.g., Thomas clothes, toys, pyjamas, pens, etc. Moon (1988), for example, referred to the work of Goodman and Altwerger, 1981, and Hansler, 1984, who found that children entering school are more proficient at handling print on cartons, signs and television than print in books.

Yet, while most children by the age of five are using the tri-stratal form of adult language, there is no simple transfer of the skills and knowledge learnt here, to the environment of reading. This is because, as Blank (1985) has shown, reading has a number of characteristics that are distinct from oral language. Text does not have the power of an actual event — it is disembedded from the physical context of what it describes (especially as text becomes more complex). This can be alien to children since their language tends to be quite embedded, e.g., 'I have a sore finger'. There is scant research on what impact this has on reading, but Blank (1985) referred to the work of Blank, Rose and Berlin, 1978, who suggested that 5 year-olds who can read well can master disembedded questions such as 'What will happen ...?', but this does not apply to poor readers. Blank (1985) also pointed out that the coherence of text for the fluent reader is aided by what is not said, i.e., by what is implicit. The 'sense' of written text comes as much, if not more, from the unstated than from the stated.

Those who have not attained mastery of verbal-verbal exchanges do not possess the skills by which to connect the seemingly endless and unstructured variety in the material they confront. In the absence of unstated organizing themes, they have little expectancy as to how the text will proceed. (Blank 1985, p. 33)

For early readers, so much effort is devoted to presenting simple words that can be easily decoded that the connectedness of the text is often even more implicit than for much more sophisticated readers. Much connectedness depends on noncontent words (but, however, then, until), which relate one idea to another. Most noncontent words are considered both meaningless and containing difficult grapheme-to-phoneme correspondences, that is, converting the written form of letter(s) into their corresponding sound values in speech. Hence, they are often avoided in texts for young readers. But this puts the responsibility for establishing cohesion on the child, for example:

Tag is a pup.
Kit is a cat.
Kit ran to get Tag.
Peg has a wig.
The wig is wet.
Peg set the wig on a big log.
(Maker, quoted in Blank 1985, p. 34)

The ideas of one sentence are so independent that they do not sufficiently prepare the reader for the content of the next. Blank (1985) further suggested that the conventions of written text often violate the rules that the child has learnt in the oral mode. For example, in text can be written 'Mr. Bird was happy. He was so happy he had to sing'. In oral language, children use the present tense, but this text is written in the past tense. Also, in the written mode, use is made of quotation accompanied
by *he said*, *they shouted*, etc. It should not be difficult to see that for poor readers, and this includes a substantial proportion of hearing-impaired children, these subtleties of the written form may be illusive.

Lunzer and Gardner (1979) also pointed to some of the major differences between written text and the spoken word. Firstly, with text there is no common situation (i.e., between speaker and listener), so the frame of reference must be inferred from the text. Secondly, words stand alone, unsupported by non-verbal behaviour, with no opportunity for feedback from the listener. Thirdly, reading is uninterrupted, and monotonous with text often more complete and dense than the spoken word – potentially a problem for the more immature reader. Lastly, text is often ordered differently to the spoken word.

It is hardly surprising therefore, that initial reading can pose such a challenge to young children, and particularly those with sensory difficulties (such as the hearing impaired). But how do children actually acquire reading skills? As Downing (1985) noted:

*Our ignorance about how children learn to read is still enormous, despite all the research that has been carried out.*

(Downing 1985. p. 43)

Nevertheless, Appendix 4 presents some of the theories which have attempted to offer an explanation. A summary of these is presented in Table 4.2.

**Table 4.2 A summary of the main theories of reading**

<table>
<thead>
<tr>
<th>Theory</th>
<th>Exponents</th>
<th>Main ideas</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bottom-up</td>
<td>Gaskins (1988)</td>
<td>Readers first learn individual letters of the alphabet and phonemes; these are used to build up the sound for words.</td>
</tr>
<tr>
<td></td>
<td>Thompson (1992)</td>
<td></td>
</tr>
<tr>
<td>Top-down</td>
<td>Goodman (1969)</td>
<td>Readers read for meaning; they come to recognise whole words, without having to identify each individual letter</td>
</tr>
<tr>
<td></td>
<td>Smith (1971)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Merritt (1985)</td>
<td></td>
</tr>
<tr>
<td>Interactive</td>
<td>Rumelhart (1977)</td>
<td>Information for processing is gained from a variety of sources simultaneously (letter and word identification, the word in the context of the reader's knowledge of syntax and semantics). Some interactive theories stress a compensatory model: e.g., if the reader is poor at lower level word recognition, s/he will compensate by looking for contextual information.</td>
</tr>
<tr>
<td></td>
<td>Stanovich (1988)</td>
<td></td>
</tr>
</tbody>
</table>
4. READING ABILITIES OF DEAF CHILDREN

4.1 A survey of reading performance

Adults who become deaf after they have learned to read, probably read better than their hearing contemporaries because, given their lack of one sensory input, they may compensate by making greater use of others, e.g., sight for reading. When we look at those who are born deaf or who become deaf before they learn to read, the picture, however, is very different, with a plethora of research showing distressingly low reading attainment levels. Perhaps the seminal study in this area is that of Conrad (1979) who found that, in a study of 468 deaf 15–16 year old school children that the average reading age was 9 years. This evidence was so depressing that Conrad had to comment:

*It is clear – and not an over-statement – that we do not know how to teach deaf, or even partially-hearing, children to read.*

(Conrad 1979, p. 175)

Kyle (1980) reported other research which comes up with similar findings: Kyle *et al* for example, found that reading attainment levels amongst a sample of partially hearing 15–16 year olds was about 11 years, whilst a survey in the USA by Di Francesca of 17,000 6–21 year old children found an average reading age of 9 years 2 months. King, and Quigley (1986) reported this same study, noting that the average annual improvement on reading tests was only 0.2 grade levels per year (compared, of course, with an average of 1.0 grades for hearing children).

It is not surprising that, in a book (Wood *et al*, 1986) the contents of which included communication and language, talking and listening and mathematical reasoning of deaf children, the section on reading was described as 'our gloomiest chapter' (p. 94). The authors admitted that, despite years of effort by teachers, the vast majority of severely and profoundly deaf children leave school incapable of reading. One reason is perhaps that the processes used in skilled reading, both by deaf and hearing readers are not fully understood. Add to this our ignorance about the linguistic competencies of the deaf and 'we are confronted with a problem of quite staggering complexity' (Wood *et al* 1986, p. 94).

An important characteristic of deaf children's reading attainment levels noted by Webster (1988a) is that beyond about the age of 8, attainment tests show a plateau being reached beyond which deaf children find it difficult to progress with sufficient speed, that is, progress that will let them keep pace with the reading attainment levels of their hearing counterparts. For hearing children of eight or nine years of age, there is a sudden shift away from reading and comprehension of isolated words and sentences to reading whole passages. Yet it is precisely at this stage that deaf readers' performance curve flattens out. Banks, Gray and Fyfe (1990) noted that various strategies have been suggested for overcoming this plateau including the development of cognitive strategies for extracting information and the use of top-down reading strategies (see Chapter 5). A basic problem, however, is that our knowledge of the ability of the typical deaf reader is still very limited, partly because developmental studies of reading abilities of deaf children are largely incomplete. Furthermore, the range of abilities measured in large surveys reflects narrow,
bottom-up approaches to reading. There is also a dearth of information in the literature about deaf sub-test performance around the important reading age of nine years.

Banks, Gray and Fyfe (1990) therefore carried out their own longitudinal study aiming to chart the reading development of a group of severely deaf children over a three year period, starting from a nominal reading age just below the plateau of nine years. The research found that while the sequence and comprehension abilities of the group continued to improve over the period, the vocabulary and syntax plateau did emerge. The results do show, however, that the plateau, even for profoundly deaf children, is not inevitable for all aspects of reading. The authors agreed with Conrad (1979), however, that severe deafness does seem to preclude the acquisition of internal speech, which seems to be vitally important for fluent reading.

The use of an auditory (rather than visual) coding may be essential if the reader is to hold in memory lengthy sequences of words in memory in order to derive syntactic information. (Banks, Gray and Fyfe, 1990, p. 31-32)

The implications of Conrad's analysis are dealt with in more detail below (see sections 5.2 and 5.3).

Webster (1988a) suggested, however, that the supposed plateau may be an artefact of test construction rather than the cognitive capabilities of deaf children themselves; before the age of 8, tests tend to deal with lower level skills such as word recognition whereas beyond this age the children suddenly get exposed to more complex language, including syntax, and are overwhelmed. Webster (1985a) also questioned whether comparisons between hearing and hearing-impaired children are completely fair since the sort of standardised tests used may be sampling different test behaviours in the different groups, a proposition also noted by Wood et al (1986). If this is so, Webster (1985b) asked whether researchers ought to be avoiding the question Why can't the deaf child read? replacing it with Does the deaf child read by different processes? We will deal with the latter question in more depth in section 5.3.

4.2 Deafness, language, and reading difficulties

What is it that makes reading so difficult for hearing-impaired children? This is a complex question and one to which there are no simple or conclusive answers. One obvious problem is that most deaf children approach the task of reading with a significantly more restricted vocabulary than hearing children. It was noted by Lewis and Richard (1988) that the normal language development environment of hearing children is facilitated by several features of 'motherese', that is, the kinds of language used by a mother in communicating with her small child: a slower delivery, higher pitch; exaggerated intonation contours; shorter, highly redundant and repetitive utterances; the use of restricted but relevant vocabulary; expressive facial and non-verbal components. The content and style of interactions emphasise the 'here and now' which bring relevance and interest to the child and help stimulate the child's attention. The result is that the language of adults becomes connected with
the child's own thoughts, enabling insights into the meaning of language to be gained.

Not only is the deaf child's language restricted, this problem is exacerbated when it comes to reading. As Webster (1985a) commented, the deaf reader's problem is a dual one: never having met the word/sentence patterns which the written code represents, and never having met the printed symbols of the written code. In a sense, therefore, the deaf child is having to learn two languages at the same time – the oral language, and the written language (which, as was noted in Chapter 3, contains some different structures to the oral form).

Wood (1982) commented that the deaf child's interactions with adults are inhibited by divided attention between the object communicated about and the act of communication itself, i.e., doing in series what the hearing child does in parallel. Thus, a deaf child has to remember what an act of communication involved, to decide what it related to, or remember an experience so that a later act of communication can be related to it. With deaf children facing problems of attention, memory and integration it is hardly surprising that they take longer to go through the pre-linguistic stage of language development.

In contrast, hearing children bring their cognitive skills to bear on the task of reading earlier, testing out hypotheses about the meaning of text from many information sources: sounds, letter shapes, whole words, sentence syntax, story context, picture clues, likely context, knowledge of the world and how it operates. Yet, as Webster (1988c) showed, children with even a mild hearing loss may have many problems such as:

a) delays in acquiring speech sound since the fricative /f/ or /v/ sounds, nasal sounds like /m/ or /n/, plural endings and sounds which are weak or unstressed may be missed;

b) discriminating between sound, blending, sequencing and remembering sounds;

c) poorer vocabularies and more limited range and flexibility of words;

d) restricted understanding of what words mean and their functions in language;

e) lack of attention span, concentration, motivation, and independent styles of learning.

Once some of the elements of language have actually been acquired, deaf children may then experience difficulties in transferring and using many of its essential elements for reading. Webster (1988a) identified several areas of research where these difficulties are particularly identified. In terms of sound, he cited the work of Dodd who suggested that deaf speakers use less than half of the 40, or so, phonemes available. Cooper and Arnold (1981) found that the deaf may also have problems with visual perception skills in perceiving and discriminating between letters. Semantic awareness may also be delayed, with literal use being made of language and an apparent lack of metaphorical expression. For example, a difficulty in understanding expressions such as 'clean as a whistle', 'a biting wind', or 'take your
time' which tend to be understood only when the reader becomes aware of the rich nuances of form, structure and meanings of language. As far as syntax is concerned, there may be a delay in the acquisition of English grammar. Webster (1988b) argued that poor syntax control must account for many of the difficulties deaf children have in reading comprehension, a point acknowledged by Arnold (1993).

*I am sure that half (or more) of the problem of deafness is syntax.*

(Arnold 1993, letter to the author)

In examining ways of overcoming some of the difficulties outlined above, the question arises whether they are the product of delayed development or, in some way, the result of defective or deficient cognitive processes. If the latter is the case, then the scope of educationalists to improve the situation may be constrained. If, however, deaf readers have cognitive capabilities on a par with their hearing peers, but suffer from delays in development caused by their disability, then educationalists can look at ways of addressing these delays and using instructional strategies for overcoming them.

5. COGNITIVE FUNCTIONS: DIFFERENT OR DEFICIENT?

5.1 Historic overview

Arnold (1992a) related that, while early work with the deaf was very optimistic (e.g., Wertheimer), this was soon eclipsed by the writings of Pintner in the early years of the 20th century, who was convinced that the deaf were brain-damaged. The study by Pintner and Patterson (1917), for example, suggested that deaf children have a small memory span for digits because they are unable to use 'auditory images' and are dependent instead on visual imagery. Quigley and Kretschmer (1982), reviewing the work of others, related how this view had a strong influence up until the 1940s after which it tended to be replaced by a view that the deaf are not so much inferior as cognitively concrete (e.g., Myklebust) and less able to cope with abstract concepts. From the mid-1960s, however, under the influence of researchers such as Furth and Vernon, the deaf began to be regarded as intellectually normal, although writers like Arnold still believe that, while not different (in Myklebust's terms), the deaf are not quite the same either, often processing information in different ways to hearing people. Indeed, as Conrad (1979) noted, deaf people have often been used as control groups in research on issues such as verbal memory because it has been assumed (often erroneously) that they use strategies other than verbal ones for processing information.

5.2 A short-term memory deficit?

A popular assertion is that deaf people suffer from a short-term memory deficit, the assumption being that deafness itself necessarily leads to an impairment of verbal language which in turn leads to any of the following:

a) the absence of auditory imagery;

b) the inability to subvocalise;
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C) a dependency on less efficient visual coding;

d) an inability to recall sequences.

Conrad (1979), however, rejected the notion that a short-term memory deficit in deaf children is a theoretical necessity. The main problem with many of the studies which have claimed to have found such a deficit is that they have regarded 'the deaf' as a homogenous group instead of one in which there are large degrees of heterogeneity. Furthermore, in experiments, the tasks chosen have often been those which require a high degree of verbal language for good performance; if tests are selected carefully and the adequacy of performance considered, deaf children can often achieve better results. For example, because they tend to use visual coding, deaf children will often have difficulties in discriminating between the digits 2, 3, 5, 6, 8, 9, and 0 because of their curvilinearity; they do better when the material presented has adequate intraset discriminability. It is because of these difficulties that Conrad (1979) suggested that we still lack a reliable understanding of the short-term memory capabilities of hearing-impaired children.

The issue of a short-term memory deficit, however, was again raised by Kyle (1980), arguing that, while at the age of about 7 years deaf and hearing children have similar reading vocabulary between the ages of 7 and 9 years a gulf develops. This is because reading skills come to involve, less a knowledge of vocabulary, as the kind of syntactic skills with which deaf children tend to struggle. Kyle suggested that this may be due to limitations in short-term memory, with such memory storage being essential so that meaning can be deduced from a sentence or passage. There is, however, insufficient information on the reading abilities or processes used by deaf children to accept this kind of assertion. One of the outcomes of this research is that it may add to the growing body of evidence on the cognitive capabilities of the hearing-impaired used in reading.

5.3 The use of different processes

Conrad's (1979) study argued that while it is likely that many, if not most, hearing people use forms of internal speech when reading and performing cognitive functions, most deaf readers may be unable to use internal speech. This was suggested by his own experiment which showed that 94 per cent of the hearing children in his sample made use of internal speech, whereas only 74 per cent of even the least hearing-impaired children used it (significantly fewer: p<0.001), suggesting that:

..... degree of deafness is a variable of the utmost importance in determining whether or not a child develops the ability to internalize speech and to use it, at least when he reads words.
(Conrad 1979, p. 102)

The proportion using internal speech declines with hearing loss (apart from those with a hearing loss of 65 dB, which Conrad puts down to a sampling function). It is at around the 85 dB level of hearing loss that the decline in the use of internal speech becomes most noticeable. Nevertheless, hearing loss itself, does not necessarily preclude using internal speech since within the sample a small number of profoundly
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deaf children were shown to be using internal speech. These, however, tended to be amongst the most intelligent children since using internal speech not only correlated significantly with degree of deafness but also with intelligence (measured by the Raven's Matrices intelligence test). Overall, Conrad found that:

... children who use internal speech are likely to be less deaf and more intelligent than those who do not. (Conrad 1979, p. 105)

So, while a minority of deaf students (on the whole, the more intelligent and less deaf) make use of internal speech, this means that the rest – the majority – must be using other processes, the most likely candidate being a visual one. While Conrad (1979) showed that both intelligence and hearing loss are determinants of both linguistic and reading abilities, the research of Wood et al (1986) argued that additional variables should include home background, the influence of school and also teaching techniques. The researchers found, for example, that those children judged to have lower intelligence and greater hearing loss tended to have their reading more controlled by the teacher (i.e., more interruptions, guidance, etc.). The researchers argued that there is a need to explore the effect of more enabling styles of teaching to see if reading problems result from teaching styles or the nature of the handicap (for a discussion of teaching techniques see Chapter 5). An interesting rejoinder is that the authors found gender differences in their test results with girls' scores being more closely bunched and boys' more spread, i.e., a pattern similar to that found in hearing children. This tends to add weight to the view that linguistic development in deaf and hearing people display important similarities rather than differences.

A number of other studies also showed that deaf readers use different strategies for processing or retrieving information to those with hearing. Allen (1971), for example, looked at initial processing by taking three types of card: Card C, with a solid colour in each square, Card W with words printed in black ink and a CW Card, with a colour name printed but in a conflicting colour, e.g., the word 'red' printed in yellow ink. The students were asked to name the colours on the C Cards and identify the words on the W Cards, with the CW Cards used to test interference, that is, the extra time taken to read the word if the reading habit is stronger than the colour-naming habit. The hypothesis was that, with the reading levels of both hearing and deaf groups controlled, the habit to read should be equal in both groups. In practice, the deaf students exhibited less interference on the conflicting CW Card, suggesting that there are differences in how deaf and hearing students process the material:

*The deaf do not show a 'compulsion to read' to the same degree as do hearing children when confronted with verbal material.*

(Allen 1971, p. 296)

Allen (1971) therefore concluded that the hearing-impaired use strategies for apprehending and processing verbal material that are qualitatively different from those use by hearing students.

This conclusion is supported by the work of Chen (1976) whose research was based on an earlier study by Corcoran (1966). Working with a sample of hearing people, Corcoran examined the phenomenon of 'acoustic confusion' in the recall of letters by
getting a group of subjects to examine a passage of prose and cross out the letter 'e'. The results showed that the probability of missing a silent 'e' was greater than missing a pronounced 'e' (p<0.002). Corcoran's conclusion was that the acoustic image of a word is scanned as well as its visual stimulus. Chen (1976) followed up this work by examining how hearing and deaf students compared in their use of acoustic images. Using Corcoran's method of letter 'e' cancellation in a prose passage, Chen found that those who were only hard of hearing used a mixture of both acoustic and visual images but that the severely deaf probably depended more on visual sources. This, of course, supports Conrad's (1979) view that the severely deaf tend to rely heavily on visual images rather than internal speech.

Yet in contrast to this, Cooper and Arnold (1981) suggested that the problems hearing-impaired people face in processing textual information may lie, not so much with a lack of access to acoustic images, but by deficits in visual perception – especially mechanical reading skills which require perception and discrimination between letters and words. Why is it, they asked, do those hearing-impaired with good speech have reading levels closer to profoundly deaf than to the hearing? To test their hypothesis, the researchers took a sample of 19 hearing-impaired and 19 hearing children (the control group) and gave them five sub-tests of the Frostig Developmental Test of Visual Perception. They found that the hearing-impaired children showed deficits on all the visual sub-tests of the Frostig Test compared with norms for children of a similar age. The consequences of this are that those deaf children with difficulties in figure-ground perception will have problems in recognising words since figure-perception involves the perception of parts of the visual field in relation to others; for example, the child may fuse letters so that 'clip' becomes 'dip' or he/she may add, omit or substitute letters.

Other researchers have suggested that deaf readers rely, not on internal speech or visual perception but on word association strategies. Wood et al (1986), for example, gave a sample of 60 hearing-impaired and 60 hearing children the Southgate Sentence Completion Reading Test to see if the two groups used the same strategies for completing sentences such as:

a) Birds are covered with ....
trees/skirts/sky/nests/feathers

b) Careless driving leads....
to happiness/cars/tractors/accidents/improvements

For hearing children there was an even distribution of errors across distractors, but the deaf children made the same type of errors showing that they were at least using a systematic approach. Thus in a) a common answer was 'nests' and in b), 'cars'. Wood et al (1986) concluded that these results do not simply reflect delayed reading development – they show the deaf children are using a different process, that is, word association.

This finding was taken up by Hayes and Arnold (1992) who hypothesised that the word association phenomenon found by Wood et al in a 1981 study is nothing more than a product of the structure of the Southgate Reading Test itself and would not be found in a cloze and word association test. The results of the Hayes and Arnold study (1992) showed that, using a cloze test, the 'associational strategy' is not a
general phenomenon amongst deaf readers. The 'associational' findings of Wood et al (1981) may, instead, have other explanations. For example, the errors may be based upon the reader's failure to use temporary phonological storage which is necessary for sentence comprehension. Hayes and Arnold (1992) concluded, however, that the strategies used by hearing-impaired children are problems of late development rather than deviant in nature.

Gray et al (1991) noted that, for hearing children, acoustic storage is the most effective medium for storing strings of words in working memory, where an articulatory loop is used to repeatedly rehearse new material. The question is: what strategies do the hearing-impaired use? The authors postulate that deaf children make use of schematic recall strategies as opposed to verbatim strategies. With short stories, hearing pupils are able to recall them in their presented (verbatim) order; but with longer passages, too much strain is placed on working memory so a story schema (a cognitive knowledge structure) is used, as a framework for interpreting and retaining detail.

The use of a schematic strategy thus enlists the aid of long term memory to overcome limitations in short term storage capacity.

(Gray et al 1991, p. 99)

The question is: can deaf children make use of similar strategies? The researchers constructed an experiment in which a sample of deaf and hearing children were asked to read a story presented in verbatim (scrambled) order, and 'make' the same story (i.e., in the same order) using pictures which had been shuffled. The procedure invited a verbatim recall strategy since the original sentence order must be retained while the pictures are being rearranged. Results showed that hearing children did indeed make use of this strategy but that the hearing-impaired children had a marked tendency to make use of a schematic strategy. So, provided the linguistic demands of the passage are not too great, this is a further piece of evidence to support the hypothesis that deaf children are capable of utilising story knowledge and inference to construct the story line from text.

This section has suggested that there is broad agreement that deaf children have difficulty in reading. Where there are sharp differences of opinion is whether these problems are caused by retarded development or by inherent deficits in cognitive functions. It seems fair to say that the result of these studies are contradictory and inconclusive (although it is acknowledged that the inability of many severely deaf to use internal speech means they are using processing strategies for some functions that are different).

6. CONCLUSION

It is not possible to say conclusively that any of the models of reading presented above is flawless, nor that they represent a complete explanation of how children become fluent readers. Indeed, much of the research seems contradictory. It appears that readers (particularly if they are not hearing-impaired) may hunt for clues at various levels, e.g., lexical, letter, feature. Good readers, however, may have developed the skills of decoding graphical information directly, irrespective of its context. In contrast, poor readers (and most deaf children fall into this category)
may have more need to search for contextual clues and have greater difficulty in decoding at the letter or word level (or at least with sufficient speed to release sufficient STM for comprehension processes).

For hearing-impaired children, in general, the greater the hearing impairment, the more serious the impact on reading ability. It is perhaps no exaggeration to say that many, especially profoundly deaf pupils, leave school functionally illiterate. We have seen that progress is often quite satisfactory up to the age of about 8. It is here, however, that the so-called 'learning plateau' emerges, due largely to the changing nature of the reading tasks being undertaken – especially the expansion from mere vocabulary to the use of more complex syntactic structures. As Arnold (1993) noted, syntax is half or even more than half of the problem behind reading difficulties.

Since hearing-impaired readers tend to fall into the category of 'poor', it may be necessary to follow the recommendations of Gaskins et al (1988) that poor readers be given explicit instruction on how language works. If specific elements of language can be taught (e.g., vocabulary, semantics, syntactics), then it may be possible that the routinisation or mastery of certain elements of language and reading may develop skills that are transferable across a number of language elements. For example, teaching one type of transformational syntax may illustrate to a novice reader that in language, word order is semantically significant. Furthermore, developing mastery of, say, certain aspect of word recognition or word order, may free up STM for other important processes such as comprehension. Some approaches for teaching language and reading to hearing-impaired children are now discussed in Chapter 5.
CHAPTER 5
Teaching Reading to Deaf Children

1. INTRODUCTION

This Chapter examines various strategies that have been used for teaching initial literacy to hearing children, and then looks at methods of teaching reading to hearing-impaired children. In doing so, it evaluates different approaches such as the use of language partners, bottom up and top down teaching methods (the latter including the use of 'active learning' techniques, story schemata, games and simulations). These approaches are examined in detail so that practical teaching strategies can be selected which seem appropriate to the instruction of hearing-impaired children.

2. GENERAL APPROACHES TO TEACHING READING

We have seen that there are various models of how children learn to read including bottom-up, top-down and intermediate approaches. It is not surprising therefore that the teaching of reading reflects the diversity of theoretical paradigms. In practice, teachers often adopt what can only be described as an eclectic and pragmatic approach to the teaching of reading, trying any technique that seems appropriate to the situation and the needs of the individual child. The research of Hollingsworth *et al* (1990) into teaching methods in six western US schools found that less than 10 per cent of teaching time was spent in practices which could be construed as whole language, with conventional practices (basal readers, workbooks and worksheets) taking up nearly 70 per cent of reading time. In the UK, an HMI Report (DES, 1990), based on visits to 3000 schools, noted that over 80 per cent of teachers in the sample used a variety of approaches to the teaching of reading, but that over 90 per cent taught phonics in one way or another.

What is also surprising is that despite the volumes of research into the process children use in learning to read, there is a remarkable paucity in the literature of practical suggestions as to how teachers can facilitate this process. In this section we will look at some of the main approaches.

2.1 Teaching Phonetics

Stahl (1992) suggested nine guidelines for what he calls 'exemplary' phonics instruction:
a) Build on the child's rich concepts about how print functions. It is no good teaching a child letter–sound correspondence if the child does not even understand what stories are or how print functions. So children benefit from an early exposure to print (such as being read stories), after which they need more systematic study.

b) Build on a foundation of phonemic awareness, i.e., an awareness of the sounds in spoken words. For learning to read, especially about sound–symbol relationships, it is important that the child knows the words in terms of the sounds they contain. Stahl related his experience with a little girl with reading difficulties. As part of a reading assessment Stahl asked her to say meat and then repeat the word with the /m/ sound removed (eat). The girl said chicken, because she viewed words only in terms of their meaning (a little less meat, to her, was chicken). After some weeks of instruction on reflecting on the sounds in spoken words, she became an excellent reader.

c) Be clear and distinct. For example, to teach the letter b, show the word bear, either in the context of a story or in isolation, and point out that it begins with the letter b, and that this letter makes the /b/ sound. Another approach is to show the letter b and then a word such as bear which begins with that letter.

d) Integrate instruction into a total reading programme. Phonetics should not take more than 25 per cent of instructional time and practice spent.

e) Focus on reading words not learning rules. Effective decoders do not even use phonic rules; they see patterns of letters which can be used to aid identification. Phonics instruction helps children by drawing attention to the order of letters in words, and forcing them to examine common patterns in English through sounding out words, and by showing similarities between words. Stahl conceded that rules can be useful in helping children see patterns, but in general, they are not useful enough to be taught on their own. For example, teaching that ought has six sounds is a complete waste of time. When rules are used, they should be presented as tentative, with exceptions, and should only be used as a way of highlighting a particular spelling pattern.

f) Include onsets and rhymes (called rimes in the original text). Onsets, the part of the syllable before the vowel, and rhymes, the part from the vowel onwards, may be useful because of their letter–sound correspondence is quite regular. For example, ea taken on its own is thought to be irregular, but as a rhyme is very regular at all times except in -ea (bead vs. bread), -eaf (sheaf vs. deaf), and -ear (hear vs. bear). The rhyme -ean, for example, nearly always has the long e sound. Stahl gave an example of rhyme–based instruction where a pupil is given the sentence The little red hen gathered the wheat and asked to compare the word wheat in the sentence with meat and to say 'If m–e–a–t is meat then this is wheat' and to cross-check if the pronunciation makes sense within the context of the sentence. Stahl supported this approach because it is helps both decoding and comprehension.
g) Use invented spelling practice, in which, by working out their invented spellings, children may be learning phonetic principles. Stahl was cautious, however, admitting that there is little research evidence to support this approach.

h) Develop independent word recognition strategies, focusing attention on the internal structure of words. Instructional strategies could include getting the child to sound out a word letter by letter, find a word that shares the same rhyme, or spell out the word through invented or practice spelling.

i) Develop automatic word recognition skills through practising reading words, preferably in context. Once this automatic word recognition has been mastered, the child is able to recognise words without conscious attention (and hence devote more cognitive processing to comprehension).

Stahl was hopeful that most children will be able to complete the phonics stage of word recognition by the end of the second year of primary school, and hopefully earlier.

It is possible that many of these strategies would be quite useful for hearing-impaired children, for example, where possible, teaching the sound of words, or focusing on the internal structure of words. The advice to avoid the direct teaching of rules, however, while possibly appropriate to hearing children, may not be sensible as far as deaf pupils are concerned: While hearing pupils learn the structure and rules of language by listening to them in everyday usage, hearing-impaired children are not so fortunate. If they cannot gain access to these rules by hearing them used in active language, then, surely, the only alternative is to teach them how language works directly. This issue is explored in further depth in section 3.

Hinson and Smith (1993), however, have sounded a note of caution about phonetics teaching, arguing that, while some children may benefit, different children achieve reading fluency in different ways. It is also important that the introduction of phonetics is timed correctly, that is, after the child has begun to correct his or her own mistakes when reading. Hinson and Smith also warned that the teaching of phonetics should not be seen as an end in itself, but should be related to meaningful reading materials. Indeed, they warned that an overemphasis on phonetics can even slow down a child's progress since it may inhibit their understanding of larger units of print such as phrases and sentences.

An HMI Report (DES, 1990) suggested a clear link between higher reading standards and the teaching of phonetics

_However, while the value of teaching these skills was rarely disputed, how and how often to teach phonics were more controversial issues._

(DES 1990, para. 31.)

Research by Gaskins _et al_ (1988) purported to show clear evidence for the success of a phonetics teaching programme which built up a sight vocabulary of 120 key words. In exercises, children were required to decode unknown words using a compare and
contrast strategy against the words they knew and there were drill and practice exercises to reinforce new key words. Two tests were subsequently administered to assess the effectiveness of the instruction. A significant improvement was claimed for one test (but figures are not provided), while (rather worryingly) a 'nearly significant increase' (p. 40) is claimed for the second test – in other words, the gain was not significant!

2.2 Teaching the whole word method

In contrast to the phonetic approach of teaching individual letters, the whole word approach uses 'flashcards' to illustrate a word, at which point the child has to say it. Then exercises are introduced to show that letter symbols (graphemes) can be represented by sound (phonemes), until the child can make fairly automatic letter-to-sound conversions. Many words have to be learnt partly or entirely by their visual appearance because so many English words are irregular in spelling. Beech (1985) argued that the advantage of this approach is that it promotes reading for meaning at a very early stage. When a small sight vocabulary has been established then it can be deployed in various combinations to produce meaningful sentences.

For Smith (1971) the essential role of the teacher is in providing the learner with help with some of the rules of reading. Arguing that children are not 'taught' to read, but come to reading with a firm grasp of language (which they have often learnt despite the assistance of adults). They can:

a) distinguish characteristics of objects, events and concepts;

b) integrate visual, acoustic and sensory information with semantic attributes;

c) continually develop and refine their store of knowledge by testing its implications and relations;

d) look for significant differences between objects.

What the child does not know is where to look for these distinctive features. He/she cannot be shown or taught them, but must learn the rules of language for himself/herself. The role of the teacher is this process is to provide immediate feedback (at the moment it is needed) about whether the child is right or wrong; the provision of examples is also useful. The child will sometimes be wrong, but to become fluent, he/she must be willing to make mistakes. The teacher therefore must be tolerant in accepting errors. Again, the problem with this approach may be similar to those which follow Stahl's (1992) recommendations for avoiding the direct teaching of rules. For hearing-impaired children may not instinctively pick up the rules of language by trial and error. Indeed, the rate of errors (ignorance and misunderstandings) may outweigh successes so heavily as to demotivate the child. The direct teaching of rules should be considered.
2.3 Practical teaching strategies

Whether reading is a bottom-up or top-down process or some combination of the two, the development of the ability to read can be regarded as a matter of skilled performance (Lewis, 1985). It is essentially, therefore, an information processing skill comprising a hierarchy of sub-skills which early readers need to pay attention to and practice to the point where they become automated, i.e., to the point where control of the activity passes from the awareness of the performer. This allows attention to be released for higher-level activities such as comprehension. An important aspect of teaching, therefore, could be providing the learner with help and practice in developing these reading sub-skills. Lewis (1985) warned, however, that the assumption that teachers must teach these skills to the point where they are used with 100 per cent accuracy may not be right and may put unnecessary pressure on the child. Perhaps of relevance here is the importance of risk taking if graphemes are to be processed quickly enough for comprehension (see section 3.3).

One practical technique, first used in the USA shortly after World War II, is the 'SQ3R' method (Lunzer and Gardner, 1979), which stands for Survey-Question-Read-Recite-Review. It is a method which the child is meant to apply to every general text that he/she meets. In using this approach, the child surveys the text in order to anticipate what is coming, asks questions which may be answered by the text, reads the text, recites or goes over the main points established, and reviews what has been learnt, paying attention to any points which have been missed.

The SQ3R study method has been incorporated into 'reading laboratories' or reading schemes which have become popular in the USA but in the UK educational system have been mainly confined to remedial classes in secondary schools. The aim of such schemes is to develop a wide range of related abilities such as increased vocabulary, an understanding of more complex sentences and structures, the use of contextual clues to aid comprehension and the development of global understanding and inference. The purpose of the reading laboratories is to encourage 'reading-thinking' skills as opposed to mere rote learning or memorisation, and stresses the importance of learning from mistakes, and self-evaluation at each stage of the learning process. Pupils, for example, mark their own work to assist reinforcement. Fawcett (1979) evaluated the effect of reading laboratories on a sample of 1018 junior and secondary school children and found that the programme made a statistically significant improvement in speed, accuracy, vocabulary and comprehension. But these gains were best exploited when the experience was followed up, or associated with an imaginative and varied programme designed to promote critical thinking in relation to reading any passage. Fawcett (1979), however, did sound a note of caution, that reading schemes, such as the one described, can be criticised for being too narrow and limiting; reading must also include activities which are motivating and performed to satisfy a purpose. Downing (1985) supported this view, stating that reading tasks must have significance for the reader in comprehension if to be achieved. The implication of this analysis for the teaching of some of the rules of language are that this may become a cognitively arid activity, devoid of meaning for the reader. It is vital, therefore, that the teaching of
rules should be performed within a context or activity which is significant for the hearing-impaired learner.

It is also important that reading materials are used which are not too complex for the cognitive level of the reader, but which, at the same time, provide sufficient stimulus to be motivating. Beech (1985) described how materials can be improved by the use of illustrations to accompany the text as these can improve the memorability of material, especially when depicting spatial relationships between described objects. Donaldson and Read (1985) argued that material should be used which systematically highlights features of word structure while requiring the child to attend to phrase and sentence meaning. Furthermore, reading materials should also be used which encourage correct expectancies about variations in the ways sounds and symbols correspond so that awareness is increased about the syntactic information carried in word structure – plural endings, verb tenses, adverbial suffixes, etc. It was acknowledged, however, that some grammatical variants can be particularly difficult because they represent a level of language development which a child has not reached, e.g., many 5-year-olds say 'a elephant' or 'a other'. Much disillusionment in reading stems from children meeting syntax that they cannot process – because text is saturated with phrases and sentences that are not the norm in speech.

It should not be assumed, however, that just because researchers and teachers adopt particular strategies towards teaching instruction that the classroom is necessarily an effective place for learning to read. The research of Wells (1986) found that the language environment of the classroom may be less rich than that of the home, providing less interaction with adults and with children forced to act more as respondents rather than initiators. This is because teachers may, at a theoretical level, feel it is important to relate to the individual learning needs of the child, but are under pressure from large classes, fewer resources and from relentless demand for more accountability. Too often, the curriculum concentrates on the specification of structured and graded teaching steps that will help ensure that all pupils progress in a pre-determined sequence to a pre-determined objective (see Chapter 3 on the National Curriculum). This is a teacher-dominated style of interaction. Yet effective learning occurs only when children are allowed to take an active role in which they strive to make sense of their experiences. Well's (1986) conclusion was that they must share in the responsibility for initiating and carrying out their tasks. Merritt (1985) supported this view arguing that language skills cannot be 'taught' – they arise naturally out of the child's need to communicate. What they need is games they can return to 'as and when the spirit moves' (p. 121) – not drills to be performed when the teachers dictates. Smith (1971) also argued that reading cannot be 'taught' – it has to be acquired; the major contribution of the teacher is to provide information, feedback and encouragement, a point supported by Sutton (1985). Sutton suggested that for pre-school children, their ability to read is partly determined by their ability to build hypotheses about the structure of language; what is important to their development is that they achieve a high degree of response so that errors can be detected and self-corrections made. The instinct of most teachers to use a variety of approaches, according to the individual needs of children, is probably right.
It does seem, however, that most teachers seem to concentrate rather heavily on the teaching of phonetics, especially in the early stages of a child's reading development (DES, 1990). Again, this is probably right, since it seems unlikely that most children will be able to read directly for meaning before they are able to recognise a significant number of key words on sight and make a letter–sound correspondence. For hearing-impaired children, this processing cannot rely so much on letter–sound correspondence, but on a more visual encoding system.

It also seems important that teachers are conscious of the need to put any reading exercises within a context that is meaningful and significant for the child. Hence, reading lists of words does not seem to be an appropriate task; learning words should therefore be done within some kind of context, e.g., within a story or by placing the written word against the object it depicts. This means that, following the ideas of Rumelhart (1977) and Stanovich (1980), the children will be able to gain semantic assistance from these objectives when attempting to decode at the feature, letter or lexical level.

The role of teachers in this process is, of course, vital. Again, it is important that fixed 'positions' for and against teacher–centred or child–centred approaches are not adopted. The extent of teacher control will depend on the teaching context and the nature of the task being undertaken. What is essential is that the reading experience is an enjoyable and fulfilling one for the child. As Stanovich (1980) showed, good readers can acquire meaning from a passage rapidly because many of the lower level word recognition skills have already been automated. Such automation is, at least in part, a product of practice. If poor readers are to practice reading and have any hope of acquiring these skills then motivation to read is clearly essential. Since deaf children are disproportionately within the 'poor' category, motivating them to practice reading is, clearly, important.

In the process of asking questions about the text, and in making and wishing to test hypotheses about the nature and function of language, the child should be able to elicit immediate feedback. Here the use of information technology and specifically computer assisted learning could be important. While none of the researchers or writers discussed in this Chapter specifically mention the use of computer assisted instruction, it is possible that this means of instructional delivery could fulfil some requirements for learning through games and enjoyment as well as providing information, feedback and encouragement to learners. The integration of computers into the classroom to assist in reading is examined in Chapter 6.

3. TEACHING READING TO DEAF CHILDREN

There have been few attempts to look systematically at how children are actually taught to read in the classroom, nor are there any well designed evaluations demonstrating the effectiveness of any reading scheme used with deaf children. As Wood et al (1986) noted:

*The field abounds with opinions but is noticeably lacking in evidence.*

(Wood et al 1986, p.104)
This is a view shared by King and Quigley (1985) who raised a number of important instructional issues arising from the literature including: can reading be taught or can it only be 'caught'?; should language be established before beginning formal reading instruction or can language be learned through the process of reading?; should initial reading focus on decoding or on meaning?; do exercises that focus on components of the reading process (e.g., vocabulary) or reading skills (asking questions of the text) in reduced-context environments help progress?; should the sub-skills of reading be taught or should it be regarded as a holistic process? should new vocabulary, syntax and concepts be pre-taught or should they be encountered only in contextual reading? Practical approaches to teaching reading are explored in the sections that follow.

3.1 Language partners

Wood et al (1986) compared the ways in which reading is taught to deaf and hearing children and found some interesting differences:

a) Deaf children stopped reading spontaneously and were stopped more often by the teacher than hearing children (and for a greater variety of reasons);

b) Deaf children were more likely to be stopped because they did not pronounce a word properly (even though it sometimes seemed they knew it);

c) The reading rate achieved by deaf children was about 20 words/minute (the hearing group achieved 64 words). Since experimental studies suggest that at a speed of less than 40 word per minute comprehension begins to break down:

> It therefore appears highly unlikely that a deaf child with poor expressive and spoken language can make much sense out of text read at half this rate. (Wood et al 1986, p. 106)

Indeed, Webster (1988c) suggested that adults have a tendency to be less effective language partners for deaf children, with both parents and teachers adopting didactic and controlling approaches, commanding, managing or correcting the child. One result of these experiences is that deaf children can often adopt passive, unquestioning styles of learning. An important aspect of remedial teaching therefore is the encouragement of natural hypothesis-testing strategies to language in general. Add to this the scale of interruptions and it is doubtful whether the child is left with much sense of the story.

Webster (1988b) pointed out that language in schools may be taught in a decontextualised way, devoid of purpose and isolated from real experience (rote vocabulary drills, and grammar exercises characteristic of many 'structured' teaching programmes). These fail to harness the child's potential as a 'scientist' in testing hypotheses, seeking out rules and reconstructing their own models of language.

> Teachers must then address additional problems for deaf children, moving them towards independence in learning, aware of how to go about their own study, learning how to learn. (Webster 1988b, p. 81)
This is a view supported by Erting (1992) who argued that we need to move away from a pathological and deficit view of deafness, to one which sees the deaf child as a competent learner but one who requires a visual environment and language. Above all, the printed word must be made accessible by relating it to the child's ways of seeing and communicating.

Webster (1988b), in criticising drill and practice was attacking one element of the bottom-up approach. We saw in Chapter 4 that there is disagreement amongst researchers as to whether this, or the top-down approach are most effective in teaching reading. It should come as no surprise therefore that a similar argument is raging when it comes to teaching reading to deaf children. Sections 3.2 and 3.3 look at some of the arguments and research on both sides.

### 3.2 Reading materials

Another problem is that the level of text presented to the deaf children is often too high, especially if it contains 'pluri-functional' words such as pronouns which take their meaning from the grammatical structure of the sentence. Wood et al (1986) suggested that what is important is the development of the child's language, leaving reading to a relatively late stage (say, 8 years of age). These suggestions, though, are based on observations of one successful school and are therefore not presented as being conclusive.

### 3.3 Teaching approaches: bottom-up processing

An essential element of the bottom-up reading approach is grapheme-phoneme correspondence (GPC). Yet, as Wood et al (1986) point out, if Conrad (1979) is right, and most deaf children do not have internal speech, then they cannot use GPC, i.e., convert what they see into sounds. This means, if the bottom-up is the only valid approach, that hearing-impaired children cannot become good readers. As the authors show, however, Conrad's tests used only lists of isolated words to assess reading performance, which would be criticised by a top-down theorist as inhibiting the ability of the deaf reader to use some knowledge of the structure of written language, no matter how limited. Teaching reading word-by-word, may only serve to limit reading comprehension.

Banks, Macaulay and Gray (1991) also argued that this emphasis on foundations may be counter-productive because it focuses on activities which the slow reader finds unproductive. The result is that the slow reader falls further behind, a condition which they point out has been labelled by Stanovich (1986) as the Matthew effect after the Gospel according to Matthew: For unto every one that hath shall be given, and he shall have abundance: but from him that hath not shall be taken away even that which he hath' (XXV:29). In effect, what Stanovich (1986) was saying is that good readers get even better because they tend to read more, learn more word meanings and hence read even better and enjoy increased vocabularies. Children with limited vocabularies tend to read slowly and with less enjoyment, read less material which inhibits the development of their vocabulary and in turn their tendency to read. Yet what Banks, Macaulay and Gray (1991) failed to point out is
that it is precisely the bottom-up strategies which they deprecate that Stanovich (1986) recommended strongly.

In essence, Stanovich (1986) argued that there is an increasing body of evidence to support the notion that early reading success is correlated with phonological awareness. Furthermore, reading acquisition itself may facilitate phonological awareness, a case of reciprocal causation, which may have what Stanovich refers to as 'bootstrapping effects' (p. 363). It seems important that this pre-requisite phonological awareness and skill at spelling-to-sound mapping are established early, otherwise a negative causal chain is created. In contrast, a better reader gets to attain a proficiency level where decoding itself is no longer the primary determinant of reading level (because word recognition becomes automated).

Stanovich (1986) went on to suggest that Smith's (1971) hypothesis that good readers are sensitive to redundancy afforded by sentences and that they are able to identify words by sampling only a few features may be wrong. Advances in eye movement technology have shown that fluent readers sample the complete visual array even when reading predictable words. In fact, the effect of good reading is not that they rely less on visual information, but that they use less capacity to process it.

Another important issue is that of compensatory processing. Stanovich (1986) argued that the extent to which the reader has to rely on context depends on the skill of word recognition. If word recognition is slow, then s/he has to draw more on contextual information. Slow readers, however, may 'plod' through text, not picking up clues from the context because their word recognition skills are so poor. At this level, they are more likely to have to rely on phonological information. In contrast, the skilled reader has access to such information but post-lexically, where it serves to support comprehension processes operating on the contents in working memory.

3.4 Teaching approaches: top-down processing

As we saw in Chapter 4, the top-down approach is strongly supported by some researchers. This section looks at a number of these strategies used with hearing-impaired children.

a) Active learning

Banks, Macaulay, and Gray (1991) used the term active learning and saw it as a way of encouraging the active participation of the reader through the use of: predictive skills, questioning of the text, comprehension monitoring, hypothesis reviewing and reciprocal teaching (where the teacher models the activity with the pupil, gradually withdrawing support). Two elements of reciprocal teaching are cloze inferencing and semantic mapping. With cloze inferencing, words are deleted from a passage and the learner has to fill them in, whereas with semantic mapping, a spatial representation or diagram of the main ideas of a passage is drawn (hopefully, getting the reader to focus on the main elements of the text and encouraging the activation of relevant prior knowledge). Semantic mapping provides an explicit representation of the structure of the text, while in cloze inferencing the discourse structure of the text remains implicit. They may therefore complement each other, semantic
mapping providing a global structure and cloze inferencing being a more fine-grained and infrastructural.

Banks, Macaulay and Gray (1991) set out to evaluate the effectiveness of semantic mapping as a top-down reading strategy, beginning with the hypothesis that semantic mapping should be a more effective strategy for deaf readers than cloze inferencing because it focuses on the strengths of the deaf in global passage processing, while cloze inferencing makes demands on 'lower level' processing of single word meanings and syntactic analysis of local sentence content. A second hypothesis was that deaf pupil's performance on the passages used in the ordinary (control) lessons should be inferior to their performance on either the semantic mapping or cloze passages. The researchers argued that the data gathered confirmed both hypotheses. The sample used, however, was small making the results, at best, indicative.

A similar teaching strategy is Directed Activities Related to Text (DARTS) which attempts to get the reader to actively work on the text and to develop an overview of its content. Through the DARTS method the reader is directed to, for example: underline relevant information using different colours; label diagrams; highlight important vocabulary/ideas; outline the sequence of events in a story; highlight details relevant to time, place and subject; generate questions about the text. It has not proved possible, however, to find any detailed studies which examine the effectiveness of this strategy in practice.

b) Schemata

The work of Banks et al (1991) was an attempt to use some of the processes of the top-down approach through the use of what they call 'story schemata'. They argued that there is evidence to suggest that when hearing children listen to a story they use previous experiences of other stories to help them organise and recall the one they are listening to build up cognitive structures or schemata: 'prototypical representations' of story formats. Banks et al (1991) questioned whether hearing-impaired readers possess this story-schemata knowledge and if so, if they can access it when reading or receiving stories. The researchers did, in fact, find that hearing-impaired children had lower scores than hearing children of a similar age leading to the conclusion that their schemata are, indeed, weaker. Their conclusion was that it may be necessary to make the episodic structure of stories more explicit as part of any top-down, discourse-orientated teaching strategy.

A similar approach was adopted by Banks et al (1989) when attempting to ascertain whether teaching some top-down reading skills at the whole passage level to deaf children can be effective in helping them to improve their reading, specifically the use of story-structure questioning. A schema for a story might include the setting, beginning, problems faced by the main character, a solution to the problem and an ending. In story-structure questioning, each passage is divided into different story parts and questions devised for each part (see Table 5.1, overleaf).
Table 5.1 Examples of story-structure questions (Adapted from Banks et al (1989, p. 131))

<table>
<thead>
<tr>
<th>Story-structure</th>
<th>Story-structure questions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Setting</td>
<td>Where did .... happen?</td>
</tr>
<tr>
<td></td>
<td>When did .... happen?</td>
</tr>
<tr>
<td>Beginning</td>
<td>How did the story begin?</td>
</tr>
<tr>
<td></td>
<td>What happened at the beginning?</td>
</tr>
<tr>
<td>Problem</td>
<td>What is .... problem?</td>
</tr>
<tr>
<td></td>
<td>What does .... have/want to do?</td>
</tr>
</tbody>
</table>

The researchers tested the effectiveness of using story questioning by training a sample of deaf pupils in its use and measuring its effect on their ability to remember a story. The results showed that those children who had been trained in the story-structure technique showed a 20.8 per cent improvement between pre and post-test scores (p < 0.002). As Black (1993) showed, however, this is not in itself a reliable measure of the effectiveness of the variable (the story-structure training), since it cannot be deduced from a research design such as this, that it was the training itself which produced the improved test score. This type of research design is notoriously weak since there is the distinct possibility that improvements in post-test scores arose largely out of the cueing effect of the pre-test. Significantly, only those in what were designated as beginning and moderate reader groups benefited from the training, with only four of the fourteen pupils maintaining this improvement after a four week period. The researchers maintained that their research was successful for poorer readers probably because they tend to spend too much time on bottom-up features of print. They claimed that the scores were not maintained because no attempt was made to get them to transfer the strategies they had learned to untaught stories; this itself has to be taught. Overall, it is difficult to agree with the researchers' view that the experiment was successful.

c) Language games and simulations

A teaching strategy recommended by Arnold and Wildig (1981) is the use of games, although if used with deaf pupils care must be taken to ensure that any essential vocabulary they may need is prepared before hand, and time is taken to understand the rules of the game. For example, rather than talking in the abstract about a grocer's shop, it is better to have a model of one (or even better, a visit to real one). In using models, various question forms and target answers could be generated such as: What's this (question) and It's an apple (target answer). What is important is that the two-way nature of spoken language is emphasised plus some of its semantic and syntactic elements. Any language learnt should be followed up by reinforcement by oral, aural and graphic methods. One of the problems of teaching deaf children, however, is that the teacher needs to correct mistakes whilst at the same time encouraging the pupil to use language freely. Here, although the authors do not
mention it, the use of computer assisted learning (CAL) could be of enormous value. A well designed CAL program could deliver learning through graphically interesting and interactive games and reinforce key points of learning. Its anonymity could also be useful since the child need not feel embarrassed by making errors, unlike a 'live' situation where the child might sense the disapproval or frustration of a teacher. At the same time it would remain to be seen if pupils responded equally negatively to computer generated answer judging.

What is essential in games, and, indeed, in any other form of learning, is that it is seen by deaf pupils as a relevant experience. Taking a similar approach to Arnold and Wildig (1981), Booth and Hall (1988) set out to improve the relevance of reading by the use of directed walks around the neighbourhood of the school with the children encouraged to copy down words on signs, to visit local shops to search for important signs and to discuss their meaning and use. On returning to the classroom, one exercise was to 'construct' a cafe and to make relevant notices for it. While no quantitative research or analysis was carried out to support this study, the researchers reported significant changes in the children's enthusiasm for reading. Again, as in the example of Arnold and Wildig (1981), since the scope and variety offered by any local environment was limited, there seems a strong case for using CAL to simulate 'surrogate' walks around a variety of different neighbourhoods in which many varieties of learning experiences can be presented.

The need for reading to be relevant to the interests of the deaf child was also stressed by Söderbergh (1985), who recommended what she terms natural reading where deaf children are encouraged to associate words on cards with their actual referents (chosen according to the child's interests). So, for example, in teaching the words 'quickly' or 'slowly' a game is played in which children run or walk around the classroom to act out their meaning. She found that the most popular words were the names of family members, friends, and pets; next were items dear to the child such as food. She noted that nouns were more easily learned than verbs or adjectives (although it should be noted that this was in the Swedish language, not English). Söderbergh (1985) also found that, in an experiment using two deaf children, there was a natural tendency for these children to try and construct sentences and whole stories out of the words they were given. She concluded that:

*One of the reasons for failure in reading instruction – in addition to the fact that written words are not limited to reality but to spoken words – must be the insistence on giving deaf children single words, instead of providing connected discourse, and stories containing enough clues from pictures, reality and sign language for the children to break into meaning of these stories. (Söderbergh 1985, p. 83)*

d) Changing materials

Deaf children may have difficulties coping with reading materials designed for children of the same chronological age. As Webster (1988b) pointed out, the problem for deaf pupils is that their linguistic experience may leave them with a restricted set of grammatical rules so they will never be familiar with the language of most book materials, because the language of most infant books will be too complex...
for them. This is a vicious circle; to get better at reading means practising it – but this is difficult if materials are too difficult.

One solution is to simplify these texts but as Webster (1988c) has warned, one of the dangers of this approach is that by restricting the vocabulary, syntax and information load of the piece, this may remove important cue sources and make the text even harder to read. Another attempt at modifying text is through highlighting parts of speech with a coding system, e.g., verbs with a diamond, nouns with a circle, etc.; but the problem here is that the exercise is not tied to the meaningful experience of the child and may become too complex.

It is unfortunately the case that most reading schemes, in the pursuit of controlled repetition of vocabulary or phonic rules, present the child with an alien pattern of language of the 'pat a fat rat' variety, which cannot be related to the whole of the child's growing linguistic experience. (Webster 1988c, p.6)

Webster's (1988c) solution was to modify the reader by bringing the language of the text alive through the use of pictures, puppets, noise, objects or strange sets; the teacher can draw attention to clues in the sentence or story context and discuss what is likely to happen. Webster (1988b) also recommended that the stories used should have a dramatic plot, be emotionally involving, and contain cohesion and resolution.

One of the problems of measuring the effectiveness of top-down processes, however, is the type of test procedures adopted to analyse such processes. Gray, Fyfe and Banks (1991) reviewed several methods: modified cloze tests; the retelling of told and written stories in sign; the written recall of printed English stories; and picture arrangement tests. They concluded that it is picture arrangement tests that seem to offer the most effective possibilities, especially since it seems that deaf children communicate stories more effectively through pictures than do hearing children.

4. CONCLUSION

As there are conflicting theories as to how language and reading are learnt, so there are differing theories as to how they should be taught. It seems, however, that, in practice, in teaching hearing-impaired children, teachers adopt a pragmatic approach, selecting whatever strategy seems valid to each individual child. It does appear, though, that, particularly at the early stages of reading, there is more emphasis on phonetics teaching.

In teaching hearing-impaired children, any initial difficulties become magnified by the time most children reach the age of 7 or 8 when the skills of syntax must be acquired. Therefore, any teaching programme which could address the issue of syntax could make a major contribution to helping deaf children to read. What form should this programme take? If a deaf child simply cannot decode efficiently then it is not help in syntax that is needed, but phonetic awareness (Stanovich, 1986). Assuming, however, that the pupil has achieved a basic, workable decoding ability,
how can new heights be scaled to syntactic competence, or at least improvement, beyond the plateau?

The issue of how hearing-impaired children come to comprehend and use sentence transformations (syntax), both in spoken language and reading, is dealt with in Chapter 6. In addressing this problem, one of the key lessons which needs to be carried forward from this Chapter is that, to be successful, any teaching strategy for reading must engage the interest and motivation of the child. This means presenting information in contexts that are relevant and meaningful to the child, and probably with an emphasis on pictorial or graphical forms. In carrying out research into the effectiveness of the proposed syntax instruction the advice of Wood et al (1986) will be borne in mind:

the focus of research into reading must change from a concentration on tests and large-scale issues to detailed studies of different processes of instruction and evaluations of their effectiveness.

(Wood et al 1986, p. 110)
CHAPTER 6

The Syntax Problems of Deaf Children

1. INTRODUCTION

Arnold (1993) has suggested that syntax is more than half the problem deaf children face when learning to read, and it is a problem which continues even once deaf pupils reach post-secondary school age. Berent (1993) reported that in the USA, for example, about 70 per cent of deaf students withdraw from their courses prior to completion. A prime cause of this worrying attrition rate is a deficiency in English language skills such as reading, and we know that syntax is a major component of reading difficulties. Berent (1993) suggested a more aggressive approach to English language instruction be used, including more research on the efficacy of language teaching methods and materials (p. 60). This Chapter looks at the kinds of problems deaf children have with syntax in order to establish the requirements for a set of such teaching materials which will be dealt with in Chapter 7. In doing so, it will first of all attempt to set out an operational definition of the concept 'syntax' and then look at the ways in which hearing children acquire syntactic competence. This will be used as a model against which to examine the syntactic development of hearing-impaired children.

2. WHAT IS SYNTAX?

2.1. Definitions and Descriptions

Syntax has been described by Storrie and Matson (1991) as: The way we order words to form sentences (p. 20), a sentence being a group of words that make complete sense. As Atkinson, Kilby and Roca (1988) pointed out, however, there is some diversity of opinion among linguists about the range of phenomena that can be considered syntactic, some arguing that parts of morphology, processes that occur at the word level, should be included. An example of morphology is the addition of the letter -s, to form plurals, or -ed to produce the past tense of a verb. For the purposes of this Chapter, though, syntax shall be examined within the context of the sentence, rather than the morphology of individual words.

Syntax is only one component of grammar which also comprises:

a) a lexicon, in which every word of the language is listed along with information about its meaning, pronunciation and relation with other words;
b) phonology, a description of word sounds and how they may be combined to form words;

c) semantics, a description of how the meaning of a string of words in the language is made up of the meanings of the individual words in the string.

One feature of the theory of grammar, and one which is important for an understanding of the rules of syntax, is that of generative grammar which is a 'finitely statable theory which accounts for the grammatical properties of the infinite set of sentences in the language under study' (Atkinson, Kilby and Rose, 1988, p. 158). Hearing people come to know the grammatical rules which govern sentences partly because they are able to hear and practice these rules in everyday communication. As Burton-Roberts (1986) puts it, people are therefore capable of:

... making an infinite number of judgements as to what is and what is not a grammatical sentence of your language. But the sense in which you know these rules is different from the sense in which you know the rules of chess, know how to read music ... You know the rules of your language IMPLICITLY, as if by instinct. (Burton-Roberts 1986, p. 255)

According to generative grammar, sentences have both a deep structure and a surface structure. Surface structure is the actual form of the sentence produced either orally, in sign language or in print. The deep structure is the underlying representation of the sentence, related to its meaning. Thus the surface structure is more represented by the lexical and phonological elements of a sentence and the deep structure more linked to semantics. To function effectively, it is vitally important that pupils come to recognise the deep structure of sentences, especially as sentences increase in complexity. The rules of grammar include two important sets of rules:

a) **Phrase structure rules**, which show what a grammatical sentence can look like, for example:

\[
S \rightarrow \text{ART N V ART N}
\]

The symbol S represents the notion 'sentence of a language', while the symbol \(\rightarrow\) means 'may be of the form'. ART represents the article of the sentence, N a noun, and V a verb. A phrase is any sequence of words in the language that is a member of some category, a category being a group of words that can replace one another in any sentence without affecting grammaticality. Thus, a sentence may be thought of as being a phrase in the category S. The goal of the linguist is to distinguish between grammatical and ungrammatical sentences of the language, i.e., specifying which sequences of English words are members of the categories. It should be noted that the phrase structure given above is only one example of a phrase structure rule. It is also possible, for example, to have a sentence in which there is no article at all:

*Bill saw John*
In this case we have a verb and two proper nouns, so our phrase rule has now to include:

$$S \rightarrow PN \ V \ PN$$

There are a vast number of other phrase structure rules, but Wigg and Semel (1984) suggested that there are five basic sentence patterns in the English language, and that all sentences are developed from one of these patterns through a process of applying various transformations (see b), below). The basic sentence patterns are illustrated in Table 6.1.

These five sentences may be generated by applying phrase-structure rules, with each of the five sentences being divided up into two units: (1) a noun phrase (NP) and (2) a verb phrase (VP). A sentence described by a phrase structure rule can be rewritten in the form of a tree structure:

$$s$$
$$\begin{array}{c}
NP \\
VP
\end{array}
$$

The boy ate the cake

The noun phrase in patterns 3, 4, and 5 (Table 6.1) can be divided into (1) a determiner (T), 'the', and (2) a noun (N), 'boy', which becomes:

$$s$$
$$\begin{array}{c}
NP \\
VP
\end{array}
$$

$$\begin{array}{c}
T \\
N
\end{array}$$

The boy ate the cake

The verb phrase (VP) in pattern 5 can be further subdivided into a verb (V) and a noun (NP) – the left-hand tree overleaf, or adjective – the right-hand tree, according to the rewrite rule:

$$s$$
$$\begin{array}{c}
NP \\
VP
\end{array}
$$

$$\begin{array}{c}
TN \\
N \\
V \\
NP
\end{array}$$

The boy ate the cake

$$s$$
$$\begin{array}{c}
NP \\
VP
\end{array}
$$

$$\begin{array}{c}
TN \\
N \\
V \\
Adj
\end{array}$$

The boy is tall

These sentences are essentially simple, active and declarative in type and are designated as kernel sentences. While the concept of the kernel sentence has been downplayed by linguists in recent years, Blackwell et al (1978) believed that it provides a helpful basis for language programmes for hearing-impaired pupils.
Table 6.1 The five basic sentence patterns with examples

<table>
<thead>
<tr>
<th>Pattern</th>
<th>Phrasal structure</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pattern 1</td>
<td>NP₁ + VP + Adj.P</td>
<td>Boys run home</td>
</tr>
<tr>
<td>Pattern 2</td>
<td>NP₁ + VP + NP₂</td>
<td>Boys play games</td>
</tr>
<tr>
<td>Pattern 3</td>
<td>NP₁ + Cop + NP₂</td>
<td>The boy is my brother</td>
</tr>
<tr>
<td>Pattern 4</td>
<td>NP₁ + Cop + Adj</td>
<td>The boy is tall</td>
</tr>
<tr>
<td>Pattern 5</td>
<td>NP₁ + VP(became) + Adj.NP</td>
<td>The boy is ill/a student</td>
</tr>
</tbody>
</table>

Source: adapted from Wigg and Semel (1984) p. 292–293

b) Transformational grammar contains supplementary rules for transforming kernel sentences into more complex ones. Examples include changing active sentences to passive, affirmative to negative, declarative to interrogative, and single phrases to compound phrase structures. Let us take the example of an adverb movement transformation:

*We played, yesterday*

If adverbs modify the entire sentence then it is possible to move the adverb to the beginning of the sentence and for it still to be grammatical:

*Yesterday, we played.*

If, however, the adverb only modifies the verb (that is, it is in the verb phrase constituent), then transforming the adverb in this way would lead to an ungrammatical sentence. (The asterisk denotes a sentence that is ungrammatical.)

*Slowly we drank.*

Blackwell et al (1979) pointed out that not all transformations carry the same weight in importance of function. The question transformation, for example, is a vital operation for a child to perform. Similarly, negatives must be learnt if the child is to be understood. Let us look therefore at both these issues in more detail.

2.2. Transformational example: Question formation.

In the example which follows, a) is the declarative sentence, and b) the question formed from it. The simplest form of question is one that seeks a yes–no response, but there are varying degrees of complexity in the transformation.
Example i)

a) John is happy
b) Is John happy?

In this transformation there is only one moving part, with is moving to the front of the sentence. It must also be remembered, as in the formation of all questions, that the transformed sentence must end with a question mark.

Example ii)

a) The boy is jumping
b) Is the boy jumping?

This appears to be similar in construction to example i), but, in fact, there are two verbs: a main verb (to run); and an auxiliary verb (to be). In transforming this sentence it has to be remembered that it is only the auxiliary verb that shifts to the beginning of the sentence.

Example iii)

a) Bill thought John had forgotten his lunch
b) Did Bill think that John had forgotten his lunch?

This transformation is considerably more complex than the previous two because it involves the production of the auxiliary verb did; the main verb thought has to be changed to think; and the non-moving part of the sentence, had forgotten his lunch, has to be transferred intact to the interrogative form.

Having examined some of the complexities of transformational syntax, let us now look at how these rules are acquired by hearing children.

3. THE DEVELOPMENT OF SYNTAX IN HEARING CHILDREN

McAnally, Rose and Quigley (1987) reported the work of Brown, who suggested that the development of syntax is a sequential process involving five defined and distinguishable stages, based on the child's mean length of utterances (MLU). The MLU is determined by counting the number of morphemes per utterance in a sample of spontaneous language. It can be seen in Table 6.2 that the first two-word utterance begin in the Early Stage I period (MLU>1), with the semantic relationships of words at this stage either functional or grammatical in character. In functional relationships the entire utterance means no more than the meaning of each word, e.g., no milk, there milk. In grammatical utterances, however, the utterance means more than the meaning of each word. Brown claimed that by the end of the two-word stage it is the grammatical relationships that become more dominant. An important issue at the two-word stage is whether children have a knowledge of any syntactic structures they are using. Opinion seems to be divided as to whether they do have such an understanding or whether they are merely picking up and using word order rules rather than grammatical categories.
Table 6.2 Brown’s Language Stages with Comparable Mean Length of Utterance (MLUs) and Ages

<table>
<thead>
<tr>
<th>Brown’s Language Stage</th>
<th>MLU</th>
<th>Approximate Age</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-Stage I</td>
<td>0.00-1.00</td>
<td>0-18 months</td>
</tr>
<tr>
<td>Early Stage I</td>
<td>1.01-1.49</td>
<td>19-22 months</td>
</tr>
<tr>
<td>Late Stage I</td>
<td>1.50-1.99</td>
<td>23-26 months</td>
</tr>
<tr>
<td>Stage II</td>
<td>2.00-2.49</td>
<td>27-30 months</td>
</tr>
<tr>
<td>Stage III</td>
<td>2.50-2.99</td>
<td>31-34 months</td>
</tr>
<tr>
<td>Stage IV</td>
<td>3.00-3.74</td>
<td>35-40 months</td>
</tr>
<tr>
<td>Stage V</td>
<td>3.75-4.50</td>
<td>41-46 months</td>
</tr>
<tr>
<td>Post-Stage V</td>
<td>4.51+</td>
<td>47+ months</td>
</tr>
</tbody>
</table>

(Source: McAnally, Rose and Quigley (1987) p. 18)

During Stage II two important developments occur. One is an embedding process in which the child inserts a functional relationship into a grammatical structure. So the child might take the words no milk and insert them into want milk to produce no want milk. The other is a conjoining process in which two grammatical relations sharing a common word are combined, with one of the common words being deleted. Thus, boy throw and throw ball becomes boy throw ball. It is at this stage that children come to adhere rigidly to a subject–verb–object (S–V–O) word order even when this is not appropriate, a process which could be explained as an over learning of a syntactic rule. As we shall see later in this Chapter, a similar S–V–O word order is adapted by hearing-impaired children, but chronologically later than hearing children, typically, at seven or eight years of age. This adds further weight to the argument, examined in Chapter 5, that the language of deaf children is delayed rather than deficient.

McAnally, Rose and Quigley (1987) reported other work by Brown which examined the order in which 14 grammatical morphemes are acquired at this stage. Although Brown’s study was only with three children, his findings were subsequently confirmed by a study by other researchers on a sample of 21 children. Brown’s chief finding was that the acquisition of these morphemes did not correlate with the occurrence of morphemes in parents' speech (hence were not socially constructed), but was related to the complexity of the morphemes themselves (hence being linked to physiological and especially cognitive development). The first morphemes to be used were largely semantic in nature – present progressive inflection (-ing), two prepositions (in, on) and plural endings (-s), whereas later morphemes were a combination of semantic and syntactic complexity – contractible copula (He’s happy, I’m sick) and the contractible auxiliary (I’ve pushed him, She’s gone).

During the 3 years that follow Stage II, children’s utterances expand and become more complex with a move away from the ‘here and now’ towards talking about what has occurred in the past or what might occur in the future and events not directly related to their immediate experience. They also begin to discuss the temporal and spatial...
relationships of objects and events. Two further structures also make an appearance: negatives and questions.

a) **Negatives.** McAnally, Rose and Quigley (1987) referred to the work of Bellugi, who identified four phases in the use of negative forms of expression. The earliest form is the negative expressed as a single word, e.g., *no, allgone* which are followed by multiword negatives such as *no milk, not go.* At Stage III more complex structures begin to appear, where the negative occurs between the subject and the verb, as in *I not like it, He no kick you.* It is at Stage IV, however, that one of the most significant changes occurs, with the emergence of an auxiliary system providing the auxiliary verb *do* for the use of negative utterances. By the time Stage V is reached, negative utterances are similar to those used by adults.

b) **Yes/No Questions.** Children begin by using rising intonation on a declarative sentence to indicate that they are asking a question. By Stage IV they are beginning to use inverted auxiliaries, such as *Am I silly? and Do I look like him?*

c) **Wh-Questions.** These questions involve words such as *who, what, where, when, whose, which, why and how* and are generally more complex than simple yes/no questions. They require, for example, the inverting of the subject and the auxiliary and the placement of the correct *wh-*word at the beginning of the phrase. Errors, however, do occur, the most common being the omission of the auxiliary as in *H*a*t that?, or putting the auxiliary in the wrong place: *Where the glass of milk is?* McAnaly, Rose and Quigley (1987) cited research which indicates that *what, where, and who* questions are more easily understood and therefore acquired earlier than *when, how, and why* words.

What seems to emerge from the research examined in this section is that syntactic structures are acquired in a systematic manner by all children. This is significant because, as McAnally, Rose and Quigley (1987) pointed out:

*The nature of the changes that occur indicates that the children are learning general syntactic rules and applying them to their generation of utterances rather than learning particular utterance forms. When a particular syntactic feature begins to appear, it tends to appear simultaneously in a wide variety of utterances.* (McAnally, Rose and Quigley 1987, p.22)

If this is true, then it offers some grounds for optimism when it comes to helping those whose development of syntactic structures is delayed (such as hearing-impaired children). It means essentially, that if the rules of various syntactic structures can be taught, these can be applied to an infinite number of relevant cases, rather than having to teach an infinite number of different word orders. Not only would the latter be time-consuming, it would put pressure on working memory, an area in which, as we saw in Chapter 5, deaf children may have processing difficulties.

By the age of 3, children are using simple sentences with one proposition such as *This is a ball.* Beyond this stage, however, sentence structure begins to take on more complex forms, changing from linear ordering to hierarchical ordering within and among sentence structures.
a) **Coordination.** This usually occurs as children combine two propositions using the word *and*, as in *This is a cake and Mommy bought the cake*. There are two types of coordination – sentence coordination in which two sentences are conjoined, as in the previous example, and phrase coordination, in which one or more phrases in a single sentence are conjoined, as in *Daddy bought the train and the ball*. McAnally, Rose and Quigley (1987) referred to the work of Bloom who found that, while in early stages, children use the word *and* in a semantically limited way, they gradually develop an ability to use *and* to express a variety of meanings, and these meanings develop in a fixed order: additive, as in *I play with this and you play with that*; temporal, as in *I'm going Grandma's and get a cake*; and causal, as in *Daddy dropped my toy and it broke*.

b) **Complementation.** McAnally, Rose and Quigley (1987) quoted the research of Bloom, Lifter and Hafitz who found that the development of complements is based on the semantics of the verb, with complements in language appearing in the following order:

- state verbs, expressing feelings or intentions such as *like, want, need*;
- notice verbs followed by the complement, such as *see, look*, as in *See what I'm doing*;
- knowledge verbs followed by the complement, such as *know, think*, as in *I know what that is*;
- communication verbs followed by the complement, such as *ask, tell*, as in *Ask Daddy to fetch my toy*.

c) **Relativisation.** These can be divided into objective clauses which modify the object of a sentence, as in *I have a brother who is really tall*, to subject clauses, for example, *The girl who hit you is my sister*. Research indicates that objective clauses are acquired after the age of 5 years and subject clauses after 7 years. It seems that object clauses involve less processing since the clause is added at the end of the sentence whereas with subject clauses which occur in the middle of sentences have to be stored in working memory while the rest of the sentence is being read.

d) **Passivisation.** The use of the passive sentence construction is only acquired effectively by middle childhood. Table 6.5 below illustrates the two categories of passive construction, that is, reversible and irreversible and compares these with examples of active constructions.

Children younger than 4 years of age tend to understand irreversible passives before reversible passives often making systematic errors on the latter, imposing a subject–verb–object sequence, ignoring the auxiliary verb and preposition, and interpreting the phrase as if it was an active construction. Thus, the sentence *Tom was hit by Susie* is construed as *Tom hit Susie* (see Table 6.3). As we shall see in section 4 below, this is precisely the kind of mistake made by deaf children, but at a chronologically later age. It is also possible that children come to understand passives with action verbs before
they come to understand them with non action verbs, so *Tom was hit by Susie* would be grasped more readily than *Tom was liked by Susie*.

Let us now turn to the syntactic competencies of deaf children and examine how they compare with the developmental process described above.

4. DEAF CHILDREN'S SYNTAX

4.1. An overview of problem areas

Webster (1988b) has suggested that poor syntax control explains many of the problems which deaf pupils have with reading comprehension. Research reported by Quigley and Kretschmer (1982) carried out in the 1970s amongst 450 deaf students aged between 10 and 19 years old found that they had difficulty comprehending sentences with a variety of syntactic constructions: negation, conjunction, determiners, verb processes, pronominalisation, question formation, relativisation, and complementation.

Even when they understood the vocabulary and the concepts involved, they still had difficulty in understanding (reading) the test sentences they were presented with. Table 6.4 gives examples of the structural environment which hearing-impaired children find most difficult and examples of the kinds of errors they make, and Table 6.5 the frequency with which they occur so that the most problematic areas can be identified.

Table 6.3 Reversible and irreversible forms of passive sentence construction compared with active reversible and irreversible forms.

<table>
<thead>
<tr>
<th></th>
<th>Active</th>
<th>Passive</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reversible</td>
<td>Susie hit Tom</td>
<td>Tom was hit by Susie</td>
</tr>
<tr>
<td>Irreversible</td>
<td>Susie washed the car</td>
<td>The car was washed by Susie</td>
</tr>
</tbody>
</table>
### Table 6.4 Examples of syntactic constructions in the language of deaf students

<table>
<thead>
<tr>
<th>Structural environment in which construction occurs</th>
<th>Description of construction</th>
<th>Example sentences</th>
</tr>
</thead>
<tbody>
<tr>
<td>Verb system</td>
<td>Verb deletion</td>
<td>The cat under the table</td>
</tr>
<tr>
<td></td>
<td><em>Be or have</em> deletion</td>
<td>John sick. The girl a ball</td>
</tr>
<tr>
<td></td>
<td><em>Be–have</em> confusion</td>
<td>Jim have sick</td>
</tr>
<tr>
<td></td>
<td>Incorrect pairing of auxiliary with verb marker</td>
<td></td>
</tr>
<tr>
<td></td>
<td><em>By</em> deletion</td>
<td></td>
</tr>
<tr>
<td>Negation</td>
<td>Negative outside the sentence</td>
<td>Beth made candy no</td>
</tr>
<tr>
<td>Conjunction</td>
<td>Marking only first verb</td>
<td>Beth threw the ball and Jean caught it</td>
</tr>
<tr>
<td></td>
<td>Conjunction deletion</td>
<td>Joe bought ate the apple</td>
</tr>
<tr>
<td>Complementation</td>
<td><em>Extra for</em></td>
<td>For to play baseball is fun</td>
</tr>
<tr>
<td></td>
<td><em>Extra to</em> in POSS–ing complement</td>
<td>John goes to fishing</td>
</tr>
<tr>
<td></td>
<td>Infinitive in place of gerund</td>
<td>John goes to fish</td>
</tr>
<tr>
<td></td>
<td>Incorrectly inflective infinitive</td>
<td>Bill liked to play baseball</td>
</tr>
<tr>
<td></td>
<td>Unmarked infinitive without <em>to</em></td>
<td>Jim wanted go</td>
</tr>
<tr>
<td>Relativisation</td>
<td>NPs where <em>whose</em> is required</td>
<td>I helped the boy's mother was sick</td>
</tr>
<tr>
<td></td>
<td>Copying referent</td>
<td>John saw the boy who the boy kicked the ball</td>
</tr>
<tr>
<td>Question formation</td>
<td>Copying</td>
<td>Who a boy gave you a ball?</td>
</tr>
<tr>
<td></td>
<td>Failure to apply subject–auxiliary inversion</td>
<td>Who the baby did love?</td>
</tr>
<tr>
<td></td>
<td>Incorrect inversion</td>
<td>Who TV watched?</td>
</tr>
<tr>
<td>Question formation, negation</td>
<td>Over generalisation of contraction rule</td>
<td>I amn't tired. Bill willn't go</td>
</tr>
<tr>
<td>Relativisation, conjunction</td>
<td>Object–object deletion</td>
<td>John chased the girl and he scared.</td>
</tr>
<tr>
<td></td>
<td>Object–subject deletion</td>
<td>(John chased the girl. He scared the girl)</td>
</tr>
<tr>
<td>All types of sentences</td>
<td>Forced subject–verb–object pattern (SVO)</td>
<td>The dog chased the girl on a red dress. (The dog chased the girl. The girl had a red dress on)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>The boy pushed the girl (The boy was pushed by the girl)</td>
</tr>
</tbody>
</table>

It can be seen from Table 6.4 that some of the errors which deaf children make serve to make the meaning of the sentence obscure to the point of incomprehension. With question-formation, for example, the sentence *Who a boy gave you a ball?* is an attempt to ask a question by taking a statement and putting the word *who* onto it. The result, however, is that it becomes difficult to disentangle what the point of the question is: does the child wish to know if it was a boy who gave the ball, or to identify which boy from a group of boys? More complex problems emerge when it comes to combining clauses to make a sentence. Rather than repeat the object in a sentence, for example, *John chased the girl and he scared the girl* it would be usual to use a pronoun in the place of the second use of the word *girl* and say *John chased the girl whom he scared*. Thus the second use of the word *girl* is omitted. Yet, typically, when deaf children come to construct this sort of sentence they omit the object altogether to make *John chased the girl and he scared*, which completely reverses the meaning of the sentence. Problems of combining two clauses become particularly acute when one of these clauses is embedded in the other. Quigley and Kretschmer (1982) gave the example of two sentences: *The boy kissed the girl and The boy ran away*, as being understood by most deaf students; but when one sentence was embedded in the other to make: *The boy who kissed the girl ran away*, most students, including some who were 19 years of age, thought it was the girl and not the boy who ran away. Quigley and Kretschmer (1982) commented that these structures appear so frequently that they must be part of the internalised language structure of deaf individuals, adding:

This point may have major significance in explaining the reading problems of deaf students. (Quigley and Kretschmer 1982, p. 71)

In terms of frequency with which typical syntactic structures occur, Quigley and Kretschmer (1982) also provided evidence for deaf students aged 8 to 10 (Table 6.5, third column) and 10 to 19 years of age (Table 6.5, fourth column) compared with hearing students. The Table shows that there are several areas where both deaf and hearing students have difficulties; for example, pronominalisation and especially the use of personal pronouns and reflexisation. Also, the use of verb sequencing and tense sequencing is weak amongst both deaf and hearing pupils. In each case, however, the performance of deaf children is significantly worse than that of the hearing. There are also areas like pronominalisation, where there are syntax structures which hearing children find relatively easy but deaf pupils struggle with, e.g., backward pronominalisation and the use of possessive adjectives and possessive pronouns. Deaf pupils fared very badly in the use of question formation such as the use of *what, why, who*-type questions, plus yes/no and tag questions (such as: *'James bought the jam, didn't he?*'). Let us now examine some of these problem areas in more detail.
Table 6.5 Summary of performance of syntactic structures and their frequency of occurrence per 100 sentences in the Reading for Meaning series

<table>
<thead>
<tr>
<th>Structure</th>
<th>Deaf students</th>
<th>Hearing students</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Average across ages</td>
<td>Age 10</td>
</tr>
<tr>
<td>Negation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Be</td>
<td>79</td>
<td>60</td>
</tr>
<tr>
<td>Do</td>
<td>71</td>
<td>53</td>
</tr>
<tr>
<td>Have</td>
<td>74</td>
<td>57</td>
</tr>
<tr>
<td>Modals</td>
<td>78</td>
<td>58</td>
</tr>
<tr>
<td>Means</td>
<td>76</td>
<td>57</td>
</tr>
<tr>
<td>Conjunction</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Conjunction</td>
<td>72</td>
<td>56</td>
</tr>
<tr>
<td>Deletion</td>
<td>74</td>
<td>59</td>
</tr>
<tr>
<td>Means</td>
<td>73</td>
<td>57</td>
</tr>
<tr>
<td>Question formation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>WH-questions:</td>
<td>66</td>
<td>44</td>
</tr>
<tr>
<td>Comprehension</td>
<td>74</td>
<td>48</td>
</tr>
<tr>
<td>Yes/No questions</td>
<td>57</td>
<td>46</td>
</tr>
<tr>
<td>Tag questions</td>
<td>66</td>
<td>46</td>
</tr>
<tr>
<td>Pronominalisation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Personal pronoun</td>
<td>67</td>
<td>51</td>
</tr>
<tr>
<td>Backward</td>
<td>70</td>
<td>49</td>
</tr>
<tr>
<td>pronominalisation</td>
<td>65</td>
<td>42</td>
</tr>
<tr>
<td>Possessive</td>
<td>48</td>
<td>34</td>
</tr>
<tr>
<td>adjectives</td>
<td>50</td>
<td>21</td>
</tr>
<tr>
<td>Possessive</td>
<td>60</td>
<td>39</td>
</tr>
<tr>
<td>pronouns</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reflexivisation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Means</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Verbs</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Verb auxiliaries</td>
<td>54</td>
<td>52</td>
</tr>
<tr>
<td>Tense sequencing</td>
<td>63</td>
<td>54</td>
</tr>
<tr>
<td>Means</td>
<td>58</td>
<td>53</td>
</tr>
<tr>
<td>Complementation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Infinitives and</td>
<td>55</td>
<td>50</td>
</tr>
<tr>
<td>gerunds</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(Cont. overleaf)
### 4.2. Subject–Verb–Object pattern

A major problem which was identified in Table 6.4 is a Subject–Verb–Object (S–V–O) pattern which is forced on a sentence and a tendency to read English as though its structure was linear rather than hierarchical. Table 6.6, below, illustrates some typical examples of English structures, the way they should be read, and the way they are usually interpreted by deaf people using the S–V–O pattern.

As Wood et al (1986) pointed out, one of the mistakes deaf children make here is the assumption that there is a direct relationship between the semantic and syntactic features of a sentence. For example, in the passive construction *Mary was hit by John*, the 'deep' subject (agent) of the sentence is John not Mary. Sometimes subjects become deleted as in *Mary fed the dog and went out* – the subject of the verb, Mary, has to be 'retrieved' from the first clause. Wood et al (1986) referred to the work of Chomsky, who suggested that what was happening here was that readers worked on what he called the Minimum Distance Principle (MDP) whereby they tend to choose a noun in the sentence that is closest to the verb. So:

*The boy was helped by the girl* (boy helps girl)

*The boy who kissed the girl ran away* (girl runs away)

Yet, as Wood et al (1986) stated, whether it is the S–V–O or MDP model which is at work, at least it seems that hearing-impaired children are using some sort of linguistic system.
Table 6.6 Typical English structures showing actual reading against S-V-O interpretation by deaf people.

<table>
<thead>
<tr>
<th>Structure</th>
<th>Actual reading</th>
<th>S-V-O reading</th>
</tr>
</thead>
<tbody>
<tr>
<td>Passive</td>
<td>The boy was helped by the girl</td>
<td>The boy helped the girl</td>
</tr>
<tr>
<td>Relative</td>
<td>The boy who kissed the girl ran away</td>
<td>The girl ran away</td>
</tr>
<tr>
<td>Complement</td>
<td>The boy learned the ball broke the window</td>
<td>The boy learned the ball</td>
</tr>
<tr>
<td>Nominal</td>
<td>The opening of the door surprised the cat</td>
<td>The door surprised the cat</td>
</tr>
</tbody>
</table>

(Source: Quigley and Kretschmer (1982) p. 71)

4.3. Verb systems

A detailed research study on verb systems was carried out by Quigley, Montanelli and Wilbur (1976) to examine deaf students' mastery of four aspects of the verb system: auxiliary verbs, tense sequencing, verb deletion and the confusion associated with the words be and have. They used a sample of 427 deaf students aged between 10 and 18 years of age and a sample of 60 hearing subjects.

The results of the study indicated problems in all four areas under scrutiny.

a) Auxiliary verbs. The rules for their use were not well established in the language of deaf students.

- Tense and voice. In the case of the use of the progressive tense, the passive voice and the perfect tense, deaf students did significantly worse when compared to hearing students, as indicated by Table 6.7 below. The use of the passive tense was the weakest for both hearing-impaired and hearing students but the hearing-impaired did significantly worse with an average of only 56 per cent of them recognising an incorrect use of the structure compared with 70 per cent of hearing students.

- Negation. The deaf subjects had particular difficulty with sentences in which do support was required. For example, *The boy no go to school*, was judged as grammatically incorrect only 41 per cent of the time by 10 year olds (and 76 per cent by those aged 18). In contrast, the negative elements of modal auxiliaries (can and will) when contracted, were learned quite well, for example: *I can't buy a new toy*. Unfortunately, the contraction could also be over-applied so that *willn't* was accepted as correct by 70 per cent of 10 year olds (and even 59 per cent of those aged 18).
Table 6.7  Average percentage correct scores across 10–18 aged groups for auxiliary verbs

<table>
<thead>
<tr>
<th>Auxiliary verbs</th>
<th>Example</th>
<th>Percentage of time correct</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(1) Deaf</td>
<td>(2) Hearing</td>
</tr>
<tr>
<td>Progressive tense</td>
<td>The boy is opening the door</td>
<td>61</td>
</tr>
<tr>
<td>Passive tense</td>
<td>The door was opened by the boy</td>
<td>56</td>
</tr>
<tr>
<td>Perfective tense</td>
<td>The man has lost his keys</td>
<td>59</td>
</tr>
</tbody>
</table>

(Source: Quigley, Montanelli and Wilbur, 1976)

- Question-formation. Modal auxiliaries such as can and did were recognised as used correctly or incorrectly in 53 per cent of cases by those aged 10 and 81 per cent of the time by students aged 18. Even hearing students found modal auxiliaries slightly more difficult than the use of do to make a question as in: Did you buy a new car?

b) Tense sequencing. There was considerable difficulty here in recognising errors in conjoined sentence where either of the verbs in the conjoined sentence was marked incorrectly, e.g., A boy pushed Mary and she cry or Next Saturday the boys wash the car and father will pay them. The type of tense made a difference to performance with the past tense the least difficult (mean = 56 per cent), then the future tense (mean = 55 per cent) and the present progressive (mean = 63 per cent) the most difficult.

c) Verb deletion. Deaf students usually recognised that a verb had been deleted in a sentence, but had extreme difficulty in supplying one that was correct in either number or tense. Verbs deleted in a transitive sentence structure (mean = 81 per cent correct) were marginally less difficult to identify than those in a transitive sentence (mean = 80 per cent correct).

d) 'Be' and 'Have' confusion. If be or have were deleted from a sentence, deaf students were generally able to recognise this, and able to restore a form of be much more readily than a form of have. Generally, however, they had poor judgement for where have or be had been substituted for each other.

5. CONCLUSION

We have seen that the acquisition of syntactic knowledge is a systematic and fairly sequential process in hearing-children, beginning with simple phrase structures but soon becoming more sophisticated and complex with using the rules of transformational grammar. In the case of hearing-impaired children, however, this process is either
delayed or seriously distorted. The research of Quigley and Kretschmer (1982) revealed that problem areas are mainly transformational and include pronominalisation, verb sequencing and tenses, question formation and the use of negatives. Blackwell et al (1978) suggested that, from the practical viewpoint of communication, particularly in a classroom environment, question formation and the use of negatives are especially important. The next Chapter examines some of the teaching strategies that have been used to teach various aspects of syntax to hearing-impaired children.
CHAPTER 7

Methods of Teaching Syntax to Deaf Pupils

1. INTRODUCTION

We saw in Chapter 3 that the education of deaf children has a long history, a significant part of which has included the teaching of language. In the early years of the 19th century this was dominated by a structured approach with the memorisation of rules and grammatical forms. Towards the middle of the century, however, methods were re-evaluated which resulted, in some circles at least, in a shift towards natural methods which emphasised the development of language within a context, that is, by associating it directly with objects and actions.

This move towards natural methods, however, was by no means universal. Gallaudet, for example, whose methods were highly influential in the education of the deaf in the USA until the end of the 19th century, made use of the memorisation of grammatical rules and vocabulary, presented in isolation. One aspect of this was the Harford System in which diagrams were used to represent grammatical relationships and syntactic rules. Another approach, adapted in the Kentucky School for the Deaf after 1858, included the teaching of the alphabet and labels for 100 objects; after this, nouns were presented in combination with adjectives and later the verb to be introduced. As lessons progressed, students were required to supply the nouns for prescribed sentences which were then combined into stories or used to describe pre-prepared pictures. In the late 19th century, the Storrs Symbols system sought to extend the Harford System by introducing a set of 47 symbols which provided the student with visual grammatical patterns and relationships.

In the 1930s, however, the natural language approach became more popular, a development which was further reinforced by the study of language through psycho linguistics in the 1950s and 1960s, emphasising the deep structure of language contained in syntactic and semantic linguistic structures. A forceful proponent of the natural language methods was van Uden, who believed that through experiences, diaries, storytelling and reading, the deaf child could acquire the rules of grammar in the same natural way as hearing children. As McAnally, Rose and Quigley (1987) noted, however, van Uden's methods also included elements of structure with emphasis placed on the teacher's use of basic sentence structures to mirror the vocabulary of the child. Since van Uden's pioneering work, many other researchers have developed teaching approaches which combine elements of structure with a determination to expose children to the language of everyday communication and
2. NATURAL LANGUAGE METHODS AND SYNTAX

This method recommends the 'immersion' of hearing-impaired children in their own language environment during which, it is believed, they will pick up the grammatical features of that language. The role of the teacher is primarily to maintain communication and interaction between children and between him or herself and the child. The teacher accepts the child's expressive syntactic structures as appropriate for each particular language stage and so will therefore not promote correct adult syntax since advocates of the natural learning method do not believe that this would be effective in acquiring syntactic structures. Children generate their own grammar. They do so in situations which offer opportunities for communication, experiences which can be encouraged and organised by the teacher. These can include classroom drama using real objects and props, surveys where adults are interviewed and the results recorded, or games and creative play.

Yet while it may be true that hearing children learn language structure from these activities it is clear that, due to their impairment, deaf children do not have the same degree of access to this language environment. For many deaf children, their knowledge of syntax becomes stalled at a chronologically early age, with the result that their linguistic and reading development become seriously impaired. The natural approach also ignores evidence (see section 3) that certain syntactic structures can be taught with some degree of success. Indeed, this is, in a sense, recognised by many natural language programmes which, especially as children get older, introduce more structured approaches, focusing on specific language principles. Natural language methods, emphasising communication in a natural setting are then used to reinforce the principles learned in the structured session.

3. STRUCTURED AND COMBINED APPROACHES TO TEACHING

The vast majority of teaching programmes in the USA use exclusively neither the structured nor the natural approach to teaching language, but a combination of the two. The essential principles of this approach are that:

a) language modelling occurs in all areas of the curriculum, not only in language classes (see, for example, the Rhode Island Curriculum, section 3.3);

b) the child must be given frequent examples of the sentence patterns or targeted language form;

c) structured stimuli must be used so that the child is able to perceive the patterns of language and eventually reproduce them independently;

d) the child is able to apply newly acquired language patterns to novel stimuli.
Early examples such as the Fitzgerald Key tend towards the structured end of the instructional spectrum, while later examples such as the Apple Tree and Rhode Island Curriculum are more combined in methodology. We will examine each in turn.

3.1. The Fitzgerald Key

The most widely accepted structured method to be introduced in the 20th century was the Key, developed by Edith Fitzgerald (1929) at the Wisconsin School for the Deaf. The Key had six columns, each labelled with interrogative words and symbols to indicate grammatical structures and functions. Table 7.1 shows that words were classified into one of six categories and symbols used to signify various connective words or phrases.

3.2. Apple Tree

The term Apple Tree, a course introduced in 1975, is an acronym for: A Patterned Program for Linguistic Expansion through Reinforced Experiences and Evaluation. The basic idea behind this programme is that children are introduced to successive sentence patterns of increasing difficulty and complexity. Thus in Table 7.2 (overleaf), the pupil starts with a simple NP + Vbe + Adjective structure, then goes onto one where the adjective is changed for an adverb (but repeating the NP + Vbe pattern). There are 10 patterns in all, each successive structure building on previous ones.

Table 7.1 Early Use of the Fitzgerald Key with Young Deaf Children

<table>
<thead>
<tr>
<th>Who</th>
<th>Whom: What</th>
<th>Where</th>
<th>When</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>see</td>
<td>a car</td>
<td></td>
</tr>
<tr>
<td>I</td>
<td>went</td>
<td></td>
<td>to school</td>
</tr>
<tr>
<td>I</td>
<td>laughed</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mary and I</td>
<td>laughed</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mary</td>
<td>is tired</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mary</td>
<td>was sick</td>
<td>in school</td>
<td>yesterday</td>
</tr>
</tbody>
</table>

(Adapted from: McAnally, Rose, and Quigley (1987) p. 115)
Table 7.2 Language Patterns presented by the *Apple Tree* learning program

<table>
<thead>
<tr>
<th></th>
<th>NP₁ + V₁be + Adjective</th>
<th>NP₁ + V₁be + Where</th>
<th>NP₁ + V₁be + NP₁</th>
<th>NP₁ + Verb</th>
<th>NP₁ + V₁ + Where</th>
<th>NP₁ + V₁ + Where + When</th>
<th>NP₁ + V₁ + NP₂</th>
<th>NP₁ + V₁ + NP₂ + Where</th>
<th>NP₁ + V₁ + NP₂ + NP₃</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td><em>The bird is black</em></td>
<td><em>The bird is on the tree</em></td>
<td><em>The bird is a crow</em></td>
<td><em>The bird can eat</em></td>
<td><em>The bird can eat outside</em></td>
<td><em>The bird can eat outside every morning</em></td>
<td><em>The bird can eat worms</em></td>
<td><em>The bird can eat worms in the grass</em></td>
<td><em>Mother bird can give baby bird a worm</em></td>
</tr>
<tr>
<td>2</td>
<td><em>The bird is black</em></td>
<td><em>The bird is on the tree</em></td>
<td><em>The bird is a crow</em></td>
<td><em>The bird can eat</em></td>
<td><em>The bird can eat outside</em></td>
<td><em>The bird can eat outside every morning</em></td>
<td><em>The bird can eat worms</em></td>
<td><em>The bird can eat worms in the grass</em></td>
<td><em>Mother bird can give baby bird a worm</em></td>
</tr>
<tr>
<td>3</td>
<td><em>The bird is black</em></td>
<td><em>The bird is on the tree</em></td>
<td><em>The bird is a crow</em></td>
<td><em>The bird can eat</em></td>
<td><em>The bird can eat outside</em></td>
<td><em>The bird can eat outside every morning</em></td>
<td><em>The bird can eat worms</em></td>
<td><em>The bird can eat worms in the grass</em></td>
<td><em>Mother bird can give baby bird a worm</em></td>
</tr>
<tr>
<td>4</td>
<td><em>The bird is black</em></td>
<td><em>The bird is on the tree</em></td>
<td><em>The bird is a crow</em></td>
<td><em>The bird can eat</em></td>
<td><em>The bird can eat outside</em></td>
<td><em>The bird can eat outside every morning</em></td>
<td><em>The bird can eat worms</em></td>
<td><em>The bird can eat worms in the grass</em></td>
<td><em>Mother bird can give baby bird a worm</em></td>
</tr>
<tr>
<td>5</td>
<td><em>The bird is black</em></td>
<td><em>The bird is on the tree</em></td>
<td><em>The bird is a crow</em></td>
<td><em>The bird can eat</em></td>
<td><em>The bird can eat outside</em></td>
<td><em>The bird can eat outside every morning</em></td>
<td><em>The bird can eat worms</em></td>
<td><em>The bird can eat worms in the grass</em></td>
<td><em>Mother bird can give baby bird a worm</em></td>
</tr>
<tr>
<td>6</td>
<td><em>The bird is black</em></td>
<td><em>The bird is on the tree</em></td>
<td><em>The bird is a crow</em></td>
<td><em>The bird can eat</em></td>
<td><em>The bird can eat outside</em></td>
<td><em>The bird can eat outside every morning</em></td>
<td><em>The bird can eat worms</em></td>
<td><em>The bird can eat worms in the grass</em></td>
<td><em>Mother bird can give baby bird a worm</em></td>
</tr>
<tr>
<td>7</td>
<td><em>The bird is black</em></td>
<td><em>The bird is on the tree</em></td>
<td><em>The bird is a crow</em></td>
<td><em>The bird can eat</em></td>
<td><em>The bird can eat outside</em></td>
<td><em>The bird can eat outside every morning</em></td>
<td><em>The bird can eat worms</em></td>
<td><em>The bird can eat worms in the grass</em></td>
<td><em>Mother bird can give baby bird a worm</em></td>
</tr>
<tr>
<td>8</td>
<td><em>The bird is black</em></td>
<td><em>The bird is on the tree</em></td>
<td><em>The bird is a crow</em></td>
<td><em>The bird can eat</em></td>
<td><em>The bird can eat outside</em></td>
<td><em>The bird can eat outside every morning</em></td>
<td><em>The bird can eat worms</em></td>
<td><em>The bird can eat worms in the grass</em></td>
<td><em>Mother bird can give baby bird a worm</em></td>
</tr>
<tr>
<td>9</td>
<td><em>The bird is black</em></td>
<td><em>The bird is on the tree</em></td>
<td><em>The bird is a crow</em></td>
<td><em>The bird can eat</em></td>
<td><em>The bird can eat outside</em></td>
<td><em>The bird can eat outside every morning</em></td>
<td><em>The bird can eat worms</em></td>
<td><em>The bird can eat worms in the grass</em></td>
<td><em>Mother bird can give baby bird a worm</em></td>
</tr>
<tr>
<td>10</td>
<td><em>The bird is black</em></td>
<td><em>The bird is on the tree</em></td>
<td><em>The bird is a crow</em></td>
<td><em>The bird can eat</em></td>
<td><em>The bird can eat outside</em></td>
<td><em>The bird can eat outside every morning</em></td>
<td><em>The bird can eat worms</em></td>
<td><em>The bird can eat worms in the grass</em></td>
<td><em>Mother bird can give baby bird a worm</em></td>
</tr>
</tbody>
</table>

(Source: Anderson et al (1980) p. 32)

3.3. The Rhode Island Curriculum

Another approach to teaching language and syntax is the *Rhode Island Curriculum*, a programme based on the framework of transformational grammar developed by Chomsky and the cognitive development stages of Piaget. Essentially, the objective of this programme is to encourage pupils to internalise syntactic and semantic structures rather than having to memorise them, and does this through procedures integrated into the entire curriculum. The steps behind the programme are: *exposure, recognition, comprehension, and production*. Exposure to language may involve a number of different formats including the use of story books, interactive games and dialogue between the pupil and the teacher. Recognition is the ability of the child to identify words, phrases or questions as familiar. Comprehension is defined as the child's ability to understand language, including its form, function and meaning. The last step, production, is where the pupil generates various types of output including writing, speech, sign language and pantomime. The *Rhode Island Curriculum* begins with pre-school children and continues into the secondary school level.
The second level of language instruction focuses on the acquisition of five basic sentence patterns, which are generally grasped by pupils between the pre-school age and the age of 7 years. These basic sentence structures (as we saw in Chapter 6) are called kernel sentences from which more complex sentences can be constructed or analysed, usually starting at about 8 years of age. Examples of these sentence patterns are presented in Table 7.3, below. Unlike the Apple Tree approach, these sentence patterns are not designed to be progressive in complexity, but are used to compare and contrast with each other to show how syntactic structures can influence semantics. With pattern 1, the structure is very simple with the use of only a noun phrase and verb, but adverbials can be introduced with question forms such as where, when, and how as in:

*The man worked* (actor + action)
*The man worked at night* (actor + action + when)
*The man worked in the office* (actor + action + where)
*The man worked quickly* (actor + action + how)

Pattern 2 illustrates the actor + action + verb structure and can include discussion of who and what forms. Pattern 3 introduces descriptors or attributes of the actor linked by a linking verb or the verb of being as in *Bobby is happy*. Sentence pattern 4 relates the actor to another attribute as in *Bobby is a good runner*, while pattern 5 contrasts with pattern 1 with its use of adverbials. A practical teaching session might, for example, involve a teacher bringing a basket of fruit into the class, and, selecting different pieces of fruit, emphasising structures such as (see over):

Table 7.3 The Rhode Island School for the Deaf Curriculum: Five Basic Sentence Patterns and Examples

<table>
<thead>
<tr>
<th>Pattern</th>
<th>The boy</th>
<th>laughed</th>
<th>NP</th>
<th>v</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pattern 2</td>
<td>The boy</td>
<td>bought</td>
<td>NP₁</td>
<td>V</td>
</tr>
<tr>
<td>Pattern 3</td>
<td>The boy</td>
<td>is</td>
<td>NP₁</td>
<td>LV</td>
</tr>
<tr>
<td>Pattern 4</td>
<td>The boy</td>
<td>is</td>
<td>NP</td>
<td>LV</td>
</tr>
<tr>
<td>Pattern 5</td>
<td>The boy</td>
<td>lives</td>
<td>NP₁</td>
<td>LV</td>
</tr>
</tbody>
</table>

(Source: Adapted from Blackwell (1978) p. 69)
The apple is red
The apple is round
The teacher peels the orange
Ms Pat peels the orange
Outside, the apple is red
Ms Pat cut the apple

After this the teacher checks for comprehension by asking students to, for example, point to certain types of fruit, or identify the fruit which is round; noun phrases may be identified by getting the student to label selected pieces of fruit; students may be asked to identify the verb phrases: What did Ms Pat do with the apple?; next, sentence patterns used may be contrasted by getting the student to write the pattern for each.

Having dealt with simple sentence structures, transformational patterns such as conjugation, subordination, and relative clauses are introduced, as and when the student's need arises to communicate with these forms (note the influence of natural methods here). A basic principle of the Rhode Island Curriculum, however, is that each of the transformations is taught through the identification of the kernel or basic sentence patterns and what changes in the pattern occur in making the transformation. For example:

The boy fell down this morning
The boy hurt his knee
The boy went to the hospital
The boy fell down and hurt his knee this morning

At even more complex transformations such as complementation, nominalisation and deletion, sentence diagrams are often introduced.

3.4. TSA Syntax Program

Another widely used language programme is TSA Syntax Program developed by Quigley and Power (1979), which was designed as a remedial programme for children aged 10 and above who are experiencing difficulties with English language structures. The programme focuses on nine of the most commonly used transformational structures namely: negation, conjunction, determiners, question formation, verb processes, pronominalisation, relativisation, complementation, and nominalisation.

3.5. The Display Kit programme

The Display Kit programme (DKP) is a pilot scheme developed by Fyfe et al (1993) and is one of the few instructional programmes to be developed in the UK aimed specifically at teaching an aspect of syntax to deaf children. Since this is a pilot study, the results must be viewed cautiously, and the size of the sample used – just two deaf children – not large enough to yield anything like statistical significance. Nevertheless, the researchers have tried to demonstrate how a simple paper-based
set of materials can be used to improve performance in the transformation of declarative sentences into their interrogative form.

The study concentrated on only questions which demanded a yes/no response (since they were deemed to be less complex than wh-type questions), and classified these questions into three categories (see Table 7.4). At the difficult level of transformation (in Table 7.4) there are three verbs in the sentence, only one of which plays a part in the transformation. One problem is that the non-changing part, had stolen the money, must be retained in working memory while the interrogative part of the sentence is produced. The researchers hypothesised that a display kit designed to identify the 'moving parts' of the syntactic rule could improve performance. This, however, depended on the system placing a maximum reliance on the visual mode; being capable of modification so that rules of varying complexity could be presented; capturing the attention and motivation of learners; ensuring that all information was made use of; and the use of colour-coding.

The Display Kit itself, consisted of what were termed a principle envelope and a store envelope. Taking an easy question as an example the test procedure was as follows:

a) a sentence was displayed on the front of the principle envelope;

b) the pupil was asked to read the sentence;

c) cards with words on them were taken from the principle envelope and laid out on the table, and a sentence made which repeated the one on display;

Table 7.4 Classification of Yes/No type sentences by difficulty, example sentences and possible errors in transformation

<table>
<thead>
<tr>
<th>Level of difficulty</th>
<th>Example sentence</th>
<th>Possible errors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Simple</td>
<td>Mary is contrary → Is Mary contrary?</td>
<td>• Failing to move is to the beginning of the sentence</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Doing this but leaving is in its original place</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Forgetting the question mark</td>
</tr>
<tr>
<td>Intermediate</td>
<td>He is running → Is he running?</td>
<td>Moving the main verb (to run) instead of auxiliary verb (to be)</td>
</tr>
<tr>
<td>Difficult</td>
<td>John thought Mary had stolen the money → Did John think Mary had stolen the money?</td>
<td>• Failing to produce the auxiliary verb did</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Failure to change thought to think</td>
</tr>
</tbody>
</table>

(Source: adapted from Fyfe et al, 1993)
d) it was explained to the pupil that to make a question s/he needed a question mark; one was taken from the store envelope;

e) attention was drawn to the fact that the question mark was coloured red; this told the pupil to look for the word on the display that was underlined in red (the verb); the pupil was then encouraged to look for a word in the scattered cards that was underlined in red and turn it over;

f) the word on the other side was written in red; the rule is: always move the red word to the front;

g) the pupil was then asked to read and then answer the question;

h) finally, it was pointed out that if a capital letter and full stop had been used in the sentence the final question sentence would have contained a capital in the middle and a full stop and question mark at the end which could not be correct.

The DKP provoked lively interest amongst the children, indeed, so much that they began prompting each other's responses so that subsequent sessions had to be organised separately. Putting the 'inert' part of the sentence on a single card helped the pupils focus on the important (moveable) features of the sentence. Colour coding proved to be very efficacious, with pupils learning how to scan the sentence for 'moving parts'.

The authors made some suggestions for future developments and improvements. One is the gradual removal of important cues, e.g., the red underlining of verbs. Another is the introduction of the wh-form of the interrogative format. What is particularly interesting is that the authors make a direct recommendation that the instructional procedure be computerised:

In general, the computerised version should excel the physical kit in objectivity and sensitivity, as well as in vividness and immediacy.

(Fyfe et al 1993, p. 132)

These structured methods, however, have not been without their critics. Although the Fitzgerald Key, for example, provides the deaf child with a framework for the comprehension and production of language, it can do so in circumstances devoid of context so that all the pupil is left with is the surface structure of language, divorced from its functional objectives. Another problem with such structured approaches is that the rules of English do not always fit into a linear sequential pattern presented in formats like the Key. It is the belief in deaf pupils that language is linear that allows them to make errors such as the S-V-O word order, discussed in Chapter 6. At least the Fyfe et al (1993) approach attempted to teach some of the rules of syntax in quite a flexible way, rather than getting children to place words in a rigid, predetermined structure.

In teaching syntax, Arnold (1989a) offered a word of warning, pointing out that the teaching of English in a very structured way, using what he called the grammatical approach, needs to be viewed problematically. It is a mistake, for example, to
assume that there is only one grammar when, in fact, there are many. The question is whether an explicit grammar can help the teacher in encouraging good English. For hearing children, differences in grammar usage may be a matter of prescriptive rather than descriptive norms, because qualitatively the problems of deaf pupils are greater, the developing grammar of deaf people taking a different form to that of hearing people. Nevertheless, we will now take a look in more detail at some of the practical instructional strategies of teaching language that have been used, based on the theoretical models we have just discussed.

4. INSTRUCTIONAL STRATEGIES

Some useful practical guidelines for using a structured approach to teaching morphological and syntactic skills have been provided by Wiig and Semel (1984), although it should be noted that their work was concerned with children with general learning disabilities rather than specifically with hearing-impaired children. Their suggestions include the fact that:

a) Unfamiliar words or sentences should be presented according to their difficulty, with more familiar ones presented before less familiar;

b) Words, clauses and sentences used for intervention should be very familiar to the learner; to achieve this, they must be selected from vocabulary lists for age/grades at least 3 years below the child's current vocabulary age or grade level;

c) Sentence length should be limited to five to 10 words, and clause length to two to four words;

d) Pictures of referents for content words which have a referential meaning should be used in association with printed representations of non-referential words or function words;

e) Unfamiliar words or sentence formation should be introduced in at least 10 illustrated examples, which should feature different selections of words;

f) The learner should be able to first recognise and then comprehend any new word or sentence formation before being asked to apply it to a task;

g) Knowledge of word or sentence formation rules should first be established with highly familiar words before the learner moves on to higher level contexts or to less familiar vocabulary;

h) Knowledge of the new words or sentence formation should be tested in at least 10 examples that feature vocabulary not previously used.

As well as teaching itself, an essential part of the instructional process is assessment of learning outcomes. Wiig and Semel (1984) identified several assessment strategies that are applicable to either the structured or combined approach to instruction.
a) **Correct–Incorrect Model.** This requires the student to simply identify whether a particular sentence structure, or structure within a sentence is right or wrong. This may be in the form of a yes/no response, or expanded into multiple-choice questions.

Example: *The boy went to school yesterday, hadn't he? (right/wrong)*

b) **Completion Model.** Here, nouns, verbs or a sentence pattern is deleted from a sentence and the child has to identify what has been omitted. Sometimes possible solutions are provided in the form of a multiple-choice selection, but in a slightly more difficult scenario, no assistance is given and the answer must be provided by the student.

Example: *First John saw Jeff. Then John saw his father.*

   *John saw Jeff ______ (after he saw his father/ when he saw his father/ before he saw his father).*

c) **Classification Model.** The learner is required to categorise selected sentences according to their structural identities, e.g., into active or passive categories.

Example: Categories the following as either active or passive:

   *The dog was hit by the car.*
   *The car hit the dog.*

d) **Cloze Model.** The student is required to take any single element or phrase and replace it with an element or phrase of his or her own choice. This is more complex than the completion model because the student is having to choose what is replaced as well as having to decide what must be inserted in its place. Wiig and Semel (1984) commented that this was a particularly useful method for teaching auxiliaries, personal and reflexive pronouns, prepositions and relative pronouns.

Example: *He gave the book to the boy ______ lives next door (what/ who/ which)*

e) **Combination Model.** In this model, the student is required to combine two or more sentences together. This itself can be achieved in incremental steps using the correct–incorrect, multiple-choice, and completion formats.

Example: Model: *Paul's face is muddy

   Paul cleaned his face with a towel*

Step 1: Correct–Incorrect

   *Paul cleaned his muddy face with a towel
   Paul's face on the towel was muddy*
Step 2: Multiple-choice

Paul cleaned his muddy face with a towel
Paul's face on the towel was muddy
Paul cleaned his face on the muddy towel
Paul cleaned his towel with his muddy face

f) **Scrambled Sentences.** Here the word order in sentences is jumbled up and the student has to re-order the words to make sense. Levels of difficulty can be changed by increasing the number of structures to be manipulated. This is a useful format for practising the rules for word and phrase order in kernel sentences, for adjective order in expanded noun phrases, and for phrases and clauses in transformations.

Example: Sentence transformation

*Eat the steak the boy did?*

*Did the boy eat the steak?*

g) **Revision Model.** The student is asked to rearrange and revise semantically related sentences.

Example:

Teacher:  
*The golden eagle is a bird of prey*
*Birds of prey eat mice*
*Eating mice keeps down the rodent population*

Student:  
*The golden eagle, a bird of prey, eats mice and, by doing so, keeps down the rodent population*

h) **Resolution into component propositions.** Here, the child is asked to identify and resolve sentences with two or more clauses into their component propositions. Typical formats comprise sentences with conjunction deletion, connectives and conjunction of clauses, noun phrases complements, and relative clause transformations.

Example: Relative clause transformation

Sample:  
*The boy who lives next door found my cat*

Choices:  
*The boy found the cat*
*The cat found the boy*
*The cat lives next door*
*The boy lives next door*

i) **Proximity of Meaning.** The child has to identify and select transformations that share the same meaning.

Example: Same/different judgement

*The truck followed the car.*
*The truck was followed by the car.* (same/different)
Blackwell et al (1978) also offered some useful principles in teaching linguistic principles to hearing-impaired children. They stressed, for example, that language development should seek to teach rules so that the child is helped to develop a grammatical strategy, and these linguistic principles should be presented in relation to real life events. In addition, errors in the production of language should be accepted, as they reflect an attempt on the part of the child to master a rule; errors should be followed by praise, and the offering of a new rule from which the child can learn.

No single model presented above provides, in any sense, the ideal one for all children. Essentially, any teaching or assessment strategy must be flexible enough to incorporate what is necessary for the needs of any individual child or group of children. What is important, however, is that pupils are provided with ample opportunities for practice and feedback. It is here that the use of information technology can play a vital role.

5. TEACHING MATERIALS AND THE USE OF TECHNOLOGY

Some of the most influential materials were developed in the 1920s by Croker, Jones and Pratt called Language Stories and Drills, consisting of four volumes of language practice exercises. These comprised (1) a story introducing new vocabulary, (2) practice in writing questions to answers already given, (3) comprehension questions, and (4) exercises using new language. While these books formed the basis for many materials found in schools for the handicapped children today, teachers often had to supplement these with ideas of their own. McAnally, Rose, and Quigley (1987) cited the work of Nelson who listed a series of language activities in vogue in the first few decades of the 20th century, many of which are still used today, including:

a) News items;
b) Educational trips;
c) Action work in which the child performs an action and then tells and writes what was performed;
d) Prose compositions of all types;
e) Vocabulary notebooks;
f) Topics, developed through the use of objects, pictures, toys and stories;
g) Picture stories;
h) Letters, notes and cards.

To this list must be added the use of film, especially in the USA, which saw considerable growth in the 1960s and after, with the introduction of captioning, specifically for deaf people. Other important media included overhead transparencies and slides and programmed instructional materials. The most important examples of the latter were the Project Life filmstrips, designed to support and supplement specific skills introduce in classroom instruction. The filmstrips were pre-programmed and presented multiple choice questions and immediate feedback to responses which were recorded on small cards for the teacher to review. The programme dealt mainly with language issues and is now available commercially as the PAL (Programmed Assisted Learning) System.
Other widely used materials, cited in McAnally, Rose and Quigley (1987), include the *Reading Milestones* series by Quigley and King (1984), a basal-type reading programme which identified syntactic structures and introduced new vocabulary and idioms at a controlled pace. Assessments, teacher's guidelines and instructional strategies were provided at each level. More technological devices that have had an impact include the real time graphic display, which converts the orthographically generated word into a printed form as it is being spoken, and the Telecommunication Device for the Deaf. Computer assisted learning provides yet another significant avenue for technological assistance. With developments in both software and hardware platforms making the production of highly graphical and interactive programs possible (assuming competent design), and considering the important contribution of computer assisted learning in special needs education, including teaching deaf children, this will be dealt with in more detail in Chapter 8.

6. CONCLUSION

This Chapter has shown the importance of not adhering rigidly to any one of the approaches to teaching grammar, but selecting the most useful and appropriate elements from each. Thus, it is important to teach syntax within the context of situations or with objects or through experiences which have direct relevance to the child. This is one of the essential features of the natural approach. Yet, it is also important to understand that merely immersing the child in a language environment may not be sufficient to teach the rules of syntax to the child. This requires instruction within the framework of a structured or combined approach.

In providing structure, however, it is vital that certain principles, gleaned from the experience of other researchers, are adopted. It is important, for example, that materials present vocabulary that is easy and familiar to the child, and that short (5–10 word) sentences are used. Where unfamiliar words are used they should be introduced in at least 10 illustrated examples. An understanding of new words should be tested on at least 10 examples before the learner is allowed to move onto higher contexts. Essentially, children should be exposed to words or phrase structures (and given numerous examples for reinforcement), and tested until it is clear they recognise them accurately (as in the *Rhode Island Curriculum*). The meaning of the words and phrases must then be grasped, before the pupil is asked to generate examples of the word or phrases themselves. It may also be useful if the learner is encouraged to compare and distinguish between different types of sentence structure, so that rather than learning syntactic forms by rote, they are able to apply rules in novel situations to differentiate between different sentence types, as recommended by Blackwell (1978). To test whether the learner has mastered the skills mentioned here, a variety of testing strategies, of varying degrees of complexity, can be utilised, such as correct–incorrect questions, completion and replacement exercises, and, for transformational sentences, combination tasks.

All these are complex and time-consuming tasks for individual teachers to accomplish. There is also the problem of standardisation, with not all teachers necessarily having the skills, experience, or indeed, resources, to put these sorts of strategies into action. A programme designed on sound instructional principles
could solve at least some of these difficulties. If this was a computer assisted learning program (as recommended by Fyfe et al (1993)), then it might have further advantages. The ability of CAL to present numerous examples would meet some of the criteria for providing multiple examples of sentence structures set by Wiig and Semel (1984).

The computer can also be programmed to test and reinforce new skills by repetition. But if instructional approaches were to remain at the drill and practice level, then this would fall into the danger, highlighted by advocates of the natural approach to language teaching, of delivering stilted learning, perhaps devoid of context for the child. What is essential, is that the instruction should offer material that is interesting, relevant and meaningful for the child. The use of a cartoon or storybook format might be relevant here, where sentence structure could be displayed or tested in a colourful and graphical environment. The use of this style, with one picture semantically linked to those before and after it, might force the learner to search for clues to unravel the meaning and structure of sentences within a contextual environment.

There is nothing particularly new about using pictures or what Blackwell (1978) referred to as real life situations to teach syntax. What could be innovatory here, though, could be the introduction of such pictures through a computer assisted learning multimedia format, using text, graphics and even sound (making use of any residual hearing), to apply state-of-the-art technology to the age-old problem of deaf literacy. The ways in which the computer has been used in special needs education in general, and in teaching hearing-impaired children in particular, are examined in the next Chapter.
CHAPTER 8
Computer Assisted Learning and the Syntactic Instruction of Deaf Children

1. INTRODUCTION

We have seen (Chapter 3), that the successful integration of deaf children into mainstream classes depends, at least in part, on the provision of adequate resources, particularly individual instruction from teachers. It was also noted, however, that, with pressures from the National Curriculum and large classes, such individual attention could not always be forthcoming. It was suggested that the provision of additional learning resources in these classrooms might make mainstream teachers more enthusiastic about accepting deaf children into their classes, so smoothing the path towards integration.

Successful integration also depends on the ability of the hearing-impaired child to cope with the demands of the curriculum, and this in turn relies on a functional level of literacy. It was noted (Chapter 5), however, that deaf children have particular difficulties with language and reading beyond the stage of basic vocabulary, when words and phrases are combined into syntactic structures. It was suggested that a computer assisted learning program, delivering syntactic instruction could, given the pressures on teaching resources, play a role in significantly improving the skills of hearing-impaired children in this area.

Two questions, however, remain. One is whether an effective program already exists for teaching syntactic structures to deaf children, or whether one will have to be designed, tested and evaluated in a classroom environment. The other is whether computer assisted learning is, in practice, an effective medium for delivering such instruction. Certainly, many commentators have described the strengths and merits of computer assisted learning.

... children find microcomputers non-threatening, non-judgmental, stimulating and highly motivating; learning steps can be individually paced and controlled by the child; children can take risks and make mistakes; there is opportunity for repetition and overlearning and forming concepts, linked with immediate feedback and praise. (Webster 1989 p.90)
Discussing the motivational aspects of the computer, Elder et al (1983) described how pupils enjoyed using the medium, while Williams (1986) commented with enthusiasm:

*In the next decade, microcomputers will stimulate radical change in every part of the educational system. Their potential has already been recognised and exploited in other fields — schools will not so much be moving with the times as running to catch up.* (Williams 1986, p. 145)

While Beech (1985) argued perhaps rather optimistically, that:

*Each extra computer in the classroom could almost be the equivalent to having an extra teacher in the classroom* (Beech 1985, p. 122)

The question remains, however, as to whether the appeal of the medium can be matched by its effectiveness as a tool for enhancing learning. This Chapter therefore considers a variety of learning strategies and, in particular, the impact on children’s learning of typical computer assisted learning programs both in mainstream and in special education. It also considers the content of a range of special needs programs, particularly those related to language and reading. This will include some produced specifically for hearing-impaired children, to see how well they deliver the effective syntactic instruction that has been proposed as essential.

2. THE DESIGN LIMITATIONS OF CURRENT PROGRAMS

A broad range of the literature was examined and it was found that, with very few exceptions, many computer assisted learning programs are limited in terms of their instructional methodology, functionality and aesthetic appeal (and hence both their instructional and motivational qualities). It was found, for example, that especially in the 1980s, drill and practice programs were often the norm, Dodds (1984) suggesting that the computer was used in many classrooms as a programmed learning machine, or as an ‘electronic flash card cum test-and-score machine’ (p. 36). Microcomputers were bought by schools and yet teachers were ill-prepared. Well designed programs were unavailable and instead, numerous simple but repetitive drill and practice programs were supplied.

*In silicon the educational alchemists had discovered their philosopher’s stone, and the software that they produced from their retorts in the mid 1970s and 1980s revealed that once again alchemy was failing.*

(Dodds 1984, p. 36)

The prevalence of drill and practice software was confirmed by Jackson, Fletcher and Messer (1986) in a survey of all primary schools in Hertfordshire, which found that 57 per cent of programs used were of this type (see also letter to author, Appendix 8). The other main category of program was open-ended or child-directed such as LOGO, which 30 per cent of respondents used. The survey also found that, although most schools possessed a microcomputer, often it was only one machine, so most pupils shared the machine for a brief duration. In a second survey in the same county, Jackson, Fletcher and Messer (1988) found that the percentage
of teachers using drill and practice software had actually increased, with primary school teachers being more likely to use these types of programs than junior school teachers (p>0.001). On a positive note, the authors also found a large increase in the use of problem solving software, but nevertheless, they commented that the predominance of drill and practice programs was still a cause for concern:

*Whether microcomputer use will improve the pace and pattern of children’s learning .... depends largely on what type of software predominates in schools, and it is unlikely that such a change will occur through the use of drill and practice software.*

(Jackson, Fletcher and Messer 1988, p. 224)

Hawkridge (1987) also noted that there was no shortage of drill and practice programs, especially for teaching various aspects of English language such as reading, enunciation and spelling, but the quality of such programs was variable. Elder *et al* (1983) commented that one of the difficulties of the drill and practice format was that pupils do not always respond to the types of rewards offered by the behaviourist, stimulus–response model of learning:

*Perhaps the root of this difficulty is the perception of learning as a medicine to be disguised, unpalatable but good for you?*

(Elder *et al* 1983, p. 75)

It is cause for concern that Plomp, Pelgrum and Steerneman (1990) found, in a study of Dutch secondary schools that poor quality software was mentioned more than any other factor as being responsible for the limited use of the new technology in education.

An example of a typical drill and practice routine was provided by Atkinson (1974) for the development of sight vocabulary, as outlined in Table 8.1. In this instructional system using information technology, student terminals comprising teletypewriter and audio headsets were linked to a mainframe computer, the computer sending messages down telephone lines to the remote terminals. Table 8.1 shows examples of the program messages, students responses and program feedback; note that a ‘+’ sign is a computer response to correct student input.

Another example of a drill and practice program was one developed by the Microelectronics Education Programme (MEP) called BOX CLEVER in which a number of words were displayed at the top of the computer screen and some interlinked boxes at the bottom, representing the shape of one of the displayed words, one box for each letter. The shapes of the boxes varied depending on whether the letters contained ascenders or descenders, the child being required to type in the letters of the word he or she thought fitted the box. For example, the word *right* would be represented as shown in Figure 8.1. Potter (1987), however, explained that even fluent adult learners had difficulty using the program because it was based on what he asserted to be the flawed notion that readers use word *shape* itself in reading.
Table 8.1  Example of a computer controlled drill and practice exercise for improving sight vocabulary

<table>
<thead>
<tr>
<th>Teletypewriter display</th>
<th>Audio messages</th>
</tr>
</thead>
<tbody>
<tr>
<td>The program outputs:</td>
<td>PEN</td>
</tr>
<tr>
<td>The student responds by typing</td>
<td>PEN</td>
</tr>
<tr>
<td>Program outputs:</td>
<td>+</td>
</tr>
<tr>
<td>The program outputs:</td>
<td>EGG</td>
</tr>
<tr>
<td>The student responds by typing:</td>
<td>EFF</td>
</tr>
<tr>
<td>The program outputs:</td>
<td>/////EGG</td>
</tr>
</tbody>
</table>

(Source: adapted from Atkinson, 1974, p. 171)

As well as *Box Clever*, the Microelectronics Education Programme, set up in 1981, was responsible for many other drill and practice programs, pouring over £9 million to promote computer assisted learning and the study of information technology in UK schools. Hence it is hardly surprising that after five years of effort and the expenditure of about £20 million, Self (1987) reported that the standard of educational software was in a lamentable state and that:

... educational software provision is clearly inadequate in quantity and certainly in quality. (Self 1987, p. 233)

Figure 8.1  How the computer assisted learning program, *Box Clever*, presents boxes to represent the word *right*
It is worth noting, however, that not all observers believe that drill and practice is necessarily of limited use. Wright and Anderson (1987) suggested that one of the claims made for computer assisted learning was that it made such programs more motivating for pupils because of its patience, ability to administer feedback which is immediate, attention getting, and its ability to accurately assess performance. While not totally rejecting the value of drill and practice programs in specific situations, Hope (1987) argued that care had to be taken in ensuring that they offered the child a challenge. Usually, however, the programs gave practice rather than tuition and contained remediation routes that were either poor or non-existent. Ideally, the way programs should be designed is that they contain types and quantities of practice that are suitable to the individual learner.

In terms of programs for special needs children, Webster (1989) took the view that most programs failed because they took a direct, didactic approach to instruction, which went against the principle of the child learning from experiences and interpreting evidence. Many programs, he argued, fostered a decontextualised style of language behaviour, in which the child was merely the passive recipient of software prompts and demands.

Yet there are good reasons for believing that computer assisted learning should be effective with children with special needs. As Hope (1987) pointed out, one of the primary reasons for this is that they enable children with learning difficulties to practice skills over and over again, and they are also capable of recording what the child has learnt, which is especially important for children with learning difficulties who need a structured learning situation and a record of their progress. Also, as pointed noted Budoff and Hutton (1982), computer assisted learning may be especially welcome in special needs education because it can be used in a non-threatening manner, and assist the child towards failure-free mastery of new skills or knowledge. As Rostron (1983) pointed out, they can also be used to simulate the real world environment, which can be important for children with handicap or learning difficulties because their knowledge of the world can sometimes be restricted. Hawkridge and Vincent (1992), however, sounded a note of caution arguing that in special needs education:

Computers can ease learning difficulties. They can help learners to overcome their difficulties. They cannot work magic.
(Hawkridge and Vincent 1992, p. 21)

Yet it is, in principle, possible to design computer assisted learning programs which do not have to rely on the kind of behaviourist paradigm which influenced the drill and practice approach. In its most extreme form, this approach denies the possibility of knowing how a learner thinks, but sees the human mind as a 'black box', and learning being influenced by external rewards or punishments. In contrast, Mertens and Rabiu (1993) argued that computer assisted instruction could be effective if the programs were designed on the basis of cognitive learning theories, adopting strategies, for example, which related instruction to the student's existing knowledge structures, i.e., schemas, and provided opportunities for repetition, practice and feedback to allow the learner to build additional associations around the new
information. In the next section, in which the content of various computer assisted learning programs is examined, it is clear that the advice of Mertens and Rabiu (1993) is rarely heeded.

3. THE CONTENT LIMITATIONS OF CURRENT PROGRAMS

This section looks at how the computer has been used quite extensively to teach various aspects of language including building vocabulary and speech training. It should be noted that, in examining the evidence, few of these programs are relevant for teaching syntax.

3.1 Spelling and comprehension programs

The evidence of Williams (1986) showed that, what he termed electronic worksheets, can be used to develop spelling, comprehension and creative skills. An example is a program which presents cloze passages on screen (words and letter missing) and the child supplies the answer to which the computer then checks and responds. An example is the Tray program (see section 5.1). Another example is a program which presents jumbled sentences on screen with graphics presented below the words and the child types the sentence with words in the correct order. Hangman is a computer version of an old paper-based game. A word is secretly chosen and blanks displayed with a jumble of letters. The child types in a letter of his/her choice and the letter disappears from the alphabet printed on the screen and reappears in the hidden word if correct; if wrong, the scaffold builds!

3.2 Text creation programs

Another way of employing the computer to help in language development is simply using it as a text creation tool. In primary as well as in secondary schools, computers are available, for example, as word processors for articles, especially where the children have difficulties with hand-written English because they are either physically disabled or, say, dyslexic. This is a more sophisticated use of the computer's powers than Williams (1986) 'Writing a story' description because the computer is being used in an open-ended way to create text rather than in a more structured format where individual vocabulary items are illustrated by graphical images. In using the computer in a creative capacity its powers to spell-check documents can be very useful, by providing feedback on the correct spelling of words, or say, alternative words through a thesaurus. The MEP, for example, made two word-processing packages freely available to all schools - Writer for infants, and Prompt through the Special Education Microelectronics Resources Centres. Potter (1987) argued, however, that the power of the wordprocessor in improving children's language development can be exaggerated. If children find writing an alien process then it is unlikely that the wordprocessor will, by itself, change that condition. While Potter made no comment on this, it may also be true that success will depend to a great extent on the nature of the support and guidance in using the medium provided by the teacher. It may also depend on the pupils' traits: perseverance, attention span, self-confidence and need to succeed in relation to their fear of failure.
3.3 The computer as a reading tutor

Another of the areas where computers have been used quite extensively is in assisting the process of teaching children to read. An example is the language development program, developed by the MEP called *Wordplay* which provides four lists of data: nouns, verbs, adjectives, and adverbs and a list of phrase forms. The program generates 'concrete poetry' by selecting a phrase form (e.g., adjective, noun, verb, adverb) and then the words to fill the form structure, e.g., 'Wintry' from the list of adjectives, etc. A result, quoted by Potter (1987) is:

*Wintry hedges gleam brilliantly
Radiantly, splendidly silver,
Houses glisten, puddles shine
White plains, silver fields, gleam softly*

(Potter 1987, p. 223)

Potter (1987) argued that a critical difference between this program and traditional drill and practice types was in the locus of control. With *Wordplay*, it lies with the user because they are 'programming' the content. Also, learning the different parts of speech is a means to an end (the poem) rather than an end in itself.

In line with Hope's (1987) assertion that programs were moving away from the traditional drill and practice format, the report from the National Association for Teachers of English (*IT's English*, 1990) concluded that, in teaching English, the computer is increasingly being used to enable the pupil to explore and 're-discover' the underlying rules and conventions of English themselves. The example of *Tray* was cited but the success of *Tray*, in contrast to so many other programs, was that it had been tried and tested in the classroom and then regularly modified in the light of these evaluations. The report concluded that there was thus a general need for designers of educational software to revise their programs in the light of classroom experience, something which many other software designers have failed to do.

3.4 Meta-cognitive programs

In recent years, however, Hope (1987) suggested, while offering no evidence, that the computer has become seen more as a tool in schools for enriching the curriculum, enabling low attainers to develop co-operative learning (instead of individual instruction), problem solving skills and reading for meaning. Above all, it meant, as well as gaining new skills, the child also learnt about learning itself. This comment was probably, at least in part, a reference to programs such as LOGO software, based on the ideas of Papert (1980), in which the child learns and experiments with a set of commands to control the movement of a screen turtle or robot. LOGO software has been extremely popular and influential both in mainstream schools in both Britain and the USA and also in special education. This program, however, was designed to teach meta-cognitive skills, that is, thinking about thinking, rather than content-specific areas from the curriculum which encompass the aims of the present study. Nevertheless, this probably has more to recommend it than the typical drill and practice programs already discussed (section 2) since, in attempting to teach higher order skills, the program may be empowering...
the child in knowing how to learn. This might be a useful path to emulate in any learning program since these skills are potentially transferable to a variety of different contexts, assuming that, in fact, such a causal link does exist.

3.5 Syntax programs

It was noted in Chapter 6 that the use of transformational syntax was a particular problem for hearing-impaired children and was one of the most significant factors behind the 'learning plateau' that many of them face. The only program which comes close to illustrating syntax was one, mentioned by Williams (1987), which is concerned with parts of speech which asks the child to type in five nouns, five verbs and five adjectives. It then prints a story using these words, usually highlighting them in colour. It is clear from this description, however, that the program was designed more to help the child to use language in building a story than to teach syntactic structures. In other words, it helped develop children's creative powers and skills in composition, but did not attempt to teach them any of the rules of syntax per se.

4. TEACHER ATTITUDES TOWARD COMPUTER ASSISTED LEARNING

Webster (1989) pointed out that even where software has been available, its use was likely to be limited because, like mainstream teachers, many special needs teachers were either unaware of its existence or resistant to using it. Indeed, Boyes (1991) noted that by the mid-1980s, government inspectors were highly critical of the lack of use of computers by teachers other than those directly concerned with computer studies. One factor in this may be the problem noted by Salter (1985) who claimed that the majority of colleges of teacher education make no provision for any computer course, let alone instruction specifically related to computer assisted learning.

As a comparison, Handler (1993), showed that 89 per cent of all teacher education programmes in the USA offered some opportunity for computer training to their students, but even here, quoting from a national survey, only 29 per cent of respondents were prepared to teach with computers. Yet, as Mertens and Rabiu (1993) suggested, the attitude of teachers is vital since it is they who influence the extent to which computers are used in the classroom. Furthermore, research quoted in Todman and Dick (1993) suggested that, apart from the influences of home (social deprivation being associated with negative attitudes to computers by both teachers and pupils in the school), and school experiences, an important factor affecting children's experiences with computers may be the teacher's attitude to the technology. The interrelationship, however, may be quite complex, and it may be that it is the attitudes that children brought with them to the school, possibly related to their lack of experience with computers at home, that influenced the attitude of teachers.

Unfortunately, according to Winnans and Brown (1992) there has been little research on the extent to which teachers use computers in their classes and the factors influencing their decisions about whether to make use of them. Plomp, Pelgrum and
Steerneman (1990) referred to research which suggested that a major obstacle to the implementation of new technology in the classroom may be teachers' uncertainty about its impact on learning outcomes.

Another issue is not only why teachers use, or do not use, microcomputers but also the influences on the kinds of program they use. Jackson, Fletcher and Messer (1986) found that teachers who had attended a course on microcomputer use were more likely to use child-centred packages than those who had not attended such a course. The research of D'Arcy and Gardner (1988) revealed that another factor may be whether they perceive 'good software' as being available. The factors considered as being important for this software included its flexibility (i.e., usefulness for a range of abilities), its relevance for the curriculum, its validity in the light of accepted pedagogical methods, and its motivational qualities.

5. IS CAL AN EFFECTIVE MEDIUM?

Studies into the effectiveness of computer assisted learning have been reported by Alessi and Trollip (1991), and the results are not entirely encouraging. Overall, they commented that studies showed, at best, only a small effect in favour of computer based instruction, defenders of the medium excusing themselves with the truism that results would have been better if the programs had been more skilfully designed. Alessi and Trollip (1991), however, argued that the probable reason was that the computer was often used in teaching situations for which it was ill-suited. Different media have different advantages. The computer is strong where, for example, the material is hard to teach by other methods (graphing in mathematical subjects), student motivation is lacking, or where individual student practice is needed (such as the learning of language grammar or vocabulary). The next section looks at some evaluations of vocabulary programs.

Despite the claims made for computer assisted learning as an instructional medium, it is surprising how few studies there have been which have attempted to measure this effectiveness – for example, in terms of the speed or retention of learning new verbal information, concepts, rules, or problems solving abilities. This empirical evidence is also lacking in comparing CAL to other media such as live instruction (Hawkridge, 1987). Reports on the impact of CAL tend to fall into four categories: a) those that do not even attempt to measure its effectiveness, and rely on assertions of its worth; b) those that attempt some sort of measurement but use research design programmes or instruments which are unreliable, or inadequate (especially the use of small samples); c) those that argue about the powers of the medium to motivate pupils (because, say, of the 'safer', less threatening learning environment); d) those that use reliable instruments but find no significant difference between learning through a CAL program and another medium – although even here, while no measurable gains have been measured, there may be less tangible but real benefits of using the CAL medium including its novelty.
5.1 Vocabulary programs

The effectiveness of Tray as an instructional program has been evaluated by Johnson (1985), who praised the program for its flexibility. The program is content-free, in that the teacher can input any piece of text into the program, and then remove any number of phrases, words or parts of words. The task of the user is to recreate the text by predicting letter, groups of letters, words or longer units, and hence gain points, or 'buy' them from the computer which fills in the blank but deducts a mark for doing so. Johnson (1985) commented that the strength of this program was that it required pupils to discuss, argue and hypothesise about, and experiment with various aspects of language. In doing so, they acquired better oral skills for co-operative discussion and decision-making, as well as better spelling skills and word recognition. Johnson (1985) acceded, however, that Tray is not a program which is designed to teach language, the kinds of skills and information pupils learn probably being unique to individuals. It is also clear from his description that Tray might not be a suitable program for deaf children since the rules of language have to be learnt through inference, whereas for deaf children, the structure of language may need to be made explicit.

Wright and Anderson (1987) investigated whether a computer program could be used to teach sight vocabulary to children with severe learning difficulties. The null hypothesis of the research was that there would be no difference between teacher only and computer-assisted instruction. The results showed that the computer was indeed an effective medium for teaching sight vocabulary and that most of the children in the experimental group made an improvement which was sustained and even built upon over time. What was surprising, however, was that the teacher-only condition produced slightly better results, especially with pupils of lower ability. Hence, ability levels played a role in how well a pupil did when instructed by a computer, whereas there was no such effect in the teacher-only condition. The researchers hypothesised that reasons for this could include the fact that, with the teacher-only format, there was more eye-contact between teacher and pupil (although no explanation is provided as to why this should necessarily affect pupil performance), and it allowed more flexibility on the part of the teacher to adjust interaction if problems arose. Wright and Anderson (1987) stressed that the results of the study showed that the teacher-only condition was more effective when measured against a particular piece of software rather than against all computers per se, and that the computer program did produce a large increase in performance when measured against the performance of the control group. They concluded, however, that:

the nature of the computer task may have to change according to the ability of the child. Given that children with severe learning difficulties can be characterized, primarily, as having a lower efficiency of basic information-processing..... it seems plausible that the usefulness of computer aids may covary with ability along a dimension of information load, such that for lower-ability children there should be a reduced information load. (Wright and Anderson 1987, p. 59)
Hearing-Impaired Children and CAL

These results, though, must be treated with some caution because the numbers of pupils used in each experimental group (six) achieved results which, in the authors' words, approached significance (p<0.10), rather than achieving it. Nevertheless, these results may be indicative and suggest that computer assisted learning programs should be designed with a sufficiently open environment so that the child can embark on different learning experiences or take different routes (possibly selected by the teacher), according to his or her capabilities.

The effectiveness of computer assisted learning programs in teaching decoding skills to learning disabled pupils have also been evaluated. Jones, Torgesen, and Saxton (1987) took 20 students and let them use the Hint and Hunt 1 program for 15 minutes a day for 10 weeks. The researchers did not attempt to compare the effectiveness of computer instruction against that of a teacher because the computer was seen as a supplement to teacher guided instruction not as a substitute. The result was a statistically significant increase in decoding scores compared with both a learning disabled and normal control group, both in terms of speed and accuracy of decoding. Furthermore, these improvements applied to generalised as well as targeted words. The computer was regarded merely as a means of providing learning disabled children with more individualised practice than the teacher can offer.

Although teachers might be more effective than computers in helping children practice reading if they could spend enough time with each child, the realities of the classroom strictly limit the time they have available. (Jones, Torgesen and Saxton, 1987 p. 127)

The researchers remained open minded, however, about whether the computer can be as, or even more, effective than other media, and recognised the significance of the issue:

the question of whether computers can deliver more effective practice than other devices or materials is a very important one.

(Jones, Torgesen and Saxton, 1987 p. 127)

Wise et al (1989) also used a computer program to improve the word-decoding skills of reading-disabled children using a speech synthesiser to provide feedback. Again, in post-tests, experimental group children showed significant improvements in decoding performance, but once again, the computer medium was not compared with other forms of tuition such as teacher guided instruction.

An extensive evaluation of IBM's 'Writing to Read' (WTR) program was carried out by Slavin (1991), and as in many of the studies just cited, produced results that questioned whether the computer is a more effective teaching medium than the teacher. WTR was a $2.8 million development aimed at teaching reading and writing skills to kindergarten and first-grade children. In essence, it incorporated many of the skills identified in this section including the teaching of phonetics, using the computer to type stories and providing practice with letter sounds. Analysing the results of 29 studies on the WTR program, Slavin (1991) found no significant difference to reading or writing performance compared with control groups and concluded that the popularity of the program was mainly due to IBM's marketing
techniques, the pressure of policy makers (who often know little about education), and the seductive image of disadvantaged children working with state-of-the-art computers. It should be acknowledged, however, that some children may find using computers motivating and stimulating to use.

As with computer assisted learning programs in general, commentators on special needs education also had difficulty pointing to any specific examples of 'good practice' in software aimed at special needs children. As a result, talking about pre-school children with special needs Hope (1987) commented:

\[ It \text{ would be helpful if at this stage we could turn to a body of research that described and analysed the benefits of using micros ... Unfortunately, it does not exist. } \] (Hope 1987, p. 58)

Wright and Anderson (1987) also noted, there is a paucity of research into the effectiveness of computer assisted learning programs with children with learning difficulties. They argued that this was surprising, given the different modes of CAL available, and the fact that the microcomputer allows experimentation with a range of teaching methods.

5.2 Speech feedback programs

Another use of the computer in the development of language skills is through its use as a corrective or remedial device, for example, through speech feedback, where the computer logs a users' responses to screen prompts and gives feedback through digitised or synthesised voice. This is an area which is worth investigating because it is one of the elements of computer assisted learning which this study seeks to develop. Olson, Foltz and Wise (1986), for example, carried out a piece of research to investigate the intelligibility of synthesised speech, the optimal method of targeting words on screen, and the short-term influences of different feedback conditions on disabled readers' comprehension and word recognition. Speech can be generated from a computer in two ways, either by using natural speech which is digitised, stored in memory and played back through a digital-to-analogue converter; the second is the use of artificial speech which can be synthesised by the computer from text. The advantages of synthesised speech are that it does not make excessive demands on computer memory and it has unlimited vocabulary (its ability to phonetically reproduce sounds), while its main disadvantage is its relatively poor intelligibility.

The experimenters chose synthesised speech because of the need for a large vocabulary of words and because of technical developments which had improved intelligibility levels. The research found that the use of synthesised speech feedback on targeted words made a statistically significant impact on word recognition and comprehension. Furthermore, the use of the technology was greeted enthusiastically by the pupils, aged between 8 and 18 who took part. Olson, Foltz and Wise (1986) commented that:
One very encouraging result of this study was the unanimously enthusiastic response of the subjects to the computer-based reading and speech-feedback system. (Olson, Foltz and Wise 1986, p. 99)

Davidson et al (1991) also described a speech synthesis system whereby pages from a children's book were presented on screen, and the child pointed the cursor onto a word which was unknown; the word was then spoken back to the child using digitised speech. One of the objectives of the research was to see whether this form of feedback was intelligible and acceptable. The response was positive, with the voice of a child being preferred by both teachers and pupils to male or female adult voices. Davidson et al (1991) then compared the effects of the digitised speech program on word recognition abilities of a group of ten primary school children, against a control group of ten children taught by a teacher.

Interestingly, both groups made significant gain scores, the computer group being the largest. The researchers were forced to admit, however, that there were a number of uncontrolled variables that could have accounted for the results. Rather surprisingly, of the two reading achievement tests used, the Longman Vocabulary Test, based on the Longman book used in the program, achieved the lowest gains which were not even significant. The largest gains were made on a test, the words in which did not even appear in the computer program! The researchers tried to justify this result by saying:

*It seems that increased practice goes beyond the immediate situation and influences more general reading attainment.*

(Davidson et al 1991, p. 117)

This would perhaps have some validity if attainments in the Longman test had been significant because this would have suggested an improvement in performance which might have been extended to non-target words. Unfortunately, since this is not the case, the statement, as it stands, is difficult to sustain.

The researchers did point out, however, that these results were similar to those achieved by Wise et al (1989), who found that, after a digitised speech program used with reading disabled children, 88 per cent of the words successfully read in a post-test were non-targeted words. This suggests that the effect of the program was to improve the phonological coding skills of the pupils. Davidson et al (1991), however, could not use this as an explanation since the words in their study were not phonologically regular. They therefore hypothesised that their gain scores could have been caused by the *motivational* value of the system, using the arguments of other researchers who suggested that learning with machines may be less stressful than with another person. Davidson et al (1991) therefore argued that:

*The efficacy of the system for failed readers would seem an appropriate line of research. Further work is also necessary in order to find out whether these findings can be replicated at all levels in the primary school* (Davidson et al 1991, p.117)
5.3 The computer as a motivational tool

It was noted by Riding and Weston (1986) that there appeared to have been little work done on the motivational impact of computer-presented learning, the authors suggesting that an important element of motivation was the degree to which the pupil became actively engrossed in the success of their activities and the type of feedback they received on performance. The research examined some of the feedback factors affecting this performance. Forty pre-school children were randomly allocated to four groups, with Groups 1 and 2 receiving a story after which they did some activities loosely related to the story. In receiving feedback, Group 1 received positive responses for correct answers (a smiley face and a tune), and negative feedback for an incorrect answer (a sad face). Group 2 received the positive feedback but not the negative. Groups 3 and 4 did not receive the story whilst Group 3 got both feedback types and Group 4 only the positive. Table 8.2 summarises this information:

<table>
<thead>
<tr>
<th>Story</th>
<th>Feedback</th>
<th>Boys</th>
<th>Girls</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>😊 only</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>No</td>
<td>😊 and 😞</td>
<td>4</td>
<td>3</td>
</tr>
</tbody>
</table>

The researchers found a three-way interaction between the type of feedback, the presence of the story and sex on the performance on the activities which were set, performance being superior when the story was given and where both positive and negative feedback were provided. In the condition of the feedback which omitted the sad face for a wrong answer, the presence of the story improved performance for girls but not for boys. The researchers concluded that:

*the use of a character with whom the children can identify and whom they seek to help and please has a motivating effect and generally improved performance.* (Riding and Weston 1986, p 317)

They were also sure that the computer is a particularly effective medium for delivering this kind of feedback.
6. CAL, SYNTAX AND DEAF CHILDREN

If there is a lack of effective computer assisted learning software for 'normal' children, and also a dearth of evaluations of its effectiveness, the situation is even worse as far as hearing-impaired pupils is concerned. Over ten years ago, in a national survey of microcomputer programs in the USA, Rose and Waldron (1984) found that there was a need for more instructional software, particularly in the areas of reading and language training. One of the problems is that, in many cases, instructional software used with deaf children has not been specifically designed for them, but for hearing pupils. Behrmann (1984) reported, for example, that early US programs in the 1970s were not designed with deaf children in mind, and more recently, in the U.K., Wildig and Brendlow (1992) reported examples of teachers having to modify existing instructional software by, for example, adding graphics, to make it more appropriate for use by hearing-impaired children. The next sections examine critically some of the problems with research programmes designed to evaluate educational software for deaf children.

6.1 Lack of research evidence

Braden and Shaw (1987), working in the USA, reviewed the literature on 287 references, describing computer applications with deaf children. Notably, 91 per cent of the references were found to be primarily descriptive or rhetorical, only 9 per cent attempting any sort of evaluation of the efficacy of CAL. Most of the 16 studies that evaluated CAL in terms of its academic instruction, concluded that it had a positive impact on academic achievement. Only three reported no positive effects and none reported negative effects. What raised concern, however, was the fact that the quality of the research methodology was inversely related to the degree of CAL effectiveness, i.e., where improvements on task performance had been measured (r = 0.69; p<.003). None of the studies yielding positive results used a control group or tried to control for possible instructor bias. Conversely, two of the three studies that concluded that CAL is not more effective than traditional instruction did use a control group. Braden and Shaw (1987) therefore concluded that:

There is no reason to believe that CAI is a panacea for deaf children, and in fact, there is no evidence to suggest that it is anything except an instructional placebo. (Braden and Shaw 1987, p. 191)

Furthermore, they argued that there is insufficient research of the negative effects of CAL. It may be the case, for example, that CAL produces reduced social interaction amongst children or between children and teachers.

Serving to confirm Braden and Shaw's (1987) arguments, Rose and Waldren (1984) discussed packages used to help deaf children with reading and writing skills including Writer, Findword and Catchup (see below), but no evidence was provided of how effective these programs are in practice. In examining examples of the kinds of software used in teaching deaf children, most of them seem to come into Williams' (1986) classification of electronic worksheets or games. Evidence in the literature about the effectiveness of any of these program is sparse.
The research of Rubinstein, Cherry and Small (1993) found that computer assisted learning, in this case using the platform of interactive video, made no significant difference to improving the auditory/visual speech recognition skills of deaf people (post-lingually deaf adults), compared with the results produced by a regular class teacher. The interactive video program allowed the learner to view and hear a recording of a speaker reading a phrase of sentence, and to receive feedback (a text display, with errors identified) at four different levels of comprehensiveness, after the third attempt, all words being displayed. The control group did not receive feedback on the accuracy of their responses until the third presentation, yet still their results were no worse than those of the experimental group. Rubinstein, Cherry and Small (1993), however, did not reject the use of interactive video despite these results, arguing that the medium might allow for more individual sequencing based on their responses to computer prompts, and the computer can monitor student progress. It is therefore too early to rule out the use of interactive video for training hearing-impaired students.

A computer assisted learning program designed by Mertens and Rabiu (1993) also, through inadequate research design, failed to offer firm evidence that CAL is an effective learning medium for hearing-impaired learners. They used a CAL package for a pre-service educational psychology class for deaf trainee teachers, to examine the effectiveness of CAL as a medium of instruction and its effect on the attitudes of students towards using the medium. The results of the research claimed to have found significant gain scores, but the authors were forced to concede that firm conclusions were not possible because CAL was not compared with the learning effects of another medium. Similarly, Prinz and Nelson (1985) succeeded in achieving gain scores for a group of deaf students using Alpha Interactive Language Series program, a vocabulary-building package. Test results showed gain scores over a 32 week period, but no control groups were used in the experiment.

Ward et al (1985) evaluated the effectiveness of a set of programs in which the user responds to a set of finite-state grammatical statements about graphics presented on the screen. In one of the programs, three boxes of different colours were displayed and the user was asked to comment on the position of various triangles and crosses; for example, 'Where / is / the triangle?' or 'Is / the cross / in / the green box?' The program's vocabulary consisted of 13 words and phrase units (separated by strokes as in the above sentences) with which 62 grammatically acceptable sentences could be constructed. The researchers selected six hearing-impaired children with a mean chronological age of 14 years 2 months and a mean reading age of 7 years 1 month, and gave them the program to work with for one hour per week for 12 weeks. The pupils worked individually in the presence of either an experimenter or a teacher. (The possible confounding effects of different adult assistants in this experiment was not acknowledged.)

Results showed that syntax errors occurred in 45 per cent of pre-test and only 25 per cent of post-test phrases, the number of qualitatively different types of error falling from 27 to 16. The researchers, however, point out that this only suggests that the software may have assisted learning, it does not conclusively confirm it. No control group was used since the researchers thought it unlikely that, with profoundly,
prelingually deaf children, a 20 minute experience in the pre-test would produce measurable improvements in the post-test three months later. But one very useful element of the research design was that syntax diagrams were found to be especially liked by both subjects and their teachers. Subjects were able to trace through the syntax network charts to check on the construction of, for example, an 'is' type of question.

6.2 Syntax programs for deaf children

The *Catchup* project, described by Lees and Chapman (1986), is a tool designed to help deaf children in learning to read, comes in two stages: initial reading (vocabulary) and understanding comprehension and syntactic forms of English, especially elements of language such as the passive voice and subordinate clauses. Lees and Chapman (1986) cited the example of how the program can be used to teach subordinate clauses with the use of a concept keyboard overlay, as illustrated in Figure 8.3, and the authors were able to produce over twenty descriptions of each picture. Taking the top left picture as an example, 'The circle, which has got a triangle in it, is above a square', or 'The circle, with a triangle in, is above a square', or alternatively, 'The triangle, which is in a circle, is above a square'. Given a particular phrase by a teacher, the child then has to decide which picture it alludes to. But as Lees and Chapman (1986) made clear, the purpose of this program is to test knowledge of syntax, not to teach it, the latter being left to the teacher. The authors were able to conclude that syntactic problems were usually corrected by intensive use of the scheme, but no formal evaluating the program was carried out to justify this assertion. Yet they recognised the motivational aspect of the computer assisted program:

![Figure 8.3 Example of a keyboard overlay for use in teaching comprehension of subordinate clauses (Lees and Chapman, 1986, p.12)](image-url)
All children enjoyed using the scheme and were extremely reluctant to end their turn (Lees and Chapman 1986, p. 15)

7. MAKING THE COMPUTER AN ACCEPTED TEACHING TOOL

Computer assisted learning has been greeted by some commentators as something of a panacea for classroom instruction (Beech, 1985; Williams, 1986). Overall, however, it has been widely acknowledged that the promise of the computer as a teaching tool has not fulfilled initial expectations, largely because many programs have never got beyond the mechanical drill and practice level (Elder et al, 1983; Dodds, 1984; Hawkridge, 1987; Hope, 1987). Yet computer assisted learning has remained popular because there seems to be an automatic assumption that because of the technological sophistication of the medium itself, it ought to be effective (Williams 1986; Braden, Shaw and Grecho, 1991). Unfortunately, there has been a paucity of research into whether this is the case, and where studies have been carried out the results have not been encouraging (Alessi and Trollip, 1991). A study which examined whether computer assisted learning was simply as good as, or even better than, another instructional medium in teaching, say, elements of transformational syntax, would, therefore, be achieving something which is fairly unique, and something for which other commentators have called (Hope, 1987).

In principle, special need groups may receive greater benefits from CAL than for non-special needs groups partly because of the opportunities for over-learning and practice in non-threatening situations (Budoff and Hutton, 1982). But just as in mainstream education, with special needs teaching there is a lack of research into the impact of computer assisted learning programs (Wright and Anderson, 1987). Where research has been carried out, either the results have been inconclusive, contradictory, or there are facets of the research design which call its findings into question.

Deaf children have been selected as the target population for this study partly because it was felt that they are a particularly disadvantaged group of learners and therefore, in a sense, meriting assistance (Chapter 5), and partly because the reliance of many of this group on using visual images rather than acoustic signals for encoding (Chen, 1976; Conrad, 1979; Cooper, and Arnold, 1981), may make the computer a particularly appropriate delivery medium. This is because the computer can present coloured and animated pictorial images which may facilitate the cognitive processing capabilities of deaf children. Instructional formats consisting mainly of pictures (but reinforced by some text) may produce better task performance in reading (both completion time and accuracy) than those which consisted entirely or largely of print (Reynolds and Booher, 1980). The graphics capabilities of the microcomputer may be important in benefiting the thinking, language, and reading skills of deaf children (Rose, and Waldron, 1984) while the visual and graphic-pictorial information may be an effective way of teaching concepts (Waldron, Diebold and Rose, 1985). Yet, graphical information itself may be inadequate as a source of information if depicting dynamic events, because it fails to convey the episodic nature of a story and hence the story schemata, noted by Banks et al (1991) as being important for deaf children in comprehending the
meaning of stories. Hence, the possibility of animating elements of a story through
the computer could have a significant impact on the understanding of story schemata
and therefore on information processing and understanding of syntactic structures.

Deaf people have also been chosen for this study because one of their primary
linguistic problems, the use of syntax, may lend itself to instruction through
computer assisted learning. It was noted in Chapter 7 that Fyfe et al (1993)
hypothesised that there are optimistic grounds for believing that the computer could
be a valid medium for the delivery of instruction on syntax to hearing-impaired
children. If a program were designed which achieved a significant improvement in
performance compared, say, with the achievements of children taught by traditional
live teaching methods, then this study would add an important contribution to the
literature, and correct at least two erroneous assumptions this chapter has sought to
highlight. Firstly, that the computer is, in all circumstances a teaching tool which
produces greater cognitive understanding of material than if the same material were
learnt by other means, and conversely, that its powers have been exaggerated and
that it is incapable of delivering such instruction in any situation.

Computer assisted learning may also be particularly effective with deaf pupils
because of the infinite patience of the medium. It was pointed out in Chapter 5 that
most deaf children are now integrated into mainstream schools in the UK. Yet there
is some concern that they may have difficulties coping with the demands of the
National Curriculum, partly because there is insufficient individual teacher attention
given them in already over-crowded classroom (Gray, 1993). A teaching program
which provided ample opportunities for practising specific skills could be of great
benefit to children who face the threat of isolation and retarded progress. It is also
possible that the use of computer assisted learning, by being a patient and non-
threatening tutor (Budoff and Hutton, 1982; Webster, 1989), and generally being
liked by many students (Elder, 1983; Olson, Foltz and Wise, 1986; Mertens and
Rabiu, 1993) could have an important impact on the motivation of hearing-impaired
children, as long as the type of feedback given is appropriately designed (Riding and
tasks difficult and that they are easily distracted, but that computer assisted learning
programs kept their attention for periods of up to 30 minutes.

Finally, we have seen that many mainstream teachers, whilst not in principle hostile
to the needs of hearing-impaired children, are somewhat reluctant to accept them
into their classes (Sellers and Palmer, 1992). The research may show whether the
introduction of a computer assisted learning package for deaf pupils which produces
improved gain scores in learning an element of transformational syntax, makes any
difference to teachers attitudes towards the integration of deaf children. It would
also be an opportunity to see whether the reluctance of teachers to use
microcomputers (Boyces, 1991) could be reduced, if the effect was to smooth the way
for the integration, not only of hearing-impaired children into the mainstream
classroom but of the microcomputer, as a teaching assistant and resource. Lastly,
the study may shed some light on the debate on whether it is possible to teach deaf
children elements of language and the extent to which their cognitive processing is
different. If the program, through patient (and if necessary repetative) delivery of
material succeeds in improving gain scores, this may mean that their cognitive processes are little different to those of hearing children but that only perseverance is needed. If this is the case, then the delivery of learning through the medium of the computer may be lend more credibility because of the medium's ability to provide a 'safe' learning environment in which repetition and over-learning can take place.
CHAPTER 9
The Epistemology of Knowledge

1. INTRODUCTION

The purpose of this Chapter is to look problematically at the research design of this project in the light of questions that have been posed about the nature of knowledge and the role of the researcher in seeking it. In doing this, it examines the nature of educational research, showing that, while attempting or purporting to be objective, all research takes place within the parameters of the existing social and political system. It is for this, and other reasons, that research questions, methodologies and techniques tend to reflect the prevailing interests of specific social groups, not least of which are researchers themselves. The Chapter also examines the various research paradigms that have emerged and places the role of this research project within one of them.

2. THE NATURE OF EDUCATIONAL RESEARCH

Chapter 10 on Research Design, which follows, sets out a methodology which aims to elicit research data from a study on the effectiveness of a computer assisted learning program in teaching elements of syntax to deaf children. In doing this, it attempts to use various techniques for controlling potential confounding variables so that the outcome of the research will be as objective as possible. In adopting this approach, the project is following a long tradition in social science research which has attempted to emulate the natural sciences by producing quantifiable, objective data. Since social science is dealing with unpredictable and complex human beings this objectivity, however, is difficult to achieve. But even if it did manage to successfully control the kinds of extraneous variables sometimes achieved in natural science experiments, this would still not necessarily make a social science experiment (like the one planned) objective. As Popkewitz (1984) pointed out, science purports to be objective, but the concepts we use to look at reality are only an approximation of that reality.

Further, the particular dialects of science provide a structure to how we conceive of and interpret data: all data collection and analysis emerge from some theory about what the world is like and about how the phenomena of that world (the 'facts') are to be given coherence. (Popkewitz 1984, p. 8)

Science can be seen as an occupational community, and the knowledge of social science, the knowledge of a particular social group. There are, for example, other
ways of looking at the world as well as the scientific – folk knowledge, for instance. So to say that only scientific knowledge has value is to indulge in ideology, legitimising one social group (in the case of this project, university researchers) as the arbiter of human knowledge and responsibility. This view has been supported by Barton (1988) who argued that there is a dominant orthodoxy which supports a narrow interpretation of what constitutes legitimate research including what counts as an appropriate topic of enquiry, the kind of questions to be examined, the methodology to be employed and the sorts of interpretations offered.

Concern over instruments of measurement, the precision of scientific language, the question of theory, tend ... to obfuscate questions about the relationship of ideology and politics to the research question. (Barton 1988, p. 79)

Popkewitz (1984) also suggested that science does not reside in independent existence from the rest of the world, but within its institutions, linguistic conventions and priorities. Hence the very language of science contains assumptions and stances that reflect the strains and struggles of the larger world. In this sense, as well as those already mentioned, science cannot be divorced from partisanship. Indeed, science can have a function of providing symbolic coherence in periods of social, economic and political upheaval. In the 1930s, for example, the dominant sociological paradigm was structural–functionalism which adopted a posture accepting the institutions in society that were being strained by worsening economic and political conditions. Thus scientific investigation can act as a vehicle for the legitimisation of prevailing conditions.

In much educational research, for instance, administrational structures are taken-for-granted and therefore remain unscrutinised and uncriticised. Thus, issues of school failure get laid at the door of families or individuals rather than the institutions themselves. Similarly, it could be argued that many of the problems faced by deaf children are attributed solely, or largely, to deafness (hence the painstaking references to degree of hearing loss in the literature) rather than interaction between their disability and other variables (social class, type of school and teaching methods being just some of them). Indeed, the author has been unable to find any UK research which has examined the interaction between deafness, social class and academic achievement (in contrast to the plethora of research going back many years on the effects of social class on the academic attainment of 'ordinary' children).

In planning this project, there has been an attempt to present the author of the research as a neutral observer, interested only in the 'objective truth' of the research exercise. Yet, as Popkewitz (1984) suggested, neutrality may be the belief and the hope of researchers but it is itself a value stance. Research techniques emerge from a theoretical position and so reflect the beliefs, values and dispositions towards the social world. He cited as an example conventional statistical techniques which are based on Euclidean geometry which has a linear conception of time and space. The choice of techniques involves a moral responsibility, especially in social science research since the subjects of this research are human beings.
Social inquiry also has ideological implications since it not only describes but can also give direction to how events are going to be challenged. Hence, it can also help to define political, social and educational problems, which in turn tends to favour some social groups and handicap others through the underlying definitions of power contained in the research. Indeed, as Barton (1988) argued:

*Research is not a value-neutral activity. It is a social experience in which the subjects of research can suffer and perceive particular forms of study as oppressive.* (Barton 1988, p. 91)

He suggested that this can only be avoided if the subjects of research are involved in decisions about the choice of topics for investigation and the uses to which the findings are put. This view has been echoed by the experience of Baker-Shenk and Kyle (1990) who believed that if these issues are not addressed, the validity of supposedly objective results can be called into question. Too often there has been an implicit assumption amongst researchers in deaf education that it is their role to 'cure' deafness and to ensure that the child comes to identify with the hearing world. They offer hope, however, by pointing to research carried out over the last 15 years into sign language, which has investigated issues with deaf people rather than on deaf people, bringing them into contact with the substantive research issues.

Yet, while these arguments may have some validity when dealing with adults, it is difficult to support them whole-heartedly when the subjects of research are young children. This is not to argue that children have no rights, or that activities should be forced on them for the sake of perversity, but that some forms of learning (syntax, for example) are inherently important for the child's 'life-chances' and therefore essential, whether the child recognises this, at the time, or not. Yet Barton (1988) was right in arguing for the importance of not making the research seem oppressive to it subjects, and it is for this reason, amongst others, that the decision was taken to make the CAL learning program as vibrant and interesting as possible. In this sense, it was hoped that, while being part of an experiment, the subjects would be enjoying themselves, and not see themselves as the passive objects of research. At the same time, the views of pupils on the interest and worth of the program will be sought and they will even have the opportunity to assist in its design by commenting and discussing early prototypes of the course. Pupils will also have the right to disengage from the program and choose not to co-operate with it if they wish. Of course, if this happens, the reasons for this rejection of the course will be sought, if the pupils are willing to offer this information.

It will be noted (Chapter 10) that an attempt has also been made to observe Barton's recommendations by including a survey of teachers' attitudes to the use of computer assisted learning as a teaching medium and to the choice of syntax as a valid area for research. This is an attempt, not to use educational resources to legitimise what goes on in schools (as Popkewitz (1984) claimed), but to engage the interest and commitment of teachers and to challenge and offer alternatives to current approaches to teaching.
In doing this, the research is following the advice of Wood (1981) who suggested that the training, objectives and experiences of researchers and teachers are so different that teachers often find the analyses and recommendations of researchers irrelevant, abstract or worthless. Researchers can make completely false hypotheses and fail to make appropriate deductions if they fail to listen to classroom teachers of deaf children. In one classroom study, for example, the researchers believed the deaf children were incapable of 'normal' behaviour, whereas the teacher thought the opposite. Only after months of argument from the teacher did the researchers decide to analyse their videotapes of classroom teacher-child interactively with the sound turned off. The result was that they were able to notice, for the first time, the level of non-verbal routines, similar to that of hearing children. Thus, by recruiting a teacher as an evaluator of research findings, the team came to different conclusions and a new set of hypotheses. Furthermore, it shows that gaining the co-operation and confidence of teachers is vital if the results of research are going to be translated into educational practice in the classroom.

3. PARADIGMS IN EDUCATIONAL SCIENCE

Popkewitz (1984) pointed out that scientific study contains many underlying and conflicting assumptions about what constitutes social facts, but the power of these assumptions is that they do not appear as such, but are contained in the customs, and conventions (paradigms), of research. From Popkewitz's descriptions of three alternative paradigms, it is clear that the approach of this study falls into the categories described as empirical-analytic and symbolic science. The reasons for the research being positioned in two different paradigms is that it serves two different purposes. As shall be made clear, one element of the research, concerned with measuring changes in the skills and performance of hearing-impaired children, belongs to the empirical-analytic paradigm because it is attempting to produce changes in the cognitive domain (Gagné, Briggs and Wager, 1992) and results that are generalisable to a broad spectrum of hearing-impaired children.

Popkewitz argued that the empirical-analytic paradigm is the dominant one in Western culture and sees the purpose of study as similar to that of the physical or biological sciences. Social affairs are believed to contain law-like regularities which can be identified and manipulated, just like objects in the physical world. As Zylbersztajn (1983) pointed out, this itself follows a long tradition in the physical sciences of empirical-inductivism whereby universal knowledge was to be obtained through large schemes of research, from which knowledge would be extracted from the data.

Following this tradition, the empirical-analytic paradigm sees research as based on five interrelated assumptions:

a) Theory is universal, and not bound to a specific context.

b) Science is disinterested and therefore independent of the goals and values which people may express in a situation.
Hearing-Impaired Children and CAL

Epistemology of Knowledge

c) The social world exists as a system of variables which are distinct and separable parts of an integrated system; teaching, is thus reduced to specific variables that can be measured independently, and that by identifying variables, the cause of specific behaviour can be established. Variables can also be manipulated to produce predictable outcomes typically defined as: 'If X occurs, then Y will be the effect'.

d) A belief in formalised knowledge, making clear the variables of inquiry prior to research, and to show how one variable can affect another.

e) A reliance on mathematical techniques to test hypotheses and make deductions.

It is acknowledged that the research design set out in Chapter 10 is strongly influenced by this paradigm. There is an implicit objective, for example, to produce results (such as gain scores from the effect of the CAL program) that can be generalised to other hearing-impaired audiences. The use of dependent and independent variables are clearly described in section 2 of the same Chapter, with these variables being made explicit prior to the research exercise itself (as in d), above.

In contrast, another part of the research is concerned with the attitudes of pupils and teachers, that is, it is dealing with the affective domain (Gagné, Briggs and Wager, 1992), for which the Symbolic science approach seems more appropriate. This is because symbolic science sees social life as being created and sustained through symbolic interactions and patterns of conduct, with rules made through the interactions of people (in this case the interactions of the researcher with both teachers and pupils). Rather than making these the 'facts' of science (as in the empirical-analytic approach), they are seen as arising out of negotiation in social situations in which people reciprocally define rules about appropriate behaviours. The goal of theory shifts from a search for lawlike 'facts' to a focus on interaction and negotiation in social situations where people define expectations about appropriate behaviours. Just as the empirical-analytic approach sees 'intelligence' as mathematically measurable, symbolic science sees people as mutually defining the characteristics that 'make' for intelligence and assign categories to describe those elements. Thus:

The 'objective' nature of IQ scores or achievement testing is not in the innate qualities of the people being tested or of the tests themselves, but in the social agreement that enables people to interpret the test results in a particular way and agree upon the validity of the tests.
(Popkewitz 1984, p. 42)

It can be argued that this approach does have some validity in some aspects of deaf education. We saw in Chapter 2, for instance, that negotiation often takes place between parents and 'authority' figures such as educational psychologists or medical officers on the problems and possible solutions to their child's difficulties (Barton and Tomlinson, 1981; Welton et al, 1982; Sandow, Stafford and Stafford, 1987). Barton and Tomlinson (1981) argued, however, that this is an unequal relationship,
with special needs becoming the rationalisation by which people who have power, use it to define and influence the educational system.

Popkewitz's (1984) third paradigm is critical science in which the goal is to demystify the patterns of knowledge and social conditions that restrict our practical activities. It thus aims to understand the relations among value, interest, and action in order, not just to describe the world, but to change it. Just as the empirical-analytic paradigm defines 'system' as independent sets of variables, critical scientists try to understand the totality of systems and how they interrelate.

But it is not the negotiation of categories, the establishment of a classification system, or the demystification of, say, 'literacy' that this research is concerned with. The syntactic performance of deaf children is not a negotiated phenomenon but a measurable one and therefore is more appropriately dealt with by a paradigm based on measurement. Similarly, while the concept of literacy can, indeed, be viewed problematically (for example, who defines literacy and why?), this is not the central focus of the research project, so again, the empirical-analytic paradigm is by far the most appropriate for this particular research exercise.

As Kuhn (1970) has noted, however, paradigms shift, and it is the contention of this project, that the paradigm concerned with computer assisted learning, around which a consensus has developed that this is an effective instructional medium, needs examining problematically. Kuhn (1970) described a paradigm as:

> [w]hat members of a scientific community share, and, conversely, a scientific community consists of men who share a paradigm.

(Kuhn 1970, p. 176)

Normal science consists of extending the knowledge of the facts that the paradigm suggests are especially important, by extending the match between those facts and the paradigm's predictions, and by further articulation of the paradigm itself. But normal science is a puzzle-solver and if it persistently fails to solve problems then the failure of existing rules will lead to a search for new ones. This is part of what Kuhn (1970) has called the paradigm crisis. It is a crisis which may turn into a revolution if anomalies continue and new people enter the field, researchers who are not committed to the traditional rules of normal science and who are able to conceive of a new set of rules. The examination of the effectiveness of computer assisted learning, therefore, if it proves negative, will add to the body of knowledge that is sceptical of the claims made for the medium. Conversely, if the findings are positive, it may add to the very small body of research which has produced similar findings. In a sense therefore, this project may, depending on the results of the research, either challenge or support the paradigm surrounding the effectiveness of the computer as an instructional medium. It will therefore either add to the deliberations of normal science or, if negative in outcome, possibly play a small part in creating a crisis, and in the longer term, even a paradigm shift.
4. MOTION AS EDUCATIONAL CHANGE

One of the prime objectives of this research project is to see if learning through CAL can be an effective instructional medium, and, if so, how its use can be disseminated and utilised effectively. In essence, it therefore seeks to assist in the process of educational improvement and change. Yet, as Popkewitz (1984) suggested this kind of belief in reform is a consistent theme underlying Western culture and it is a process which has become the prerogative of professionals who are seen to possess the technical knowledge to provide remedies for the problems of society.

*The intellectual qua expert maintains his (sic) position by the continual effort to find the errors of our ways and to offer the routes to salvation for a people who can never obtain perfection.*

(Popkewitz 1984, p. 130)

The way in which scientific theories are transformed into educational practices are explained by two approaches: the centre-to-periphery, and the problem-solving. Both these models of change are regarded as 'neutral', but both models only make sense when considered in relation to general social relations. Based on Popkewitz's descriptions, it seems that it is the centre-to-periphery approach which most closely fits this research project.

The centre-to-periphery approach assumes that logical and universal procedures exist for creating organisational change, and that these can be identified through some centralised research effort. The approach is generally seen as having four stages:

a) Initial *research* identifies, conceptualises and tests ideas, independently of practice.

b) *Development* helps create a programme of suitability for schools.

c) Information about the programme is *disseminated*.

d) Through *adoption/installation*, the programme becomes accepted.

The very language of this approach suggests order, clarity and objectivity. Change is see as directional, cumulative, irreversible, structured into stages and purposeful. But, according to Popkewitz (1984), in assuming this, the centre-to-periphery approach takes for granted the structures of the institutions it is examining, and by doing so, proposes solutions which fail to address the real need for change.

The problem-solving approach sees the identification and development of innovation as lying with people involved in concrete situations. Thus school staff are encouraged to identify problems, design solutions and become trained in procedures for solving difficulties. Again stages are involved including:

a) becoming aware of the need for change

b) diagnosing problems
c) examining alternative solutions

d) formulating plans for change

e) generalising and stabilising the change

Both the problems-solving and centre-to-periphery approaches rely on a change agent, who is seen as bringing deliverance to the social world, and getting participants to see the need for change. But, according to Popkewitz (1984), the role of the change agent is, in practice, manipulative, praising those who support change and condemning those who oppose it. This situation, however, may not necessarily be true if school staff highlight their problems themselves and employ the change agent. The problem with this piece of research is that the researcher is seeking out teachers to co-operate in the research exercise, and, in doing so, is in danger of defining both the nature of the problems and the solutions. It is best, therefore, that, in seeking the co-operation of teachers, their views are gleaned on the nature of the problems facing hearing-impaired children and how they view potential solutions.

It seems that this research stands between Popkewitz's (1984) descriptions of the centre-to-periphery and problem-solving approaches. It is centre-to-periphery in the sense that it attempts to introduce changes to instructional strategies through a centralised research effort, but close to the problem-solving approach in that it attempts to involve teachers in identifying problems and designing solutions. Yet, while accepting Popkewitz's description of the centre-to-periphery approach as being one fitting this research exercise, it is difficult to agree with his conclusions that the research takes the structures of education for granted or that it is not radical in its conception. On the contrary, as Chapter 8 seeks to make clear, it is a blithe acceptance of computer assisted learning as being an effective instructional medium which is part of the consensus. This piece of research is almost unique in trying to quantify whether gain scores in performance can result from computer assisted instruction or whether the medium is indeed, in Bradon and Shaw's (1987) words a 'placebo'. Furthermore, it seeks to use the medium to improve the syntactic competence of hearing-impaired children which is acknowledged (Quigley and Kretschmer, 1982; Webster, 1988b) as being particularly difficult to develop. This is, therefore, in a very real sense, addressing the need for change.

5. THE RESEARCHER AS A SOCIAL ACTOR

According to Popkewitz (1984), just as no theory is neutral, the researcher's role is far from objective since he/she creates the illusion of societal cohesion by representing the particular interests of disparate groups as being those of society as a whole. This role is essentially reformist. Thus, intellectuals have emerged as professionals of the 'helping' occupations such as teachers, psychologists and social workers. The label 'professional' gives these occupations status and legitimacy and also allows them to describe, organise and prescribe the boundaries of possible social relations for their clients. In this sense, the role of the professional occupations may involve techniques of social manipulation. For example, labelling
someone as gifted or disabled, brings to bear social values of what it is to be 'good'
and 'bad'.

Gifted or disabled are not categories rooted in science per se but
definitions arrived at through cultural negotiations among competing
interests in schooling and society. (Popkewitz 1984, p. 190)

Indeed, as we saw in Chapter 2, Barton and Tomlinson (1981) claimed that 'special
needs' is merely a rationalisation through which those people who have power
(teachers, educational and clinical psychologists) define the special needs system in
their own interests. In defining categories, the individual is no longer responsible for
the construction of reality but has it characterised and certified by licensed groups.
This is not to reject all research paradigms, but to recognise that our enquires should
be part of a general historical scepticism and social philosophical awareness which
recognises the complexity of our social and psychological condition.

These views certainly have some support amongst some commentators on special
needs and deaf education. Squibb (1981), for example, argued that there is no such
thing as 'essence' and that the nature of things lies in their relationships. So
phenomena must be seen as wholes or part of wholes. Thus, the categories put on
children should be seen, not as objective facts, but operating through a matrix of
social structures, the definition of these categories therefore being problematic. The
fact, for example, that in some areas of the UK black children are over represented
in (what were termed) Educationally Sub-Normal schools, may have more to say
about society and schools than it does about black children (Coard, 1974).

Squibb (1981) further argued that a child is not 'special' until so defined. This
process emerges within the structures of the school, classroom, consulting room,
magistrates court and the curriculum – or in the interaction between teachers and
pupils. The special child is thus the product of structured social forces, the
influences on these forces often being disguised by purportedly objective and
scientific tests. For example, in the 1960s to mid-1970s the number of children
designated as 'maladjusted' more than doubled. This could be explained, say, by
changes in the physical environment affecting the behaviour of children, but equally,
since there is little evidence that these changes were dramatic (or for the worse), it is
just as, if not more, possible, that the increased use of more tests for 'maladjustment'
brought about an increase in the 'discovery' of this phenomenon.

Oliver (1988) saw a historical continuity in the way in which categories are used to
lay the blame on individuals rather than society.

There is a sense in which the history of special education can be seen
as a social construction, or rather, a social reconstruction of the
problem. From the introduction of categories such as 'idiots and
imbeciles' in early legislation, through the medical categories of
1944, to special educational needs in 1981, it could be argued that
only the labels have changed; the under-lying reality of an education
system unable or unwilling to meet the needs of all children remains
the same. (Oliver 1988, p. 20)
The problem, according to Oliver, is that redefining categories is limited to the level of changing attitudes to disability. But like racism and sexism, disablism is institutionalised, that is, it exists, independent of the attitudes and values of individuals or groups. It can therefore be solved, not at the level of changing attitudes, but by wider, structural and political changes.

While Oliver's arguments may have some validity in the way in which various behavioural 'disorders' are characterised, there seems less strong grounds for treating hearing-impairment in this way. Deafness is a physiological fact, not one construed by teachers or professionals. Where social construction may occur is in the way professionals (such as teachers and educational psychologists) construe the impact that the disability is likely to have on, for instance, learning, and in turn, the instructional recipes they prescribe to address these problems.

Booth (1988) suggested that professionals who care for the disabled often misunderstand their own power, acquiring a set of guiding principles which amount to 'culturally inherited prejudices' (p. 103). Deaf people, for example, are pressured to acquire oral English:

*The idea that educators of the deaf and young deaf people themselves should lower their educational sights to such an extent that acquiring spoken English is their major educational ambition is absurd.....If it is successful, education provides a source of enjoyment, a discovery of interests, a knowledge of cultures and the means to continue to develop and control one's own life. The learning of languages may be part of such a process and can be assessed in relation to it but cannot replace it.* (Booth 1988, p. 111)

The problem with this view is that it distorts the arguments used by oralists to support the teaching of oral English. Their case is not that oralism should be taught as an end in itself, but that it, if successfully acquired, can be a route to a knowledge of cultures and controlling one's life - precisely the kinds of objectives Booth (1988) supports. It was for this, amongst other reasons, that the subject of syntax was chosen, because it will assist, in the long run, with spoken and written English. In doing this, there is no implicit assumption that oralism is necessarily the answer for all deaf children. Many will, in later years, develop the signing skills they have already acquired, or abandon oralism and take to signing for the first time. As young adults this is their right. Equally, however, many, and especially those who cope well with oralism, will want to develop this skill in order to function as effectively as possible in the 'hearing world'. The choice of syntax instruction therefore is an attempt to help in this process until they are old enough to decide on their choice of methods of communication and worlds.

6. CONCLUSION

This research is rooted in the empirical-analytic paradigm, but has some strong connections with symbolic science. As part of the empirical-analytic approach, it is attempting to produce measurable, quantifiable results from an experiment on the
impact of CAL learning on the syntactic capabilities of a sample of hearing-impaired children. In doing this, there are implicit assumptions of 'objectivity' and the hope that the results will be generalisable to a wider audience of deaf children. It also seeks to add to the body of research on the effectiveness of computer assisted learning. The danger of research of this kind, however, is that it assumes an air, not only of objectivity, but of infallibility, the researcher standing above the sample audience, delivering enlightenment. This is an elitist position which is best avoided, one way being to elicit the co-operation of teachers of the deaf in planning and evaluating the project (the symbolic science element). Hopefully, this will not only avoid misconceptions and errors, but produced new insights, methodologies and hypotheses.

All research takes place within the parameters of social, political and economic structures, and is subject to the institutional constrictions and priorities of the world. This project is no exception, the choice of research area being significantly influenced by the body of research literature on computer assisted learning and deafness which exists. The danger is that, being influenced by these external constraints, research itself, and the researcher, become conditioned by them, adopting unproblematic stances to the world and the relationship of their research with it.

It is the contention of this project, however, that the stance of this research is not reformist as Popkewitz (1984) suggested, (blaming individuals for their disabilities not the institutions of society), but radical, in that it directly challenges the assumption, implicit in much of the literature, that computer assisted learning is necessarily an effective instructional medium. Unlike most of the research that has so far been carried out, this project seeks to *measure* whether this is the case, and in doing so, break a non-quantitative approach within this paradigm. We saw in Chapter 8, for example, that most surveys of the impact of computer assisted learning make positive assumptions about its worth on the basis of little or no evidence; even where research has been undertaken, methodologies, in most cases, appear unsound. Above all, it attempts to treat the issue of whether computer assisted learning is more effective than, say, live instruction, problematically, instead of assuming (as many seem to within this paradigm) that because of its complexity, the computer must inevitably be a powerful teaching tool. Secondly, it also challenges the idea, implicit in much of the literature on the education of deaf children that a 'learning plateau' exists, beyond which deaf children cannot progress.
CHAPTER 10
Research Design

1. INTRODUCTION

Chapter 7 showed that this thesis is primarily concerned with three (inter-connected) themes. The first is whether a computer assisted learning program, specifically designed to develop skills in the use of syntax, can improve the syntactic abilities of a sample of hearing-impaired pupils. A typical approach to this problem would be to compare these children's gain scores based on the difference between pre and post-tests taken by both an experimental and control group. As this Chapter will attempt to show, one of the difficulties of comparing gain scores is controlling the many potential variables (such as maturation, the instructional effects of the pre-test, etc.) which may confound the research results. Efforts will therefore be made to ensure that this is not the case.

The second theme of the research concerns teacher attitudes to the use of CAL in the classroom. Even if the proposed CAL syntax program is successful within its own terms of improving syntactic performance, this may be an insufficient criterion for success if teachers are either unprepared or unwilling (due, say to technophobia or inadequate training and support), to use such programs. Teacher reluctance is, as Chapter 7 showed, partly because too much software is limited to drill and practice methods, and often confined, at least in teaching English, to basic areas of the curriculum such as vocabulary building. These are programs which tend to deal with memorisation of material. What is needed, however, is programs to inculcate higher level cognitive skills, that is, in Gagné's (1992) terms, problem solving skills that are transferable to new, unique tasks. Furthermore, most software had been written for hearing children rather than deaf, and there were very few cases where teachers had been involved in the design of programs. It is hypothesised that, if the program developed as part of this research effort is built on criteria accepted not only by instructional designers, but also by teachers, then this may influence the attitudes of teachers to the integration of CAL into the classroom and hence the long-term acceptance of the program. Indeed, one by-product of the research may be to show what criteria are most influential in determining whether teachers will use CAL in the classroom or not.

A third theme is the extent to which hearing-impaired children like and are prepared to persevere with learning through the use of CAL programs. Since repetition and reinforcement of concepts may be especially important for this group of children it is
important to discover whether they are willing to concentrate at the computer screen for educationally significant periods of time.

In seeking to address these issues, the stages in research design recommended by Black (1994a) are followed, which essentially comprise a two-stage process: design and execution (see Figure 10.1). Note that at the planning stage there are iterations so that modifications and improvements can be made to the design process. The sections below follow this basic outline, describing each planning stage of this research project in more detail (the execution stage in Figure 10.1 will comprise the latter part of this thesis).

2. HYPOTHESES & QUESTIONS

According to Black (1994a):

_Questions and hypotheses describe potential relationships between and among variables that are to be tested._ (Black 1994a, p. 1–16)

Research questions should therefore be testable and stated in ways which unambiguously define the issues being investigated. These will be resolved employing several approaches, some of them quantitative and some qualitative.

It is important that appropriate research tools are selected for use in testing and evaluating the research questions that have been chosen. Furthermore, the sample population and sample size must be selected. Table 10.1 summarises these items.

The hypotheses and questions outlined in this section involve examining the inter-relationships between a number of different variables such as type of media and teacher attitudes. Section 3 therefore provides a classification scheme for these variables, so that the appropriate variables for this research can be focused on.
2.1. Hypotheses

The main hypotheses are stated with approaches to resolving the hypotheses in parenthesis:

a) There will be a statistically significant difference between computer based instruction and live tuition (both using the same subject matter) in terms of improving the syntactic skills of deaf children. (Comparison of gain scores on pre and post-tests of syntactic abilities.)

b) The use of such a program will have an effect on teachers of the deaf in terms of their tendency to make use of computer assisted learning in the classroom. (Demonstration of computer assisted learning program on syntax to selected sample of teachers of the deaf.)

c) The involvement of teachers in the design and development of the program will make them more favourable to its integration into the classroom. (Evaluation by teachers of the deaf of prototype of computer assisted learning program on syntax, followed by questionnaire on their attitude to CAL.)

2.2. Null Hypotheses

It is also preferable if the hypothesis is to be tested statistically, that it is stated in its null form, that is, it is expected that there will be no statistically significant correlation between the variables under investigation. The following are the three main hypotheses to be investigated through quantitative data:

a) There will be no statistically significant difference between computer based instruction and live tuition (both using the same subject matter) in terms of improving the syntactic skills of deaf children.

b) The use of a program dealing with issues of direct relevance to hearing-impaired children will have no effect on teachers of the deaf in terms of their tendency to make use of computer assisted learning in the classroom.

c) The involvement of teachers in the design and development of the program will not make them more favourable to its integration into the classroom.

2.3. Research questions

A number of questions flow from these hypotheses and are specified at Table 10.1.
Table 10.1 Research questions, research tools, sample size and Chapters in thesis where research questions are answered

<table>
<thead>
<tr>
<th>No.</th>
<th>Research question</th>
<th>Research tool</th>
<th>Sample population</th>
<th>Sample size</th>
<th>Chapter location</th>
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<tbody>
<tr>
<td>1</td>
<td>What criteria are most influential in determining whether teachers of the deaf make use of CAL?</td>
<td>Questionnaire (Appendix 10.1)</td>
<td>Teachers of the deaf</td>
<td>30</td>
<td>Chapter 15</td>
</tr>
<tr>
<td>2</td>
<td>Does this CAL program, designed specifically for hearing-impaired children, encourage teachers of the deaf to use CAL as a teaching medium?</td>
<td>Questionnaire &amp; demonstration CAL program (Appendix 10.2)</td>
<td>Teachers of the deaf</td>
<td>50</td>
<td>Chapter 16</td>
</tr>
<tr>
<td>3</td>
<td>Is CAL considered to be more convenient by teachers/learners?</td>
<td>Pupil Evaluation (Appendix 10.3) Teacher Evaluation (Appendix 10.4) Researcher Evaluation (informal observation)</td>
<td>Teachers of the deaf/hearing-impaired pupils</td>
<td>Pupils: 10 Teachers: 6</td>
<td>Chapter 16</td>
</tr>
<tr>
<td>4</td>
<td>Do learners enjoy using CAL, and what is its impact on learning?</td>
<td>Pupil Evaluation (Appendix 10.3) Teacher Evaluation (Appendix 10.4) Researcher Evaluation (informal observation)</td>
<td>Teachers of the deaf/hearing-impaired pupils</td>
<td>Pupils: 10 Teachers: 6</td>
<td>Chapter 16</td>
</tr>
<tr>
<td>5</td>
<td>Does the CAL program enhance the learning of elements of transformational syntax? With respect to other teaching media, is it more effective in producing planned learning outcomes (for a given time commitment)?</td>
<td>Pre-Test (Appendix 10.5) Post-Test (Appendix 10.6) Test answers (Appendix 10.7)</td>
<td>Hearing-impaired pupils</td>
<td>20</td>
<td>Chapter 17</td>
</tr>
</tbody>
</table>
3. CLASSIFICATION OF VARIABLES

According to Kerlinger (1986) scientists call the various constructs or properties of the things they study 'variables', or in his own words: 'A variable is a symbol to which numerals or values are assigned' (p. 27). So, for example, the variable x, may take on a set of values for scores on an intelligence test or an attitudinal scale. Kerlinger also distinguished between dependent and independent variables which, he argued, are extremely important in conceptualising and designing research and in communicating the results. An independent variable is the presumed cause of the dependent variable, the latter being the presumed effect. In research, one or more of the independent variables may be manipulated by the experimenter, with the resultant changes in the dependent variable measured. In this thesis, as Table 10.2 shows, the main dependent variables are pupil achievement on a test of syntactic skills and teacher attitudes, while the proposed independent variables to be manipulated are teaching resources (text-based materials and a computer assisted learning program).

In doing this, however, it is possible that other extraneous variables such as intelligence or degree and type of deafness may confound the research results. For example, if the selected sample who took the computer assisted learning program happened to contain an unrepresentatively high number of post-lingually deaf pupils, it is possible that their gain scores may turn out to be higher than those who took, say, the text-based materials, and contained a disproportionate number of pre-lingually deaf pupils. This gain might be more an effect of the type of student in the sample than the kind of instructional course they had received. It is vital that extraneous independent variables (those that are not to be manipulate as part of the experiment) are controlled for, by anticipating them. To achieve this, data will be collected in advance and subsequently used to control extraneous variables at the data analysis stage. The measurement of key extraneous variables such as intelligence and type and degree of hearing loss is also important if the results of the study are to be generalisable in any way. It would have to be shown, for example, that the sample of pupils selected for the experiment was representative of hearing-impaired pupils (of the chosen age range) in general.

The research will also attempt to show whether the independent variable of teaching resources has any impact on the dependent variable of teacher attitudes to computer assisted learning and whether the degree of change is related to previous attitude/experience with information technology, the perceived improvement in syntax by the children, or the actual change (if any). It is conceivable, for instance, that the program may have no significant impact on syntactic performance of pupils, but is perceived by teachers to have either performance or attitudinal effects on the children. This itself may shift teacher attitudes to computer assisted learning in a positive direction, especially if they themselves are involved in its design.
### Table 10.2 Classification of the main variables related to the research

<table>
<thead>
<tr>
<th>Variable name</th>
<th>Potential Dependent/Independent</th>
<th>Active/Attribute</th>
<th>Nominal/Ordinal/Interval/Ratio</th>
<th>Indicators</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Extraneous</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Degree of hearing loss</td>
<td>Independent</td>
<td>Attribute</td>
<td>Ratio</td>
<td>Audiological test</td>
</tr>
<tr>
<td>Type of hearing loss</td>
<td>Independent</td>
<td>Attribute</td>
<td>Nominal</td>
<td>Audiological test</td>
</tr>
<tr>
<td>Intelligence</td>
<td>Independent</td>
<td>Attribute</td>
<td>Interval</td>
<td>Intelligence test</td>
</tr>
<tr>
<td><strong>Research</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Entry syntactic abilities</td>
<td>Independent</td>
<td>Attribute</td>
<td>Ratio</td>
<td>Pre-test</td>
</tr>
<tr>
<td>General reading abilities</td>
<td>Independent</td>
<td>Attribute</td>
<td>Ratio</td>
<td>Standardised reading test</td>
</tr>
<tr>
<td>Teacher attitude to mainstreaming of hearing-impaired:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>a) before study</td>
<td>Dependent</td>
<td>Attribute</td>
<td>Ordinal</td>
<td>Questionnaire</td>
</tr>
<tr>
<td>b) after study</td>
<td>Dependent</td>
<td>Active</td>
<td>Ordinal</td>
<td>Questionnaire</td>
</tr>
<tr>
<td>Teacher attitude to CAL</td>
<td>Dependent</td>
<td>Active</td>
<td>Ordinal</td>
<td>Questionnaire</td>
</tr>
<tr>
<td>Factors influencing teacher use of CAL</td>
<td>Dependent</td>
<td>Active</td>
<td>Ordinal</td>
<td>Questionnaire</td>
</tr>
<tr>
<td>Post intervention syntactic abilities</td>
<td>Dependent</td>
<td>Active</td>
<td>Ordinal</td>
<td>Questionnaire</td>
</tr>
<tr>
<td>Convenience of CAL for teachers</td>
<td>Dependent</td>
<td>Active</td>
<td>Ordinal</td>
<td>Evaluation</td>
</tr>
<tr>
<td>Learner enjoyment of CAL</td>
<td>Dependent</td>
<td>Active</td>
<td>Ordinal</td>
<td>Evaluation</td>
</tr>
<tr>
<td>Teaching resources</td>
<td>Independent</td>
<td>Active</td>
<td>Nominal</td>
<td>CAL/live tuition</td>
</tr>
<tr>
<td>Type of school</td>
<td>Independent</td>
<td>Attribute</td>
<td>Nominal</td>
<td>Local education authority designation</td>
</tr>
</tbody>
</table>
Another way of classifying variables is between active and attribute. Active variables are those that can be manipulated, in the case of this research, the types or amounts of training resources (computer assisted learning or live instruction) used. In contrast, attribute variables are those which the researcher has no control over such as intelligence, or type and degree of deafness (see Table 10.2).

A further important way of classifying variables is by putting them into one of the following categories:

a) **nominal** – a name value only with no order or ranking implied (e.g., type of hearing loss).

b) **ordinal** – an ordering or ranking of values, although the intervals between the ranks are not intended to necessarily be equal (e.g., teacher attitudes).

c) **interval** – an ordering or ranking of values in which the intervals between ranks is the same (e.g., intelligence), which includes:

d) **ratio** – where the scale is again interval, but where there is an absolute zero, for example, scores on an achievement test, e.g., of syntactic abilities.

This sort of classification scheme is important because it will influence the ways in which the data is analysed. Having incorporated the variables into a classification scheme, the next stage is to provide them with operational definitions.

4. **OPERATIONAL DEFINITIONS OF VARIABLES**

Kerlinger (1986) suggested that an operational definition of a construct or variable is used to give it meaning by specifying the activities or 'operations' that provide a means by which levels of possession can be determined quantitatively. Alternatively, an operational definition is a specification of the activities a researcher has to undertake in measuring a variable. Their importance cannot be overemphasised because they are bridges between the theory-hypothesis-construct level of scientific study and the observation level. Kerlinger also pointed out that there are two kinds of operational definition: (1) measured which describes how a variable will be measured and (2) experimental which outlines how the experimenter manipulates the variable. In terms of this research, there are three important variables that require a concise operational definition.

4.1. **Deafness**

This requires defining at two levels: (1) **degree of hearing loss**, in decibels, which is measured clinically by an audio metric test, and (2) **type of hearing loss**, which distinguishes between pre and post-lingual deafness. We saw in Chapter 3 that in the UK there are five descriptors of the degree of hearing loss ranging from mild to severe, whilst in term of kinds of hearing loss, pre-lingual deafness is usually considered the most problematic because of its impact on the acquisition of language. For this study, as has been pointed out, details of both degree and type of
Hearing-Impaired Children and CAL

Research Design

Hearing loss will be gathered for each participant in the sample so the confounding effects of this variable can be allowed for in subsequent analysis. In selecting the sample for the research (see section 5, below), any pupil whose degree and type of hearing loss is unknown, will be eliminated from the sample and a replacement selected.

4.2. Intelligence

As we saw in Chapter 3, Conrad's (1979) findings suggested that one of the prime variables influencing a deaf child's linguistic performance was 'intelligence'. This attribute, however, is not especially easy to measure, particularly where deaf children are concerned. As we have seen, Webster (1990) noted, that the validity of traditional tests for deaf pupils may be in doubt because deaf children often tackle test materials in ways that are different to their hearing peers. Furthermore, some tests, because of their reliance on the linguistic abilities of respondents, may be unreliable assessors of general cognitive abilities of deaf pupils. In practice, therefore, teachers of the deaf generally make use of tests of non-verbal ability. Unfortunately, it may be the case that, since the research sample will be drawn from different schools, the kinds of tests they use (if any) are not the same. This may make a genuine comparison of non-verbal ability across the range of pupils impossible and any attempt to control for this variable invalid.

4.3. Reading age

The kind of information which is more likely to be standard across schools is a measurement of the reading age of each child. Since, as we saw in Chapters 4 and 5, reading is such a cognitively demanding activity, this measurement may correlate quite highly with general cognitive abilities. Certainly, this variable should be controlled for since, of course, a high chronological reading age should correlate strongly with syntactic ability.

4.4. Syntactic ability

This will be operationally defined in terms of performance on a test specifically constructed for this research and evaluated in the field (by practising teachers of the deaf) to ensure validity and reliability of questions (for a copy of the tests see Appendices 10.5 and 10.6). Commercially available tests were examined and found to be inappropriate for the purposes of this research. The test devised by Semal, Wiig and Secord (1988), for example, contained only two test items related to the syntactic areas of question formation in transformational grammar. This small number of test items would not provide a reliable estimate of pupil abilities.

It is also hypothesised that attempting to test hearing-impaired children through formal testing methods may be inappropriate and demotivating for some children, especially if they are tested twice – once before the intervention and then afterwards. It is suggested that a better and more subtle method would be to test the children in the form of a 'game'. Hence, the test item booklet will be given this title and the booklet itself made as user-friendly as possible through the use of graphics as well
as text. A summary of some of these key variables and the kinds of measuring instruments they are associated with is given in Table 10.3.

5. RESEARCH DESIGN: COMPUTER ASSISTED LEARNING

5.1. Sample selection

As Black (1994b) has pointed out, all research design models have to identify the populations their study addresses, the selection of representative sample(s), and sometimes the assignment of subjects to groups. He further argued that, especially for quasi-experimental studies such as this one, the sample size may be less of a problem than the representativeness of the subjects chosen for the study. A relatively small sample that has been carefully selected may provide more valid results than a much larger sample that has been carelessly chosen.

The population in this study therefore, is deaf children in the range 7-11 years of age, a population being 'any group that shares a set of common traits' (Black, 1994: p. 3.2). Since it is unfeasible to study all hearing-impaired children in this age range a representative sample of these children must be selected, the main difficulty being to ensure that the children selected are indeed, representative (in terms, say, of intellectual ability, general cognitive traits, linguistic capabilities, etc.) of the population of deaf children of this age. To achieve this, details will be collected of the chronologically tested reading age and degree and types of hearing-impairment. These variables will be controlled for at the data analysis stage of the project. In line with the ethical principles drawn up by the British Psychological Society (1993),

Table 10.3 Variables and measuring instruments

<table>
<thead>
<tr>
<th>Variable to be measured</th>
<th>Measuring instrument</th>
</tr>
</thead>
<tbody>
<tr>
<td>Degree of deafness</td>
<td>Audio metric test</td>
</tr>
<tr>
<td>Type of deafness</td>
<td>Clinical/educational report</td>
</tr>
<tr>
<td>Syntax performance</td>
<td></td>
</tr>
<tr>
<td>a) Deaf pupils after CAL</td>
<td>Achievement test</td>
</tr>
<tr>
<td>b) Deaf pupils after live instruction</td>
<td>Achievement test</td>
</tr>
<tr>
<td>Pupil attitudes</td>
<td>Attitudinal questionnaire</td>
</tr>
<tr>
<td>Teacher attitudes</td>
<td>Attitudinal questionnaire</td>
</tr>
</tbody>
</table>
permission will be sought from the parents of all children in the sample for their children to be included in the study. The precise objectives and nature of the research will also be described so that parents are fully appraised of its intentions and can withhold support if they have any reservations about the purpose of the study.

The danger of this approach, however, is that the sample of pupils selected will be unrepresentative of the whole population of deaf children in the 7-11 age range. An attempt will therefore be made to use a stratified random sample, that is, a sample of pupils from across a wide spectrum of degree of hearing loss, type of hearing loss and level of reading competence. An attempt will then be made to show that this sample is, indeed, representative of hearing-impaired pupils of this age range as a whole.

5.2. Experimental design

As Black (1994b) has shown, one of the challenges of research design is in providing not only an experimental group (from the sample selected), but also a comparison group which does not receive the 'treatment', making it possible to control for both anticipated and unanticipated variables. As a result, inferential statistical techniques can be used to analyse the data. In this research, a quasi-experimental design structure is used because, unlike in a purely experimental design, a completely randomly selected sample would prove difficult to handle from a practical viewpoint.

The quasi-experimental design being used is the one described by Black (1994b) as a non-equivalent control group design with pre-tests. In this experimental design the choice of sample is not random, but from the limited population, the sample group can be randomly assigned between treatment and control groups. This design can be described by the following notation:

\[(R_{A_a}) \rightarrow O_{a1} \rightarrow X_a \rightarrow O_{a2}\]
\[(R_{A_0}) \rightarrow O_{o1} \rightarrow X_0 \rightarrow O_{o2}\]

Here, \(R_{A_a}\) is the group randomly assigned to the treatment group and \(R_{A_0}\) those assigned to the control group. \(O_{a1}\) and \(O_{o1}\) represent the pre-test scores for the treatment and control groups respectively, \(X_a\) and \(X_0\) the treatments they receive and \(O_{a2}\) and \(O_{o2}\) the relevant post-tests.

As Black (1994b) has noted, one of the problems with this type of experimental design is that, because the sample is not truly random, its generalisability may be limited. The case is strengthened if it can be shown that the groups are representative in terms of general characteristics and have been purposively selected for this reason. One objective of the pre-test may be to help ensure the equivalence of the treatment and control groups. In this study, therefore, it must be shown that the sample is representative of hearing-impaired children in terms of degree of deafness (mild to profound) and type of deafness (pre-lingual and post-lingual).
In order to explore some of the issues revolving around the extent to which hearing-impaired children are, indeed, deficient in terms of syntactic ability, it was decided to give a sample of hearing children the research pre-test. This hearing sample would be drawn from one of the schools taking part in the study and would be selected for being representative of the typical age cohort of hearing children. This would be done with the assistance and views of teachers in the school.

6. RESEARCH DESIGN: TEACHER ATTITUDES

6.1. Sample selection

The population for this area of the study is qualified teachers of the deaf working either in deaf units attached to mainstream schools, within integrated classes in mainstream schools, or in special schools which may be specifically for deaf pupils or contain children whose secondary problem is hearing-impairment. Since the purpose of this strand of the research is to measure changes in attitudes as a result of the introduction of the CAL program, it is important that a range of views towards CAL are represented in the sample. Therefore 50 teachers will be selected from the 700 schools in the BATOD Directory (1994). The sample selection is limited to 50 because it is felt that this is large enough to elicit a representative cross-section of views without becoming too large and unwieldy at the data processing stage. It is also limited to this number due to budget and time constraints. Each teacher will be sent a questionnaire (Appendix 10.1) to help establish a baseline identifying the different range of attitudes to CAL within the population as a whole from which to measure any attitudinal changes that occur as a result of the CAL program.

6.2. Experimental design

Once the CAL program is completed, a shortened, demonstration version of the program and a questionnaire (Appendix 10.2) will be sent to a sample of 50 teachers, again, randomly selected by systematic sampling from the database of UK teachers of the deaf. If, during random selection, any teachers are chosen from the original baseline sample, these will be eliminated and replacements randomly selected. This is because there is a danger that those who received the original questionnaire (Appendix 10.1) may have been cued by it as to the possible significance of CAL instruction.

The attitude of teachers of the deaf to CAL will also be elucidated from evaluations of the whole CAL program by those teacher of the RA_3 sample. Since the number involved here is unlikely to exceed 6 people the results are likely to be, at best, indicative of attitudes. Nevertheless, they will be qualitatively more detailed than those received from the wider sample and will be compared with them.

7. DATA QUALITY

In judging data quality it is important that the type of data collected is viewed in the context of the questions/hypotheses it is attempting to answer (Black, 1994). It is
irrelevant, for example, for a researcher to design research instruments which collect statistically significant data, if the research questions being addressed are trivial or educationally, psychologically or sociologically irrelevant.

In terms of the criteria for data quality suggested by Black (1994b), it is contended here that the research question and hypotheses selected for this research (see Section 2) are indeed educationally significant. This is because research has shown (see Chapter 4) that the reading age deaf children achieve at school leaving age is significantly below their chronological age. Chapter 4 also showed that one of the causes of this was the fact that deaf pupils, compared with hearing children, have greater difficulty with a variety of linguistic constructs, the most important one being the use and application of syntax. Chapter 3 also showed that integration could assist the hearing impaired both socially and academically but that the success of this integration is jeopardised by the fact that many hearing-impaired pupils lack the linguistic competence to survive in those mainstream classes that are academically focused. Mainstream teachers may also be ill-prepared to receive deaf children into their classes because they feel they themselves have had insufficient training and because they do not believe they have been provided with sufficient resources to cope. A research programme, therefore, which attempts to provide an example of these resources (a CAL program) teaching an important element of the curriculum (syntax) to deaf children (to assist their education and integration) is held to be of educational significance.

Data quality is also determined by the validity and reliability of the test instruments. In measuring syntactic ability, therefore, a multiple-choice test was chosen because questions can be marked with high levels of accuracy. Attitudinal changes amongst pupils and teachers were measured by questionnaires, but care was taken to ensure that there was a sufficient number of questions to promote the reliability of the measuring instrument. It needs to be acknowledged, however, that there is scant research evidence of how the views of hearing-impaired pupils can be elicited, given the language barrier that inevitably exists between child and researcher. In a sense, therefore, the attitudinal questionnaire for the pupils was not only an attempt to seek their attitudes to CAL, but also an examination of how one can elicit these views. One result of the research might be data on how researchers should communicate with deaf learners in evaluating teaching materials.

8. RESOLVING HYPOTHESES & QUESTIONS

8.1. Ensuring sample representativeness

One of the limitations in using samples in carrying out research, rather than entire populations, is that the sample selected may not be representative of the population as a whole. This is known as sampling error and is calculated by measuring the standard errors of the means. As Black (1994a) has pointed out, any mean which falls within the range of 95 per cent of all possible means in the normal distribution is deemed to be representative. Data was therefore collected on both the degree and type of hearing loss of the children in the population as a whole against which the sample could be compared. Figure 10.2, below, suggests that, compared with a
number of national and international surveys, the research sample for this project is representative in terms of degree of hearing loss. Indeed, it could be argued that the sample is, if anything, weighted more heavily towards those with profound hearing loss. It would seem unlikely, therefore, that if the research sample performed particularly well as a result of the instructional interventions, this was because the pupils tended to be moderately or mildly deaf.

It proved impossible to locate any comprehensive national survey which specified the type of hearing loss (pre or post-lingual) across the UK population. Fortnum (1995), however, pointed to some of her own research which concluded that approximately 880 children per year are born with permanent hearing impairment greater or equal to 40dB bilaterally. By the age of 5 years a further 100 children from that birth cohort will have acquired an impairment. Of this extra group, approximately 90 per cent of the acquired impairment is caused by meningitis and about 50 per cent of children who get meningitis are aged under 12 months. Thus it seems safe to conclude that 95 per cent of the 980 children under discussion where deaf before their first birthday (pre-lingually deaf). In comparing the type of deafness of the research sample with that of the Fortnum survey, it was found that 22 out of the 23 pupils were classified as pre-lingually deaf or 95 per cent − exactly equal to Fortnum. Again, it can be concluded that the sample chosen for this study was representative of hearing-impaired children as a whole.

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<tbody>
<tr>
<td>100+dB</td>
<td>□</td>
<td>□</td>
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<td>□</td>
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<tr>
<td>90-99dB</td>
<td>□</td>
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<td>□</td>
<td>□</td>
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<tr>
<td>70-89dB</td>
<td>□</td>
<td>□</td>
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<tr>
<td>60-69dB</td>
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<tr>
<td>≤59dB</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
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</tbody>
</table>

Figure 10.2 Degree of hearing loss of research sample (as proportion of total sample) compared with hearing loss across the population of hearing-impaired children

Note that for 'Present study' research sample, one pupil who was classified by his teacher as moderate/severe was, for the purpose of the above table designated as moderate, while another pupil, classified as severe/profound was categorised as severe.
8.2. Methods of resolving qualitative hypotheses

In section 2.2 it was stated that questionnaires would be used to evaluate the response of teachers of the deaf to a) the CAL program on syntax; b) the extent to which their involvement in producing the program makes them more disposed to use CAL. These hypotheses will be resolved by noting the qualitative feedback and comments from teachers. Correlation statistics will also be used to discover any relationships between key variables such as attitudes to CAL and length of time as a teacher and time spent as a qualified teacher of the deaf.

8.3. Statistical tests for quantitative data

It was decided to use statistical tests (t-tests) to compare the test results of pupils before they undertook the CAL intervention compared with after they had studied the program. A t-test will also be used to measure the extent to which pupils persevere more with live or CAL tuition. This test was considered appropriate since this is interval (time) data. A chi-square test will be used to examine the number of one, two and three syllable words in the pre and post-tests to ensure that they are of equal complexity.

8.4. Other anticipated sources of confounding

One of the greatest potential problems with this area of the research is non-sampling error, and in particular, the problem of non-response. The initial stage of the research involves the distribution of a postal questionnaire which always runs the danger of a poor return (Oppenheim, 1992). The main question, is whether respondents failed to return the questionnaire due to lack of time or whether, say, there were questions which they found difficult to answer or even offensive. This would, in effect, make those who returned the questionnaire a volunteer group and undermine the validity and representativeness of the research. Non-respondents therefore, will be contacted and encouraged to respond, and the reasons for the non-response determined. If it can be shown, for example, that non-response was due to a lack of time rather than disinterest or even hostility to the subject of the research, then there can be more confidence that respondents were representative of the whole population. As Black (1994b) has argued, it may even be worthwhile finding replacements (again by random selection) in order to maintain the size and representativeness of the sample.

9. CONCLUSION

This Chapter has stated a central hypothesis, that computer assisted learning compared with live tuition will make no significant difference in terms of improving the syntactic performance of deaf children. Certain questions flowed from this hypothesis including whether both learners and teachers like using CAL and what factors may influence their attitudes towards the medium. It was shown how the sample for this research study was selected and how steps were taken to measure the representative nature of the sample. It was shown that the sample chosen was,
indeed, fairly typical of hearing-impaired children in the UK. A methodology was then drawn up for carrying out the different parts of the project and steps taken to ensure the quality of the data. The next stage of the research is to commence the design and production of the computer assisted learning and live courses. This process is described in Chapters 11 to 13.
CHAPTER 11

Needs Assessment and Needs Analysis

1. INTRODUCTION

This Chapter sets out a systematic approach for determining the learning needs of hearing-impaired children so that these needs can be turned into learning objectives that are sufficiently concise for teaching strategies to be deduced from them. The Chapter also explains, and seeks to justify, a design methodology for the development of computer assisted learning since, as was decided in Chapter 8, this will be a central medium for course delivery. In essence, some of the work in determining primary problems hearing-impaired children face (called here a needs assessment) have already been examined in Chapter 5, when the syntactic difficulties of hearing-impaired children were discussed. This Chapter, however, goes beyond this stage as part of a needs analysis and looks at some of these difficulties and possible teaching solutions, in more detail. As a result of both the needs assessment and needs analysis, the aims of the course and its overall structure are then presented.

2. GENERAL APPROACH TO COURSE DESIGN

2.1. Analysis and design methodology

In any courseware development process it is important to use a methodology that is reliable, especially when there is a need to specify educational performance objectives around which instruction is to be planned and measured. Gagné, Briggs and Wager (1992) have defined performance objectives as statements of observable measurable behaviours. They are important because they communicate the purpose of a course to a range of interested parties including designers, pupils and teachers and also make possible the planning and development of materials.

There are, of course, a number of approaches for writing and classifying educational objectives which could have been adopted. Bloom (1956), for example, used a classification which develops taxonomies (sets of performance categories) in three domains – cognitive, affective and psychomotor. The cognitive taxonomy contains six major classes of objectives arranged in hierarchical order on the basis of complexity of task (knowledge, comprehension, application, analysis, synthesis, and evaluation). Yet as Mehrens and Lehmann (1978) have pointed out, the value of this classification has been largely restricted to helping educators think about how different assessment procedures need to be established to evaluate these various...
goals. What we need for this research, however, is a classification which assists us in the design of teaching materials.

It is here that the approach of Gagné, Briggs and Wager (1992) is most relevant because it provides us with a model for moving from performance objectives to the specification of teaching strategies. These authors have argued that several stages are involved in the planning process, namely: (1) classifying the lesson objectives by learning type, (2) listing the needed instructional events, (3) choosing a medium of instruction capable of providing those events, (4) incorporating appropriate conditions of learning indicating how each event will be accomplished by the lesson. Stage (1) involves a top–down approach which seeks to identify instructional goals defined as 'a desirable state of affairs'. These goals are identified as part of a needs assessment which, according to Kaufman (1986) identifies a discrepancy or gap between a desired state of affairs (a goal) and the present state of affairs, i.e., a performance gap. Kaufman's categories of needs assessment (outcomes, outputs and produces), are also useful because they can provide a means of specifying needs that are measurable.

The next step (in line with Gagné, Briggs and Wager's (1992) stage (1)) is instructional or needs analysis which seeks to determine the enabling skills involved in reaching a goal. Sometimes it may be necessary to carry out a task analysis (or procedural analysis) to determine the list of steps and skills used in a procedure. An outcome of the instructional analysis is a task classification, which categorises the learning into different domains or types (verbal information, attitudes, motor skills, intellectual skills and cognitive strategies). This process may give us an insight into how the task is performed which may be useful in the instructional planning process, but it does not necessarily show us how the task should be learnt. For this, it is necessary to carry out a learning–task analysis, particularly if the objectives of instruction involve intellectual skills. The purpose of learning–task analysis is to reveal the objectives that are enabling and those for which teaching is necessary. This analysis may allow us to construct an instructional curriculum map showing the relationship between target objectives and subordinate objectives and where the realisation of an objective requires instruction to cross from one learning domain to another. At this stage it should be possible to specify which objectives can be grouped together into individual units or lessons.

Once the lesson structure has been defined it is time to identify the performance objectives of each lesson that will contribute to the realisation of the final course goals previously identified. For each performance objective an instructional strategy can be chosen (e.g., tutorial, simulation, or question and answer) and also one of the events of instruction to accompany it (stage 2). Gagné, Briggs and Wager (1992) have argued that the purpose of all instruction is to provide the events of instruction which include directing the learner's attention, informing the learner of the objective, presenting the stimulus material, and providing feedback.

Stage (3) involves choosing an instructional medium capable of carrying these learning strategies and instructional events. For example, if the objective is to teach someone a procedure, then a strategy involving the presentation of rules, opportunities to practice and feedback on performance might be appropriate. The
medium of face-to-face teaching might be useful here, as could a well designed computer assisted learning course; conversely, video would be inappropriate because of its inability to provide feedback. Finally, in stage (4) the conditions of learning must be planned for, especially in terms of the appropriateness to the capabilities which learners bring with them to the course. Each of these four stages will now be discussed in this and the next Chapter in the context of this research project.

2.2. Courseware development methodology

The ideas of Gagné, Briggs and Wager (1992), in principle, form a methodology for planning the production of teaching materials in any medium. As Black (1993a) has noted, however, in the case of computer assisted learning, an additional stage in the development process may be necessary, namely, prototyping. Black (1993a) has produced a computer assisted learning courseware development plan, based on the Gagné, Briggs and Wager (1992) model, but incorporating the prototyping stage (see Figure 11.1).

Prototyping has been described by King (1984) as:

\[
an \text{original version or model on which a completed software system is formed} \quad \text{(King 1984, p.184)}
\]

It is a process that has been recommended by Gray and Black (1994) as an essential component of courseware development, because this process is rarely a simple one, with the skills of sometimes a broad range of experts required (designers, programmers, subject matter experts, etc.). Communicating ideas between these people has traditionally often been done using a paper-based format, but this can be inadequate as a means of communicating complex ideas and can lead to misunderstandings and errors. As Gray and Black (1994) have commented, a prototype can be used both to give precise details of designs (screen layout, fonts, routines, etc.) to programmers, and also to gain constructive feedback from subject matter experts (in this case classroom teachers) or pupils. Above all, it provides the courseware designer with a tool for communicating with prospective end-users (both pupils and teachers) allowing a two-way dialogue to develop. In this way, the knowledge and expertise of teachers can be harnessed, and valuable feedback gained for courseware modifications and improvements. Eliciting the views of teachers (as experts) is also in line with the research philosophy outlined in Chapter 10.

![Figure 11.1 The place of prototyping in the courseware development process (Source: Black, 1993a)](image-url)
The next stage of the design process is the actual production of the program itself and, with the successful integration of the course into classrooms in mind, plans for assisting teachers in its use need to be formulated. As Black (1992) has pointed out, it is essential to think well in advance about how the program will be used so that steps can be taken to smooth the integration of the courseware into the classroom environment. In the case of this research, the researcher himself will be present at all times to load the courseware and assist the learner. Nevertheless, this research is also examining teacher and pupil attitudes to computer assisted learning so it is appropriate to make the situation as realistic as possible by providing the kind of paper-based support a teacher would normally need when using the courseware. Thus it might be useful if the materials explained how to start and terminate learning sessions and provided learning aims and objectives, courseware maps etc.

Since the purpose of prototyping is to assist in the modification and improvement of the courseware, it seems necessary that a questionnaire should be devised to elicit detailed feedback from teachers. Yet, while teachers' attitudes are important in the sense that they are experts in teaching hearing-impaired children, the views of the children themselves should not be ignored, since it is they who will be using the program in its final form. Eliciting feedback from young pupils, especially those who may have difficulties in communication raises some concerns. Clearly, using the kind of detailed, text-based questionnaire issued to teachers would be entirely inappropriate. What will be tried is a short, graphically illustrated questionnaire which requires the pupils to tick 'smiley' or 'sad' faces. Helpfully, the design and use of this questionnaire will add to the body of knowledge of how prototyping can be used with children, and methods of eliciting feedback, particularly from children with special needs.

The final step in the courseware development process is the use of field trials to elicit formative feedback so any essential changes can be made before the program is used experimentally. This means not only getting subject matter experts to look at this 'final' as opposed to prototyped version of the courseware, but also observing pupils using the program. At this stage, it may be useful to video a small number of pupils using the course, noting how they interact with the package, and eliciting their reactions. Given the target audience, and especially their reading levels, it will be particularly important to find out whether they understand the screen or paper-based instructions. Of course, some aspects of these will have been tested in the prototype, but at the field trial stage, all elements of the program will be evaluated. It will also be possible to see the extent to which, for some pupils, manual communication support (signing) by a teacher is necessary to supplement the instructions provided by the program and documentation.

Once the field trials are complete and the necessary changes to the courseware implemented (and evaluated through further field trials if they are significant changes), the courseware is ready for use with an experimental group. The sections below deal with the implementation of these stages just described, in the context of this research project.
3. NEEDS ASSESSMENT

The needs assessment was largely fulfilled by examining the research which discussed the general language problems of deaf children and in particular the difficulties which many of them face with elements of syntax. This analysis was subsequently followed up and confirmed with informal interviews with a selection of teachers of the deaf. Using Kaufman's (1986) categories, it could be said that a performance gap (outcome) exists when it comes to using syntactic structures, a view based on observations of teachers and analysis by researchers (such as Quigley and Kretschmer, 1982). This is based on the fact that deaf children do relatively poorly on standardised tests of linguistic abilities, and that, relative to their hearing counterparts, they do less well academically overall (outputs). This means that they are disadvantaged educationally, especially in terms of their access to opportunities such as higher education (product). Needs assessment revealed, therefore, that a performance gap had to be filled by examining ways in which the syntactic abilities of hearing-impaired children can be improved.

Yet it is not only the pupils who face difficulties in this area. Teachers themselves have not, on the whole, been successful in overcoming the 'learning plateau' in getting their pupils, or at least those who are severely hearing-impaired, to master syntax. The needs assessment has suggested that teachers also, in a sense, have learning needs. It has been hypothesised, however, (Chapter 7) that CAL technology could provide a valuable resource to help teachers. The needs assessment, however, had to first ascertain teacher attitudes towards this medium to see if it is acceptable and to smooth its integration into classrooms. As Chapter 8 shows, a questionnaire is to be sent to a representative sample of teachers of the deaf to elicit their views on computer assisted learning. This comprises an essential component of the needs assessment stage, and provides a baseline by which to measure any changes in teachers' attitudes to computer assisted learning once they use this research's CAL program.

4. NEEDS ANALYSIS

One aspect of a needs analysis is what Gagné, Briggs and Wager (1992) have called a job task analysis in which the specific nature of the performance gap is specified in more detail. This may involve examining the precise ways in which someone carries out a task or procedure. In the case of this research project it can be argued that the job task analysis was carried out in Chapter 6 when, using sources from the literature, the operations necessary for transforming kernel sentences were described. There can be significant differences, however, between how a task is performed and how one would expect someone to learn that task. This is the nature of a learning task analysis in which learning objectives are hierarchically ordered to discover where sub-skills are required to facilitate the performance of the task or procedure, or where objectives are to be performed at different cognitive levels.

A failure to understand the difference between a job task analysis and a learning task analysis can lead to errors in the way learning materials are designed. It is because of this that it was felt important to examine the work of Fyfe et al (1993) who used
what they called a 'display kit' consisting of words written on cards which pupils had to rearrange from a declarative into a sentence the answer to which is either 'Yes' or 'No'. This experiment, being concerned with teaching elements of syntax, was directly related to the subject of this research study, but it was felt that the approach adopted had failed to carry out the necessary learning task analysis and therefore ran the danger of providing a mechanistic approach to the learning task and one that failed to provide meaningful learning. To substantiate this hypothesis, and to assist in the future course design process it was decided to try and replicate the Fyfe et al (1993) experiment while observing, if errors by pupils were made, where they occurred. The methodology used in attempting to replicate the Fyfe et al (1993) experiment is described next.

Fyfe et al created a set of materials on question formation at three levels of difficulty: easy, intermediate and difficult. The set of materials consisted of two envelopes: (1) a principal envelope; (2) a store envelope. On the front of the principal envelope was a coloured, horizontal strip of card on which a sentence had been written, drawn from a book familiar to the pupil. In the easy sentence, the verb was underlined in red. At the intermediate level, both the auxiliary and main verbs were underlined in red. The principle envelope contained a set of three cards with the underlined word on one card and the other words displayed on the other two (see Figure 11.2), so the cards could be rearranged to form a sentence identical to the one on the envelope.

With the easy level of transformation, the back of the verb card contained the same verb but written in red ink with no underlining. Thus, if the sentence written on the front of the envelope was:

The cat is black

the word 'is' (in blue ink) was underlined in red, with the word 'is' in red ink on the reverse side.

An intermediate level of difficulty involved a two verb sentence, such as:

The horse can jump the hedge

Here, the principle envelope contained a card with the words can jump written in blue ink and underlined in red ink on one side and on the other side the word 'jump' in blue ink with 'can' in red ink in a separate box at the lower left hand corner of the card (see Figure 11.2).

The difficult transformation involved a situation where an auxiliary verb must be produced and the verb is irregular, such as:

The boys caught a fish

Here, only the verb was underlined in red. In the principal envelope was a card with the word 'caught' written in blue ink. On the reverse side was the word 'catch' in blue with the auxiliary verb 'did' written in red and located in a box in the lower left hand corner of the card.
For each level of difficulty the 'Store' envelope contained cards that the pupil might need to complete a transformed sentence such as a red question mark and, for the intermediate and difficult levels, cards bearing the auxiliary verb written in red ink.

b) Procedures

The experiment took place in two stages, first a demonstration phase (see Appendix 11.1 for protocol) in which the experimenter showed the pupil how to use the cards to make a desired transformation, and then an exercise phase when the pupils tried the procedure for themselves. For example, with the simple transformation, the experimenter took a red question mark from the store envelope and placed it at the end of the sentence. The pupil was then told to note that the colour of the question mark was a guide to which card should be turned over next. Hence, the verb, underlined in red, was turned over revealing the word 'is' written in red ink. The rule is that a card containing a red word must be moved, and the experimenter moves the card to the beginning of the sentence.

<table>
<thead>
<tr>
<th>Example sentence</th>
<th>Easy</th>
<th>Intermediate</th>
<th>Difficult</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>The cat is black</td>
<td>The horse can jump</td>
<td>The boys caught</td>
</tr>
<tr>
<td>Principal envelope</td>
<td>the cat is</td>
<td>the horse can jump</td>
<td>the boys caught</td>
</tr>
<tr>
<td></td>
<td>black</td>
<td>the hedge</td>
<td>a fish</td>
</tr>
<tr>
<td>Store envelope</td>
<td>?</td>
<td>can</td>
<td>?</td>
</tr>
<tr>
<td></td>
<td></td>
<td>did</td>
<td>?</td>
</tr>
</tbody>
</table>

Key: cat = blue text  
cat = red text

Figure 11.2 Examples of declarative sentences at the easy, intermediate and difficult levels, with appropriate cards contained in the Principal and Store envelopes for making a transformed question formation sentence.
For the difficult level of transformation, the experimenter took the card with 'caught' underlined in red and turned it over to reveal 'catch' with 'did' in red on the bottom left hand corner. This was a cue to reach into the store envelope for the word 'did' written in red which was placed at the beginning of the sentence and a question mark placed at the end. The word 'did' was then covered over to leave the sentence reading as:

**Did the boys catch a fish?**

Once this demonstration phase was completed, the experiment commenced with the pupils using the cards to perform transformations. The results suggested that once pupils began to grasp the need to put a question mark at the end of an interrogative sentence, both pupils learned to move the auxiliary verb to the beginning of the sentence without also retaining it in the main body of the sentence. The chief underlying difficulty was that neither pupil understood the changes that take place in the principle verb, especially at the difficult level of transformation. For example: **The boys went to the club last night**, is changed to **Did the boys went to the club last night?**

Yet despite the limited success of the research a number of concerns arose. Firstly, the authors seemed to be specifying teaching solutions to learning elements of syntax without considering the ways in which learners could be expected to learn the task. In other words, they seemed to be stuck at the job task as opposed to the learning task analysis phase. The danger of omitting a learning task analysis is that the teaching materials offered may succeed in getting a child to perform a task without achieving meaningful learning. The child may, for example, as in the Fyfe et al (1993) experiment, be taught to recognise that a card with certain symbols on it should be moved to the front of a sentence. This does not mean, however, that the child understands the functions of a verb in a sentence or why modal words change position when a sentence is transformed.

It was therefore decided to attempt to replicate the Fyfe et al (1993) experiment. A draft ICM for question formation was constructed (see Appendix 11.2) and the Fyfe et al (1993) experimental approach used (see Appendix 11.3 for demonstration questions). It was hypothesised that this exercise would help confirm what enabling skills are required to perform higher level cognitive tasks and test the validity of the ICM to see whether there were any omissions or errors in its construction.

Another concern with the Fyfe et al (1993) study lay in the way the experiment was designed. In their original study, Fyfe et al (1993) used an A-B-A single-subject design, that is, an attempt was made to establish a baseline level of competence, the intervention was introduced, and then the participant was re-tested using the same questions as in the preliminary phase. As Kerlinger (1986) has shown, there are grounds for believing that this sort of research design may be flawed since it is possible that there could be a learning effect from the first test. In the current research, therefore, a decision was made to use different test items in the post-test. Four test items were used at each level of difficulty. It was hypothesised that, due to the mechanistic design approach, the learning materials would not produce meaningful learning that could be transferred to unfamiliar test items. The children
were not expected then to perform significantly better in the post-test compared with the pre-test.

Another problem lay in the actual design of test items. At the difficult level, for example, all kernel sentences were in the past tense requiring the production of the word 'did' at the beginning of the sentence to achieve the transformation. The draft ICM suggested, however, that the successful use of the word 'do' depends, in large part, on the tense of the main verb. Thus, the word 'does' is required for the present tense when the subject is singular and 'do' when the subject is plural or the subjects 'I' or 'you'. The relative success of the Fyfe et al (1993) study may have depended, therefore, largely on their over-simplification of the transformation process with the use of transformations confined to the easy level.

c) Results

Due to time constraints the experiment was only carried out with one pupil, but it was hoped that, despite the restricted nature of the sample, the results might be indicative of general trends or issues. There was some confidence that, if this pupil (a boy of 8, who we will call Michael) had difficulties with the exercise, then similar problems might be faced by most other pupils. This was because the boy was described as 'exceptionally bright' by his peripatetic support teacher, someone with many years of teaching experience with deaf children.

The difference between the concepts 'sentence' and 'question' had to be explained several times with the pupil's teacher explaining this using written examples with oral reinforcement. Michael seemed unable to grasp precisely what was required of him when asked to turn a declarative sentence into a question. Even when the question 'Is Miss Fulton here today?' was written for him he copied it down as a (ungrammatical) statement: 'There miss Fulton here today?' On being verbally told the sentence: 'Is it Friday today?', Michael wrote: 'Is was is—it Friday today?' (sic). Thus he produced a correct version of the sentence making an error with the second word 'was' which he changed to 'is' before finally correcting it to 'it'. Listening to the verbal statement spoken to him by his teacher: 'Are there boys in the school', he wrote 'Are the (sic) boys in the school?' He seemed, then, largely unable to take a simple verbal declarative sentence and change it into a question.

The intervention followed a similar instructional pattern to that used by Fyfe et al (1993) in that numerous sentences were presented with words written on cards and the declarative sentence changed into a question by moving relevant cards (Appendix 11.3). Note that the sentences were simplified by not using a capital letter at the beginning or a full stop at the end. During this 'training' Michael quickly became interested in the task of moving the cards. Having been shown once how to transform a sentence, he eagerly took cards from each pack in turn and made a declarative sentence which he read out aloud. He then put a question mark at the end of the sentence and moved the relevant modal word. He was smiling for the first time and seemed to really enjoy the task. After each level of difficulty of transformation Michael was tested by being given a set of written declarative sentences to transform (Appendix 11.4). He performed well at both the easy and intermediate level of difficulty writing accurate questions beneath the declarative
statements (significantly, as in the intervention training, omitting any capitals other than for proper nouns). As was expected, however, Michael faced a struggle when it came to the difficult level of transformation. Thus, for the sentence: 'Boys wear trousers', Michael produced the question: 'wear Boys trousers?' For the sentence: 'Mrs Fulton bought a new coat', Michael changed this to: 'a Mrs Fulton bought new coat?' For the sentence: 'The boys went to the shop', Michael paused for a long time. He was prompted using some of the cards from the training at the difficult level. As a result he was able to produce the sentence: 'did the boys to the shop'. Note here the success in using the correct tense of the word 'do', but the disappearance of the verb and the lack of question mark.

d) Conclusion

The intervention achieve quite positive results in the sense that before the training, Michael seemed incapable of producing a question from a declarative sentence, whereas after the intervention he did so with great accuracy and speed. The exception to this was the transformation of declarative sentences at the difficult level. Thus the concern that the original Fyfe et al (1993) study may have over simplified the complexity of transformations at this level of difficulty were largely confirmed. It did seem, however, that the physical movement of words written on cards was helpful to the pupil in understanding some of the principles of the transformation process. As a result of this small, qualitative research study, it was possible to move forward with more confidence to specifying the general aims and structure of the proposed computer assisted learning course.

5. COURSE AIMS

From the needs assessment, needs analysis (and subsequent task analysis), it was possible to specify the general aims of the computer assisted learning courseware which are to:

a) Show that, if used in the appropriate circumstances, computer assisted learning can be a more powerful teaching medium than, for example, live tuition, by comparing improvements in syntactic abilities derived from a course given to hearing-impaired children using each of these media;

b) Demonstrate what implementation strategies are most appropriate for encouraging teachers to make use of computer assisted learning in the classroom;

c) Add to the body of literature on whether hearing-impaired children adopt different cognitive strategies to hearing children when performing cognitive tasks.

The course objectives which flow from aim a) will be discussed in the next Chapter. Aims b) and c) are not directly connected to courseware design and so will be discussed as part of the data analysis stage of this research.
6. COURSEWARE STRUCTURE

As a result of determining the course's aims it was possible to decide that the course should comprise four main sections, namely:

a) A Teachers' guide or manual on using the courseware including background and rationale for the research and an overview of the course;

b) A Course Introduction for pupils;

c) The courseware (on question formation);

d) Practice questions which pupils can 'drop into' to check their mastery level;

The next Chapter takes this courseware structure and determines the target objectives and unit objectives for each segment.
CHAPTER 12
Courseware Design

1. INTRODUCTION

Chapter 11 looked at a methodology for the design of teaching materials, including computer assisted learning courseware and then carried out a needs assessment and then a task classification as part of a needs analysis. This Chapter takes the results of that needs analysis in terms of the specific learning needs identified and attempts to specify the learning objectives which flow from them and the cognitive levels of these objectives. The result is the design of instructional curriculum maps from which it is possible to deduce the course structure in terms of course units and the kinds of learning strategy and teaching medium to be adopted within each unit. In doing this, the particular characteristics of the target audience as learners are taken into account.

2. COURSEWARE TARGET OBJECTIVES

Gagné, Briggs and Wager (1992) have suggested that a learning objective is a precise statement of a capability that, if possessed by a learner, can be observed as a performance. Stating objectives in measurable and observable terms is important because the purpose of teaching can be communicated to the learner and a means of evaluating the outcomes of instruction determined. In the case of this research, it seems unlikely that communicating formal objectives (in written form) to hearing-impaired pupils will serve much purpose (other than to confuse or bore them). It does seem relevant, however, to communicate the purpose of the program to them which, in a sense, is a statement of the program's objectives. It may also be worthwhile communicating these objectives to teachers. A set of target objectives could, therefore, be included in the documentation that supports the software. Perhaps more importantly, writing objectives may also help the clarification of the purposes in this research.

Target objectives have been written for each Unit, and provide the basis for the specification of more detailed, Unit objectives (see section 4). The target objectives are stated below with what Gagné, Briggs and Wager (1992) have called learned capabilities, that is, a classification scheme which distinguishes between learning domains and comprises: verbal information, motor skills, intellectual skills (concept learning, rule learning and problem solving), and attitudes. This classification scheme is important because, by distinguishing between different levels of learning,
it allows the course designer to select learning strategies (for example, tutorials, drill and practice, simulation or tests), and therefore media, that are appropriate to each domain.

Also note that, again in line with Gagné, Briggs and Wager (1992), a distinction is made between various levels of target objectives. Life-long objectives, for example, are, as the name implies, very long-term, possibly only achieved later in adulthood. Apart from these, there are end-of-course or target objectives (see Appendix 11.2, Figure 1). The rest of this section specifies all of these objectives in more detail.

2.1. Life-long objectives

Hearing-impaired pupils will acquire proficiency in using syntactic structures equivalent to the skills acquired by hearing children of a similar age. In stating this as an objective, it is recognised that this goal may be difficult, if not impossible, to achieve, especially if this research strengthens the case of those like Arnold (1989b), who has argued that the cognitive processes used by profoundly deaf children may, in fact, not be identical to those used by their hearing counterparts.

2.2 Target objectives

Pupils should:

a) given a declarative kernel sentence, at either the easy, intermediate or difficult level, demonstrate how to transform it into a question.

b) choose to produce question transformations with 100 per cent accuracy.

3. INSTRUCTIONAL CURRICULUM MAPS

The next step, recommended by Gagné, Briggs and Wager (1992), is the process of learning task analysis whereby each target objective is broken down to identify enabling objectives and learning sequences, with objectives being organised into a hierarchical structure called an instructional curriculum map (ICM). An ICM has been described by Gagné, Briggs and Wager (1992) as a means of representing the functional relationship amongst instructional objectives. An ICM was produced as part of the learning task analysis (see Chapter 11). Essentially, an ICM starts by identifying the target objectives and determines what enabling objectives are required to fulfil them. A hierarchy of related objectives is therefore produced, with a clear indication of when supporting objectives are not from the same domain as the target objectives. This is essential if the course is to be designed with conditions of learning (say, tutorials, or drill and practice approaches) that are appropriate to the target objectives.

An additional purpose of the ICM is to help identify which elements can be grouped together into Units or lessons. So objectives in a particular subject area across a range of domains (e.g., Negatives), or objectives from the same domain but across a
range of subjects, may be grouped into a Unit. A summary showing the
classification of objectives into lessons in presented at Table 12.1 based on grouping
objectives by subject area. These target objectives are arranged as a first level ICM
at Appendix 11.3, Figure 1.

The complete ICM for question formation is shown at Appendix 11.2, Figure 2 with
enabling objectives beginning at a lower level of intellectual skills (classifying
concepts, then discriminations) rising to performing procedures (the rules for
creating a question). The target objective is at the problem solving level,
demonstrating how to transform kernel sentences in novel situations. The affective
domain is again important with pupils being encouraged to carry out the
transformations accurately, and having the motivation to do so.

4. LESSON OBJECTIVES

The creation of the instructional curriculum maps enabled discreet subject areas to
be identified and therefore the specification of distinct lessons with their supporting
objectives. These lessons are identified at Appendix 11.2, Figures 2 by the dotted
boxes around objectives besides which is the lesson title. The course therefore
essentially consists of four lessons, each of which is presented next with objectives.

4.1 Identifying and converting tenses

The pupil will discriminate between verbs in the present, progressive and past
tenses.

Table 12.1 Specification of target and enabling objectives with relevant learning
domains

<table>
<thead>
<tr>
<th>Objective level</th>
<th>Target/enabling objectives</th>
<th>Learning domains</th>
</tr>
</thead>
<tbody>
<tr>
<td>Life-long</td>
<td>Demonstrate transformations of all syntactic structures with 100 per cent accuracy</td>
<td>Cognitive strategies</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Target</td>
<td>Demonstrate question formation (Yes/no questions)</td>
<td>Intellectual skills: concept learning; discriminations; rule learning; problem solving</td>
</tr>
<tr>
<td></td>
<td>Choose to perform question formation transformations with 100 per cent accuracy</td>
<td>Affective</td>
</tr>
</tbody>
</table>
4.2 Using the 'do' word

The pupil will demonstrate how to select the appropriate form of the word 'do' depending on the tense of the sentence.

4.3 Identifying 'hopping' words

The pupil will discriminate between sentences which have a hopping word (words that have to be moved when a sentence is transformed) and those that do not.

4.4 Transforming kernel sentences

The pupil will demonstrate how to transform a declarative kernel sentence by moving the helping word to the first place in the sentence, capitalising the first letter of the helping word, decapitalising the first letter of the former first word and changing the period to a question mark.

5. LEARNING STRATEGY

If learning language becomes as abstract activity, divorced from its active use in the real world situation, then it cannot be learned effectively. Teachers of the deaf have understood this for many years and try to use materials and situations which have relevance and immediacy to their pupils so that language learning becomes an exciting activity.

Hearing–impairment, however, obviously makes this process an arduous and difficult one for many children, especially those with severe hearing–impairment. Furthermore, with most deaf children being mainstreamed there is not always the time available for one-to-one language coaching that most teachers would like. This is where a CAL program could help enormously.

The program will be able to offer numerous examples of sentence transformation to reinforce learning. Yet it will not be a drill and practice program in the traditional sense. It is believed that too many CAL packages have been created at this level. Escape from the Haunted Castle will offer the children a game and therefore a challenge. By trying to 'crack the code', that is, transform basic sentences into questions (at increasing levels of difficulty) they will be able to progress from room to room and eventually escape from the castle. Hopefully, the nature of the challenge, and the graphics and simulations on display, will maintain interest and attention.

Above all, the pupils will be in control. Clicking on special buttons will allow the pupil to 'drop down' into hidden parts of the course where they can get tips and help on solving the transformation problem. This help will mainly comprise simulations (where words move and capitalisation and decapitalisation of words takes place) so that the child can see how a transformation is performed. More buttons allow the simulation to be repeated as many times as needed. Then a 'Try it' button allows the
pupil an opportunity to practice on a transformation themselves before returning to the Game, to solve the transformation.

The program will offer several problems at the most basic (easy) level of transformation so that all pupils will have the opportunity to achieve some success. If they are unable to complete the Game they can Exit and will be rewarded with some positive encouragement on what they have just accomplished. Thus confidence and motivation can, hopefully, be maintained and even boosted.

It was noted in Chapter 8, that one of the prime objectives of this research is to compare live teaching with computer assisted learning as a teaching medium. Thus, learning strategies have been chosen for each medium and are presented at Table 12.2. It can be seen that computer assisted learning has been chosen to deliver most of the course content, mainly because this medium allows the use of the kinds of simulation described above.

6. LEARNER CHARACTERISTICS

It is necessary, but not sufficient, to design and organise learning purely from the viewpoint of the subject matter itself. As Black (1993a) has suggested, although groups of learners may often have common characteristics, (say, age), they are also individuals and may differ in vital ways that may either help or hinder their chances of success in learning. Thus, identifying learner characteristics makes it possible to design specific learning segments for certain individuals or groups, to select the most appropriate kinds of learning situations and events and to decide on the optimal pace of learning.

With a group such as hearing-impaired learners, consideration of both their special characteristics as a group, and also of their differences as individuals is profoundly important. As a group, Chapter 4 showed the great difficulties hearing-impaired children face in acquiring language. This, in essence, means that the time and effort needed to learn material will, on average, be longer than their hearing counterparts. In practice, it also means that some material (for example certain syntactic constructions) will be simply beyond the reach of some. While sometimes a child will have no way of knowing in advance whether a specific piece of material or skill is attainable, years of negative learning experiences may suggest that often it is not (or at least the timescales required to learn it are arduous). If this is the case, the motivation to try, or in McClelland's terms the 'need to achieve' (McClelland in Tomlinson, 1981) may be shallow and quickly extinguished at the slightest sign of difficulty.
Table 12.2: Course content, learning domain, learning strategy and instructional medium for the courseware

<table>
<thead>
<tr>
<th>Content</th>
<th>Learning Domain</th>
<th>Learning strategy a) CAL</th>
<th>b) Live Tuition</th>
<th>Medium a) CAL</th>
<th>Live tuition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Course Introduction</td>
<td>Verbal information</td>
<td>Tutorial</td>
<td>Demonstration protocol</td>
<td>Booklet</td>
<td>Verbal description</td>
</tr>
<tr>
<td>Identifying 'hopping' words</td>
<td>Rule learning</td>
<td>Tutorial/ simulation/pupil practice</td>
<td>Tutorial/ simulation/test</td>
<td>CAL</td>
<td>Verbal description/paper-based materials</td>
</tr>
<tr>
<td>Using the 'do' word</td>
<td>Rule learning</td>
<td>Tutorial/ simulation/pupil practice</td>
<td>Tutorial/ simulation/practice</td>
<td>CAL</td>
<td>Verbal description/paper-based materials</td>
</tr>
<tr>
<td>Identifying discriminations and converting tenses</td>
<td>Discriminations</td>
<td>Tutorial/ simulation/pupil practice</td>
<td>Tutorial/ simulation/practice</td>
<td>CAL</td>
<td>Verbal description/paper-based materials</td>
</tr>
<tr>
<td>Transforming kernel sentences into questions</td>
<td>Problem solving</td>
<td>Tutorial/ simulation/game/test</td>
<td>Game</td>
<td>CAL</td>
<td>Verbal description/paper-based materials</td>
</tr>
<tr>
<td>Practice (formative) Test</td>
<td>Problem solving</td>
<td>Game</td>
<td>Game</td>
<td>Paper</td>
<td>Paper</td>
</tr>
<tr>
<td>Summative (mastery) Test</td>
<td>Problem solving</td>
<td>Game</td>
<td>Game</td>
<td>Paper</td>
<td>Paper</td>
</tr>
</tbody>
</table>

This has very important implications for designing learning materials. It means that learning steps must be designed so that they are broken down into small, easily attainable stages. Feedback must be frequent and within context (rather than, say, delayed until the end of a lesson or unit), and must accentuate positive achievements rather than pointing to failures. Above all, considering many hearing-impaired pupils have so many negative experiences, the materials must be exciting, stimulating and rewarding to use so that the pupils want to use them and persist in their use. This is important because, with special needs children in general, the
repetition of material is so vital for aiding the retention and transfer of knowledge and skills.

7. MEDIA SELECTION RATIONALE

Since a decision was taken in Chapter 8 to compare the impact of live compared to computer assisted learning, both a paper-based version (for use by teachers) and a computer delivered version of the materials will be produced. In the case of CAL, however, on the advice of Alessi and Trollip (1992), the computer will only be used for the kinds of learning strategies to which it is appropriate, as outlined in Table 12.2 above.

8. PROTOTYPE SELECTION RATIONALE

Bloor and Cavalier-Smith (1990) found that developing a software prototype in cooperation with a teacher of the deaf and hearing-impaired children can produce software which is robust and of educational value (p. 637). Following the advice of Gray (1992), therefore, two kinds of prototype will be produced. The first, a requirements prototype will be used for defining pupils' requirements for courseware features such as screen interfaces (menus, icons, colours, graphics, etc.), and instructional strategies. Above all, it will be used to establish whether the pupils can use the program (navigate around it successfully and without confusion) and whether they like it. The affective domain is particularly important to the success of the program and a prototype is a useful tool for eliciting comments on pupils' views.

A second, and more detailed prototype, is the specifications variety, its uses including the communication of details of human computer interaction and the more complex areas of instructional design including question-judging routines and branching, to the programmer. Those segments of the courseware requiring prototyping are specified in the next Chapter.

9. THE EVENTS OF INSTRUCTION

The events of instruction have been described by Gagné, Briggs and Wager (1992) as a set of events external to the learner, designed to support the internal processes of learning. Although there are nine events of instruction, the authors make it clear that not all may have to be used in a single lesson, while some of them may be used more than once. What is significant is that they are designed for each individual lesson so that learners are given explicit guidance on where they are going. Such an approach may be ideally suited to young learners who may require considerable 'hand-holding' in the learning process.

It should be noted that several of Gagné's events of instruction are missing from Table 12.3. Stimulating recall of previous knowledge is omitted because the needs analysis (Chapter 11) suggested that hearing-impaired children tended to be particularly weak in syntactic transformations. As noted in section 2 of this Chapter,
informing the learner of the lesson objectives is to be done informally (and orally) before the use of either the live or CAL interventions.

10. COURSEWARE EVALUATION

As noted in Chapter 9, and in line with Black's (1993a) systems approach to course development, both formative and summative evaluation was planned in the form of an evaluation sheet to be completed by teachers at both the prototype (Appendix 12.1) and implementation stages (Appendix 9.4). This was so vital courseware modifications could be made. The actual end-users are hearing-impaired pupils, so, again, as has been noted in Chapter 9, a simplified version of the evaluation form was also designed but making use of graphical images drawn from the program and requiring the pupil to tick either a 'smiley' or 'sad' face in response to individual questions (Appendix 12.2). With the help where necessary of a class teacher, the plan was to get the pupil to elaborate on their selection, with notes taken by the researcher to record their feedback. The researcher also planned to complete a courseware evaluation form at the prototyping stage (Appendix 12.3).

Table 12.3 Courseware, subject matter, and the events of instruction

<table>
<thead>
<tr>
<th>Courseware section</th>
<th>Subject matter</th>
<th>Events of instruction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Introduction</td>
<td>Title/logo</td>
<td>Gain attention</td>
</tr>
<tr>
<td>Using the course</td>
<td>Instructions</td>
<td>Provide guidance</td>
</tr>
<tr>
<td>Course menu</td>
<td>Course structure</td>
<td>Provide guidance</td>
</tr>
<tr>
<td>Identifying and converting tenses</td>
<td></td>
<td>Presenting stimulus material/ Providing learning guidance</td>
</tr>
<tr>
<td>Using the 'do' word</td>
<td></td>
<td>Presenting stimulus material/ Providing learning guidance</td>
</tr>
<tr>
<td>Identifying 'hopping' words</td>
<td></td>
<td>Presenting stimulus material/ Providing learning guidance</td>
</tr>
<tr>
<td>Question transformations</td>
<td>Sentences which pupils transform 'on screen' into questions</td>
<td>Eliciting the performance</td>
</tr>
<tr>
<td>Practice questions</td>
<td></td>
<td>Providing feedback about performance correctness</td>
</tr>
</tbody>
</table>
11. CONCLUSION

This Chapter has outlined and organised the main courseware objectives so that discreet units of learning could be identified. For each unit, appropriate learning domains, learning strategies, and delivery media have been specified, and the events of instruction detailed for guiding learning. The next stage of the design process is the development of these ideas into detailed specifications including the actual content of the program, plus flowcharts and plans for screen design.
CHAPTER 13
Courseware Implementation

1. INTRODUCTION

The courseware implementation process requires the setting down of detailed specifications for each section of the course. Specifications are important because they set out precisely what the courseware should look like and how it should function, including details of human computer interaction (e.g., user controls, screen layout and design, and the use of colour) and learning strategies. The latter comprise teaching approaches which include tutorials, drill and practice routines, tests or simulations (Alessi and Trollip, 1991) with specifications defining precisely how each of these strategies should work. In the case of simulations, for example, specifications lay down what form they will take in terms of graphic design, animation, and what type of control the user is to have over them.

As Sommerville (1982) has pointed out, specifications are usually written in prose text, each paragraph specifying some element of a requirement. Yet the inherent ambiguity of language means it is difficult to verify if requirements are complete and non-conflicting. As was suggested in Chapters 11 and 12, courseware prototyping is essential in avoiding this ambiguity because the designer (in this case the author) can communicate parts of the specifications to programmers in software form. Thus programmers will be handed both text-based specifications and samples of functioning software as guides. Prototyping, then, fulfils a very practical function in this project. It also fits into the research philosophy of the project (Chapter 10), integrating teachers into the design process, and eliciting their reactions to prototypes at various stages of the courseware development process.

The following sections set out detailed specifications for the courseware in general as well as outlining which sections are to be incorporated into the prototype.

2. SPECIFICATIONS

Specifications describe three main areas of courseware details – functionality, learning strategies and screen design.
2.1 Functionality

a) Course Manual

The Course Manual is designed to provide an introduction to the course with separate sections for teachers and pupils. For teachers the Manual is intended to describe the aims and objectives of the courseware, its overall structure, and ways in which teachers can assist pupils while they are using the course. The pupils' section again describes the purpose of the course, but is written in much simpler language. A copy of each version of the Manual is presented at Appendix 13.1 and 13.2.

b) Multimedia courseware

It was decided that a WIMP (Windows, Icons, Mouse, Pointing) environment would be used as the main method of user input. This decision was not taken lightly. It is realised that some pupils may have relatively limited experience with information technology and the use of mouse controls in particular. Visits to a number of units for the hearing-impaired found a reliance on concept keyboards as the chief method of user input. Such keyboard control, however, does not seem appropriate since it lacks the flexibility for 'grabbing' words and moving them into a new position in a sentence—a learning strategy essential to the research. In contrast, pointing, clicking and dragging seems compatible with this strategy. It was decided, however, that, due to some concerns about the ability of young pupils to use mouse controls effectively, a short pre-course section on using the mouse would be included, as an introduction to the game, and this will be tested as part of the requirements prototype.

2.2 Learning Strategies

The choice of learning strategies for each section of the proposed courseware was given in Chapter 12. Table 12.2 in that Chapter reveals that each of the four main sections of the course use a similar learning strategy, namely: tutorials, simulations and opportunities for pupil practice on numerous examples, if desired. It is intended that, by acquiring skills in areas such as identifying and converting tenses and using the 'do' word, pupils will be able to solve problems set for them in transforming sentences into questions which will be presented as part of a game. Two alternative learning strategies seem feasible here. One is to require the pupils to study, and possibly achieve mastery, in each of the main sections of the course, e.g., 'Identifying hopping words'. This, however, could prove tedious and demotivating if the material is already familiar to some learners particularly if pupils have little knowledge of where their efforts are leading. An alternative, and it is felt, far more stimulating approach, would be to present the game at the start of the program. The units (such as 'Identifying hopping words') could be represented on screen as buttons which can be accessed at any time when help is needed. Pupils will therefore meet the challenge of the game immediately and (hopefully) be motivated to solve the challenges it presents. To do this, most (if not all) will have to 'drop down' into the various units in order to master key skills before returning to the game to put their knowledge into action.
This 'open-ended' approach has its dangers. Firstly, faced with a problem of transformational syntax which is presented in the game, it is important that pupils are able to identify when they are failing with a transformational task, and even more importantly, know where to get help. This means that on-screen instructions must be clear and intuitive and that all learners must (as part of formative feedback) be guided to the relevant help area available in the units. Secondly, since the game is presented at the problem solving level, learners will be required to bring a range of integrated rules (either pre-learned before the course or grasped during it) to the learning situation. This higher level of cognitive task may be too much for some (or possibly even many) pupils. In order to avoid demotivating learners, it is essential that the problems presented in the game begin at a lower cognitive level so that weaker learners acquire a sense of achievement by succeeding at a number of tasks, and succeed in making some progress in the game. This means that access to the units may only be offered once the higher cognitive level tasks are arrived at during the course. It is now necessary to discuss each of the learning strategies in more detail.

a) Tutorial

Since the reading ages of the pupils in the sample may be relatively low, the amount of 'tutoring' using text will be kept to a minimum. Therefore, much of the tutorial element of the course will be integrated into the simulations and will mainly be confined to delivering guidance on the nature of the task required of the pupil and to provide feedback on learners' performing a transformation.

b) Simulation

The use of simulations is one of the essential elements of the course since they will allow pupils to observe the process of making a transformation (at various levels of difficulty). Since the process of question transformations involve several stages, it is important that each stage is presented as separate and distinct so as to avoid cognitive confusion. The simulation, therefore, will incorporate the display of two types of button. One type will control the speed of the simulation, with buttons for both speeding it up and slowing it down (in the latter case where a pupil needs more time to discriminate between the different stages of transformations).

The second type will be for repeating the simulation, vitally important if redundancy of information is to be achieved. The use of animation of words and their movement within a sentence, however, is unlikely to be sufficient guide to pupils as to the purpose of what they are viewing. Therefore, textual pop up messages will appear after each movement in the transformation. For example, in the sentence: *The cow is brown*, the verb 'is' must be moved to the beginning of the sentence; next it must be capitalised; thirdly, the word 'The' must be decapitalised, and lastly a question mark must be placed at the end of the sentence. It is essential that textual support is provided in conjunction with each stage just described.
c) Pupil practice

Having viewed a simulation, pupils will be given the opportunity to practice a transformation for themselves, using a bank of up to 20 kernel sentences. Practice transformations will be available for each unit of the course. As part of this practice exercise, formative feedback will be given that is specific to the aspect of the transformation being undertaken. For example, if the learner is working on the course unit dealing with supplying the 'Do' word, only this aspect of the sentence will require transforming. So if the kernel sentence is: *The boys ran away*, the transformed sentence will have to be: *Did the boys run away?* In this case, the pupil will have to supply the correct tense of the 'do' word, (capitalised) at the beginning of the sentence, selected from a list of different tenses of this word. Since this unit of the course is not concerned with tense formation, the tense of the main verb will be changed automatically by the program.

A practice section will also be available for the pupil to 'drop down' into while playing the game itself. Since the game is meant to test higher cognitive levels of thinking, this practice area will require the pupil to perform an entire transformation rather than specific aspect of it. Feedback will be given as to whether the attempted transformation is correct, and any errors or omissions responded to with pop up text messages. Where relevant, unit buttons will flash, to show the learner which units can be accessed, appropriate to the type of error that has just been made.

2.3 Screen Design

a) Presentation of text

Since the reading ages of some, if not many, hearing-impaired pupils will be below their chronological age, the presentation of large amounts of text on the screen at any one time should be avoided. Text should be presented in small, manageable chunks, supplemented, where possible, with graphics if these can be used to reinforce text and minimise its use. The transformational process will be difficult enough for some learners without making the discrimination of individual words or letters problematic. Therefore, text will be presented in a 14 point rather than a 12 point font and in a serif style, rather than sans-serif, where discrimination between letters may be easier.

b) Screen layout

Heines (1984) has suggested that all sections of a course are given a consistent screen layout (in terms of titles, menu bars, etc.) so that users do not become confused. In the case of this courseware, several distinct screen areas will be used:

- a *navigational bar* comprising, for example, buttons for moving forwards and backwards in the course between the game and the units of the courseware, and for exiting;
a toolbox providing facilities useful for producing a transformed question sentence such as a question-mark and buttons for both capitalising and decapitalising words;

- a control bar containing buttons for controlling simulations (only available in unit parts of the course);

- a picture area where the graphics of the program will be presented;

- a sentence presentation area where kernel sentences will be presented for transformation;

- a feedback area for giving formative feedback on performance;

- a title bar which gives information on where the learner is within the overall course.

It is vital that these areas are kept separate in terms of both functional identity and graphical appearance so no conceptual confusion is possible. It makes sense, therefore, to position the areas on different parts of the screen in a consistent manner. An overall presentation of these areas is shown at Figure 13.1

c) Navigational tools

The kinds of navigational tool available to the user will depend on where he or she is in the course, with only tools required by the specific operation of that segment of the course being displayed. Table 13.1 (overleaf) illustrates the navigational tools available to the learner in each section of the course.

![Figure 13.1 Screen areas at the Easy level of transformation](image-url)
Table 13.1 Course section and navigational control and toolbox buttons available

<table>
<thead>
<tr>
<th>Course section</th>
<th>Navigational buttons</th>
<th>Control buttons</th>
<th>Toolbox buttons</th>
</tr>
</thead>
<tbody>
<tr>
<td>Using the Toolbox</td>
<td>Game</td>
<td>Repeat/Next</td>
<td>Q mark/</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Capitalise/</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Decapitalise/Accept it</td>
</tr>
<tr>
<td>Game</td>
<td></td>
<td></td>
<td>Q mark/</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Capitalise/</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Decapitalise/Accept it</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Level 1</td>
<td>Hopping</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Q mark/</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Capitalise/</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Decapitalise/Accept it</td>
</tr>
<tr>
<td>• Level 2</td>
<td>Hopping/Action</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Q mark/</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Capitalise/</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Decapitalise/Accept it</td>
</tr>
<tr>
<td>• Level 3</td>
<td>Hopping/Action/Do/</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Tenses/</td>
<td></td>
<td>Q mark/</td>
</tr>
<tr>
<td>Simulations: Hopping</td>
<td>Return to game</td>
<td>Faster/Slower/Repeat</td>
<td></td>
</tr>
<tr>
<td>words</td>
<td></td>
<td>Try it/More?</td>
<td>Q mark/ Capitalise/ Decapitalise/Accept it Return to game</td>
</tr>
<tr>
<td>Simulations: Action</td>
<td>Return to game</td>
<td>Faster/Slower/Repeat</td>
<td></td>
</tr>
<tr>
<td>words</td>
<td></td>
<td>Try it/More?</td>
<td>Q mark/ Capitalise/ Decapitalise/Accept it Return to game</td>
</tr>
<tr>
<td>Simulations: 'Do'</td>
<td>Return to game</td>
<td>Faster/Slower/Repeat</td>
<td></td>
</tr>
<tr>
<td>words</td>
<td></td>
<td>Try it/More?</td>
<td>'Do' words</td>
</tr>
<tr>
<td>Simulations: Tenses</td>
<td>Return to game</td>
<td>Faster/Slower/Repeat</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Try it/More?</td>
<td>Verb lists</td>
</tr>
</tbody>
</table>

In the courseware section Using the Toolbox a 'Game' navigational button is available to take the learner to the game when they are ready for it. A 'Repeat' control button is provided to allow the user to view simulations of how the Toolbox works. In the Toolbox itself are several buttons which play a central functional role in getting the learner to transform sentences. When activated the 'Q mark' button places a question mark at the end of the sentence. A 'Capitalise' button converts the first letter of a word that has been dragged to the beginning of the sentence into a capital letter. A 'Decapitalise' button similarly decapitalises the word that is no longer at the start of a sentence. Finally, 'Accept it' gets the learner to acknowledge the on-screen version of the sentence as their answer for checking and feedback from the system. Once pressed, the system will either give feedback that the answer is correct, or indicate where errors have been made and which unit can be attempted to receive remedial help.
The provision of navigational buttons in the Game section depends on the level of difficulty of the transformation. At Level 1 (Easy) only a 'Hopping' button is supplied since only the simulation on hopping words is necessary to transform a sentence at this level. At Level 2 (Intermediate), where action verbs containing an -ing ending are involved the Action words unit is made available, as well as the 'Hopping' button. At the Level 3 (Difficult) stage, all unit buttons are made available. All three Game levels will be supplied with the Toolbox.

The four simulation units will have a navigational 'Return to Game' button so that learners can switch easily backwards and forwards between the Game and the units. Being simulations, it is essential that the user is able to exercise some control over the speed of the word animation presented - hence, buttons for speeding up and slowing down the simulations are provided, so individual learners can view the simulations at a speed appropriate to their ability to process incoming information. The simulations are designed, in large part, to provide a redundancy of information, so a repeat button gives learners a chance to review the simulation as many times as they feel necessary. Finally, a 'Try it' button produces a question (from a bank of questions) so that the learner can practice a transformation themselves, before moving back to the Game. The 'More' button merely supplies another question within the simulations unit.

d) Colour

As Clarke (1992) has pointed out, evidence indicates that learners prefer colour and its use may aid retention of information. The various units of the course therefore will be given a different background colour to assist learners in distinguishing them. It is recognised that any information that can assist learners, especially young ones, to orientated themselves within the courseware is important. While the number of colours associated with functional areas on the screen such as navigational tools will be minimised (since colour here would offer no particular instructional information), it will be used generously within the game. This is because the graphics involved comprise an essential and integral part of the courseware. Following the advice of Reid and Wicks (1988) black, blue or red will be used as colours for text since their research (amongst a sample of over 300 learners) showed that these were preferred.

e) Graphics

In principle, a game could consist of the pupils responding to simple textual messages on the screen, say, by typing in a word. If repeated several times, this kind of learning strategy would conform closely to a drill and practice program so criticised in Chapter 8. Given the widescale penetration of computer games into UK homes, it seems inevitable that large numbers of the target audience for this research will have direct access, or indirect through friends or siblings, to various kinds of computer game. The author has studied large numbers of these games delivered on a variety of hardware platforms (e.g., Sega, Commodore, Atari) and found that there is a consistency of graphical style. Nearly all games present high resolution complex, detailed images, often in the form of a 'fantasy environment' of castles, mazes, or underwater sub-terrestrial worlds.
To present a courseware game that did not conform in many ways to this widely accepted standard would be to jeopardise the credibility of the game in the eyes of its young users. It must be admitted, however, that this research does not have the funds to achieve the levels of animation presented in most commercially available computer games. Nevertheless, an attempt will be made (subject to available finances) to offer a graphically stimulating environment which attempts to reproduce some of the 'feel' of a computer game, without, however, the use of animate sprites. Furthermore, as Clarke (1992) has suggested, learners with low verbal abilities may benefit from the use of diagrams, especially if illustrations are positioned near the text they are supporting. There may be some grounds for optimism, therefore, that hearing-impaired learners may particularly benefit from graphical support for the text.

3. FLOWCHARTS

As part of the next stage of courseware design, flowcharts have been drawn up. Alessi and Trollip (1991) describe a flowchart as a chart or diagram of how the lesson progresses or flows. They recommend that in computer assisted learning development these be produced at three levels. A Level 1 flowchart is a one page overview of the lesson sequence (see Figure 13.2, below), while a Level 2 flowchart adds essential decisions and branching. A Level 3 flowchart adds all references to any storyboards that are to be used (giving details of what the learner will see), calculations, branching, information management and user control. Level 2 flowcharts are presented at Appendix 13.3, and data structures containing the sentences used in the program at Appendix 13.4.

4. REQUIREMENTS PROTOTYPE

As outlined in Chapter 12, both a requirements and specifications prototype are to be produced. To plan this process, Level 2 flowcharts were completed for all sections of the courseware (Appendices 13.3a to 13.3g) and carefully examined to see what elements lent themselves most appropriately to the prototyping process. In essence, prototyping seemed relevant for the areas designated in Table 13.2.
Table 13.2 Areas of flowcharts selected for requirements and specifications prototyping

<table>
<thead>
<tr>
<th>Area/Function</th>
<th>Details</th>
<th>Type of prototype</th>
</tr>
</thead>
<tbody>
<tr>
<td>Screen design</td>
<td>Toolbox</td>
<td>Requirements</td>
</tr>
<tr>
<td></td>
<td>Graphics</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Help buttons</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Sentence presentation</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Feedback area</td>
<td></td>
</tr>
<tr>
<td>Navigation</td>
<td>User controls</td>
<td>Requirements</td>
</tr>
<tr>
<td>Help sections</td>
<td>Navigation between Help and Game</td>
<td>Requirements</td>
</tr>
<tr>
<td>Simulation</td>
<td>User controls</td>
<td>Specification</td>
</tr>
<tr>
<td>Feedback</td>
<td>Question judging</td>
<td>Specification</td>
</tr>
</tbody>
</table>

5. COURSEWARE INTEGRATION

One approach to courseware integration would be to send the program, plus supporting documentation, to the teachers of those children identified as part of the research sample. This strategy, however, was rejected because of the practical difficulty that not all teachers of the deaf may be familiar with or confident in using computer assisted learning. Furthermore, the use of teachers in loading the program then assisting the pupils in using it might add a further confounding independent variable to the research. A better approach will be for the researcher to take the courseware to the pupils at their school. This will ensure that the program is properly set up and functioning and pupils given any necessary coaching in mouse control before using the courseware. The presence of the researcher will give the teachers of the deaf more opportunity to assist the pupil in more useful ways such as explaining (orally or through signing) any difficult words or concepts.

Going out into the field will also enable the researcher to carry out a pre and post-intervention analysis of the pupils' question formation abilities, and to assess the impact of the program on the teachers' attitudes towards and confidence with computer assisted learning.
Figure 13.2 Level 1 Flowchart
6. PROJECT PLANNING

Following the design of the course and the setting out of the course specifications, it is necessary to plan the process and timescales along which these plans are to be executed. The project planning methodology used is that recommended by Andersen et al (1988) who argued that the primary goal of project planning is the focusing on results. These are achieved by using milestone plans which specify a series of goals to be met in order to meet the project's final objectives. The project plan also defines the logical inter-relationship between these goals, and the activities needed for progression from one milestone to another. Appendix 13.5 illustrates the milestone plan for this research project with associated dates and results paths showing the dependencies between the various activities.

7. CONCLUSION

This Chapter has attempted to lay down detailed plans for the implementation of the courseware, including specifications for the functionality of the course, learning strategies and screen design. Both Level 1 and Level 2 flowcharts were then designed and from these, areas selected for the production of both a requirements and specifications prototype. The next Chapter discusses the results of the prototyping process including feedback received and courseware amendments required as a result of prototyping and field testing.
CHAPTER 14

Evaluation Report: Courseware Development Phase

1. INTRODUCTION

This Chapter comments on the deliverables planned in Chapter 13 (see Appendix 13.5) up to and including IMP 8, the completion of the final courseware version of the program. It will look at each of the deliverables (e.g., Needs Assessment document, Courseware Design document, Courseware Implementation document and the results of plans for courseware prototypes) in terms of the process of producing them and the quality, or otherwise, of the final product. Where the deliverable is different in any respects to the original plans, this will be stated and a rationale given.

2. COURSEWARE PRODUCTS

This section evaluates each of the deliverables presented in the Project Milestone Plan (Appendix 13.5).

2.1 AN 1: Needs Assessment document

The Needs Assessment document which looked at the job task and learning task analysis for the identified problem proved a useful resource on which to build subsequent design specifications. The main direction and plans provided by this document was adhered to.

2.2 DES 1: Courseware Design document

This document identified specific learning objectives and their cognitive levels. The instructional curriculum maps that were designed from this analysis proved especially useful when it came to designing the courseware flowcharts (as part of IMP 1). Not only did they illustrate the relationship between concepts, but identified the learned capabilities required. Thus the task of selecting appropriate learning strategies at the courseware design stage was made much easier. This does not mean to say that all the strategies suggested in DES 1 were followed precisely. The prime difference between the plans laid down in DES 1 and actual events was that the requirements prototype was started but never completed; reasons for this are given at Section 2.4. Another difference was that 'Course Introduction' was not
implemented, because it was felt that it was too 'wordy' for the target audience (see Section 2.5).

2.3 IMP 1: Courseware Implementation document

As with the Needs Assessment and Courseware Design documents, most of the ideas and plans presented in the Courseware Implementation document were followed. There were, of course, some changes that were necessary. Under Chapter 13, section 2.2, Learning Strategies it was suggested that when learners are using the Toolbox to transform words, textual feedback would be given after each button was used. In discussing this issue with the programmer, it was felt that this might prove distracting to the learner and that, in any event, users would be able to see what was happening without having to be told. Furthermore, given the reading ages of many hearing-impaired children, the less reliability on the written word, the better. The programmer also commented that many children have computers at home and that they seem especially adept at 'hacking' around a program to find out how it functions. It was decided to keep textual support to where feedback was needed on pupil performance on the sentence transformations.

The Courseware Implementation document suggested that when learners were transforming 'Do' words, only this aspect of the sentence would have to be transformed, the program automatically changing other elements such as verb tenses. It was decided at the implementation stage to make the user transform all the necessary aspects of the sentence (decapitalise the original starting word, add a question mark, etc.). In this way, additional practice would be given on these other elements, and greater redundancy of information achieved.

The original plan for text presentation was that it would be in a 14 point serif font to make discrimination of individual letters easier. At the implementation stage it was decided that a font containing rounded version of the letter 'a' (this is an example) should be used, since younger children find these easier to discriminate. Unfortunately, the only font that could be found with this style of letter was Century Gothic, a sans serif font. The researcher and programmer were, however, concerned about the learners' choice of fonts and decided to examine user reactions to font size and type at the prototyping stage of courseware development.

It was the issue of making effective use of screen space that led to a major change in the overall layout of the interface. Figure 13 in Chapter 13 shows the Help bar and Toolbox areas on the left of the screen with a Control bar at the bottom. In discussions with the programmer the idea emerged for moving both Help and Toolbox areas over to the right hand side of the screen and to incorporate control bar functions into the Toolbox. This, and doing away with the Title bar which seemed superfluous, had the effect of generating more room on the screen.

In the Courseware Implementation document, Table 13.1 shows plans for an 'erase' toolbox button. The original intention was to use this to erase any operation (sentence transformation) the pupil found unsatisfactory so they could start again. In essence, it performed the opposite function to the 'accept it' button. However, when the researcher was producing screen designs it was found that in 'Unit 3: Do words' a
button was required for removing the 's', 'es', 'd', or 'ed' endings of some words when making a transformation. As already discussed, there were concerns that the screen was already crowded enough without the addition of yet another button. In discussions with the programmer it was decided to use the original 'erase' button for removing these word endings. If the learner was dissatisfied with the transformation they had produced they could always use the 'Again' button to start again. Whether learners understood that they could do this would, once again, be tested by the prototype. In the prototype version the 'Again' button was represented by a backward-facing arrow. In functional terms this arrow would loop a user to the beginning of the section so that it could be reviewed. It was not felt that a 'page back' button was necessary since the reversal of most operations (e.g., capitalise and decapitalise) could be achieved by re-pressing the appropriate Toolbox button (in effect, a toggle operation).

One of the major difficulties faced in producing the Courseware Implementation document was the design of plans which conveyed a true picture of the researcher's intentions to the programmer. One of the conventional ways of doing this is flowcharting and, indeed, most of the plans handed over to the programmer were the flowcharts (Appendix 13.3). One of the problems of flowcharts, however, is that they give an impression of a sequential movement through various screens, sometimes with optional branching. This, though, may not be an entirely true reflection of the intended functionality of a program or the way in which it can be used. There may, for example, be a number of functional areas on the screen which, when activated, produce an action or activity or which pass on a function to an object. Flowcharts are not always effective tools for suggesting such functionality. The ideas of Jackson (1983) were therefore used which incorporate the concept of entity structures. Here, the developer specifies how the actions of an entity are ordered in time. So, for example, a developer may know that a number of different actions are possible at a certain stage (in any order of selection), and that some, at least, follow from other steps. The entity structure diagram reflects this 'open-endedness' and, at the same time, any constraints within which choices can be made.

The final charts presented to the programmer therefore consisted of a mixture of both flowcharts (reflecting sequential selections and routes) and entity diagrams. Even so, the plans handed over to the programmer, in practice, became discussion documents around which the designer and programmer clarified ideas and proposed new ones. The result was that a considerable number of changes were made to the original plans. Nevertheless, the original flowcharts are presented at Appendix 13.3 against which the final program can be compared.

2.4 IMP 2 and IMP 3: Courseware requirements prototype

The researcher began work on the requirements prototype using a hypermedia tool, *Linkway Live* which had been used successfully as part of a previous development project (Gray, 1992). The advantage of using a hypermedia tool for prototyping is the speed with which screens can be created and strung together. In principle, this enabled the building of an approximate program structure allowing the learner an
opportunity to examine the overall scope of the course and the relationship between its sub-sections and, by providing buttons, navigation routes between them.

The primary drawback of Linkway Live was that, unlike, for example, Toolbook, there was no Microsoft Windows version of the program. Also, only non-proportional fonts were available when proportional ones were preferred. A further restriction was the lack of similarity between graphics used (drawn inexpertly in Linkway's paint facility by the researcher) and those intended for use in the final implemented version, to be produced by a graphics artist. Again, it was felt that this would not give a true impression of the intended final program.

Another difficulty was that Linkway Live offered only a limited number of font sizes. The smallest available soon cluttered the screen limiting the range of screen designs and strategies that could be used. In a sense, because of these difficulties, the researcher abandoned the requirements prototype and spent some time implementing a variety of screens using Windows Paintbrush (see Appendix 14.1). This strategy proved extremely useful because it allowed the researcher to see how the number of screen areas could be used effectively and the possible relationship between them. For example, it was found that, by reducing the size of the area available for graphics, three functional screen areas could be created beneath it: one for presenting a sentence, another for allowing the learner to perform transformations on a sentence and an area for providing feedback. As a result, and through several iterations and changes to the design, some amendments were made to the original flowcharts.

2.5 IMP 4: Specifications prototype

Under the original courseware implementation plans, after field tests of the original prototype, the specifications prototype was to be produced by the researcher, again, using Linkway Live. In practice, the specifications prototype was produced by the programmer using Authorware Professional the intended implementation tool for the final version of the course. In some senses, this contradicted some of the principles of prototyping recommended by Gray and Black (1994) who suggested that prototypes should be 'throw away' in quality. This was because their purpose should be to act as communication tool between courseware designers or between designers and program sponsors, or they should be used to test out new ideas, possibly using a sample of end users as evaluators. Excessive time and effort should not be put into the prototype since, if the screen design, colour or functionality were not liked by those they were shown to, very little would be lost when the prototype was discarded. A further argument put forward by Gray and Black (1994) was that prototypes should not be produced with the same tool as the implemented version because implementation tools often contained complex functionality and were too unwieldy to produce cheap software to brief timescales.

The decision to allow the programmer to prototype, however, was vindicated by events. Firstly, the programmer proved to be highly skilled in using the authoring tool so the danger of spending too much time on the prototype did not occur - although the programmer did comment ruefully that certain routines had taken him
much longer to program than he had expected. Given the complexities of Linkway's scripting (programming) language, however, it is unlikely if these routines could have been written any quicker by the researcher, if at all. It was found that, in practice, the programmer was able to take the researcher's flowcharts and, after detailed discussions between both members of the team, the programmer managed to produce very creditable versions of small prototyped sections of the course. These included screen templates for the various functional areas (based on the researcher's Paintbrush design), all Toolbox tools, help area buttons, and some imported graphics.

What was evident, at least initially, was that the programmer paid only limited attention to the flowcharts and preferred to prototype what he thought was the general intention of the researcher. A number of prototype versions were produced, trying out routines and new ideas over a period of a month, each of which was shown to the researcher to elicit comments and feedback on areas that required modification. In essence, the prototype was being used as a discussion tool between program designer and programmer which is truly within the spirit of the prototyping process. One result of this dialogue was that it became evident that significant parts of the original flowchart plans could be dispensed with.

One example was the 'Course Introduction' which, it was felt, was rather superfluous since it did not allow the learner to actually do anything. It was felt that children would want to get into an activity at the earliest opportunity and an introduction might only serve to demotivate them. Another section similarly abandoned was 'Using the Toolbox' which had been designed to get the learner to try out each of the tools. It was felt that this rather abstract activity (in that it was not linked directly to a motivating activity) so early in the program was too artificial. While not providing instructions on using the Toolbox certainly contained some risks, it was felt that these were worth taking and that, given the enthusiasm for discovery of most young learners, they would find out how the tools worked by using them. If this approach turned out to be problematic it would be revealed at the piloting stage (IMP 7) and action taken to reinstate the original Toolbox tuition.

At this prototyping stage an attempt was made to see what graphics would look like on the screen before the graphics artist commenced work. It was found, however, that just one scanned colour image of the required size took about 2 megabytes of storage space. Since an image was planned for each of the nine rooms in the castle this would mean the number of disks required to deliver the final program might prove unwieldy. An alternative solution would be the compression of the files, but this would require the use of de-compression software by end-users which might not be available in many instances. The option selected was to use black and white images because these were less demanding on disk space and were the format preferred by the graphics artist. In addition to the drawings of castle rooms which were commissioned from the graphics artist, clipart images were also used to accompany the 'Help' units sentences. Ironically, it emerged that the artist who produced these pictures is himself hearing-impaired (see Appendix 14.2).
2.6 IMP 5: Pre and Post tests

Since it was shown in Chapter 7 that there are three levels of difficulty (easy, intermediate and difficult) in transforming sentences into questions which require the answer 'Yes' or 'No', test items were designed for each of the three areas. In an attempt to achieve some reliability in test design, 8 questions were written for each of the three levels, giving a 24 question test in total. There was a concern, however, about the inter-test reliability. It might be the case, for example, that the post test might be easier than the pre test because kernel sentences were shorter or the average number of syllables per word smaller. On examining a draft version of the post-test it was indeed found that the syllable count was less. After amending the post test, the syllable count is presented in Table 14.1.

It can be seen from Table 14.1 that the total word count for kernel sentences in each test is exactly the same and the number of one-syllable words almost identical. While the pre-test has three words of three syllables, this is compensated for by the fact that the post-test has more two syllable words. A chi-test was performed (Appendix 17.14, Table 1) and was not significant at any level ($X^2 = 1.26; df = 2$). It was therefore concluded that the two tests were similar in terms of difficulty.

The tests were also designed to ensure they each covered a similar range of modal words for transformation. If, for example, one test contained many items asking for the transformation of the word 'is' and, in practice, participants found this to be one of the easier words to transform, the test would elicit an artificially high success rate. Table 14.2, therefore, shows that the word 'am' is tested at the intermediate level in both the pre and post-tests. The tests are only dissimilar in treatment of the words 'could' and 'would'. Sentences in an earlier, draft version of the tests were criticised by a teacher of the deaf as being too ambiguous. After necessary changes, the pre-test contained a sentence with the word 'would' used at the intermediate level of difficulty, while the post-test used the word 'should' (a word not used in the pre-test). It is contended that these differences are not enough to be significant.

This care in planning the tests also helps to ensure consistency between testing and instruction, since the instructional program will contain examples of all the modal words listed in Table 14.2 (overleaf). To use one set of subject matter to instruct learners but another when testing them would have called into question the validity of the test.

<table>
<thead>
<tr>
<th>Table 14.1 Comparison of numbers of words containing one, two or three syllables per word for pre and post tests</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 syllable words</td>
</tr>
<tr>
<td>------------------</td>
</tr>
<tr>
<td>PRE-TEST</td>
</tr>
<tr>
<td>POST-TEST</td>
</tr>
</tbody>
</table>
2.7 IMP 6: Live intervention workbook

A draft version of the 'live' workbook (live in the sense the pupil is taught by a teacher – in this case the researcher) was produced and sent to two teachers of the deaf. The workbook (Appendix 14.3) received a few minor criticisms (Appendix 14.4) in terms of the phrasing of two questions. These questions were duly altered and a final version of the workbook produced.

Table 14.2 Similarity of distribution of modal words between pre and post-tests across easy and intermediate levels of difficulty

<table>
<thead>
<tr>
<th>Modal word</th>
<th>PRE-TEST</th>
<th>POST-TEST</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Easy level</td>
<td>Intermediate level</td>
</tr>
<tr>
<td>is</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>am</td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>are</td>
<td>✓</td>
<td>✓</td>
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<td>was</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>will</td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>were</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>can</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>could</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>would</td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>should</td>
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<td></td>
</tr>
<tr>
<td>shall</td>
<td>✓</td>
<td>✓</td>
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<tr>
<td>may</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>might</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>must</td>
<td>✓</td>
<td></td>
</tr>
</tbody>
</table>
2.8 IMP 7: Courseware pilot version

Once completed, the courseware pilot version was taken into the field and tested by two different hearing-impaired children and two teachers of the deaf. The first child had a reading age which was so limited, it was not measurable by any of the standardised tests. It very quickly became obvious that he also had poor hand-eye co-ordination with the result that he could not control the mouse. This, plus a generally short concentration span, meant that, within a minute, he was distracted away from the program. The session with this pupil was abandoned. It is interesting to note, however, that the class teacher reported (letter to the author) that the next day, he demanded to know where the computer had gone!

The second pupil fared much better from the start. Once shown that the buttons had a function, he quickly wanted to take control of the mouse himself. The researcher gave him verbal guidance and directions and continually pointed to the screen to emphasis that, for example, a particular button decapitalised a word. Having watched the simulation of an easy level transformation twice, this pupil worked on his own and achieved three successful transformations. He appeared extremely proud of his achievements and turned round frequently to elicit approval from the researcher and his teachers. The first child was, by this time, sitting beside him and taking a further interest.

A teacher of the deaf evaluated the pilot courseware version, and agreed that the language level was appropriate to the pupils, and that the learners appeared to cope adequately with navigational controls. She approved the general screen design but did take issue with the font in which sentences were presented, preferring the sans serif font used for feedback. This information was subsequently passed on to the programmer and implemented.

On reaching the difficult level of transformation, the second pupil, to his obvious surprise, got the transformation wrong - realising that the 'Well done' feedback had not appeared, but instead some other words. Significantly, he made no attempt to use any of the 'Help' buttons, contradicting the hypothesis of the researcher that a user would 'hack' around the program and thus discover the help and simulations available. This was a cause for concern since the second pupil, on receiving feedback on a wrong answer, had proceeded to repeat his errors. This caused the researcher to think of ways of limiting the 'open' design of the program by building in an automatic remedial loop to the relevant 'Help' section, should the learner get a certain number of transformations wrong in sequence.

In general, the pupils showed great enthusiasm for using the computer. A group who visited the classroom where the program was being tested were disappointed that they could not try it out immediately. Several gave the researcher a nod of approval as they left.

Ironically, it was the reaction of the teachers that was, at least initially, most muted. It was observed that they positioned themselves well away from the computer until coaxed by the researcher to move forward. In conversation, they concurred with the researcher's view that many teachers are technophobic and described themselves as...
very infrequent users of the medium. Encouraged by the researcher, however, one teacher took her place at the computer and was guided through a part of the program. She offered some constructive criticisms that one of the font types might be difficult for a poor reader to discriminate between certain letters. She also joked:

*Now we understand! You're not really here to test the pupils. You're here to test the teachers!* (Teacher's comment to researcher)

The second teacher suggested that one of the 'tick' buttons on the toolbar should be redesigned to make it look more like what it was meant to represent. She then proceeded, due to lack of concentration, to get one of the transformations wrong—much to the delight of the second pupil.

The second pupil completed the 'Pupil Courseware Evaluation: Prototyping Stage' (Appendix 12.2) The results showed that he found the mouse and buttons easy to use, and he liked the pictures and screen colours. He thought that the program was a 'Game' rather than a learning program and he thought it 'fun'. It should be noted, however, that the questions had to be explained and signed to him several times so there is some doubt as to whether he fully understood what he was being asked to comment on. Overall, though, he seemed to have understood some of the questions posed by the evaluation form, so the use of icons and graphics on the form proved useful. For example, for the last question on whether he liked the program, he had no hesitation in choosing the man posing at the top of a mountain rather than the duck striking a computer with a sledge hammer.

A copy of the Teachers' Courseware evaluation form (Appendix 12.1) was left with them, in case they had any further comments to make on the program. No response was received. There may be a number of reasons for this, including the possibility that they were totally satisfied with the program, or that they had some reservations about the program but did not feel confident enough to comment about them.

2.9 EV 1: Pre and Post tests finalised

Copies of both the pre and post-tests were sent to two teachers of the deaf for evaluation. These teachers between them had more than thirty years of experience in teaching hearing-impaired children. As a result of feedback from one of these teachers, amendments were made to three of the original pre-test and one of the original post-test questions. Apart from these small changes, the teachers commented that they liked the design of the tests and the use of cartoons to support the text.

2.10 IMP 8: Final Courseware version

The final courseware version was delivered just four days before the researcher had arranged to use the program in a school as part of the CAL intervention. The researcher spent several hours looking for, and finding, 'bugs' in the program which were communicated to the programmer. As a result, a second version of the
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program was produced which proved to have many fewer (but by no means no) errors.

2.11 IMP 9: Final version of course used with sample

The results of using the final courseware with the selected sample of pupils is discussed and reported on in Chapters 16 and 17.

3. CONCLUSION

Not surprisingly, a number of changes had to be made to the original plans during the implementation phase of the project. Thankfully, however, none of these alterations were extensive, the Needs Assessment and Courseware design documents proving to be quite a robust basis on which to build the program. The most important development stage where there were differences between the plans the their implementation came, perhaps not surprisingly, during prototyping. Here, decisions were taken to abandon the production of a requirements prototype and to concentrate instead on a specifications version. This was produced by the programmer rather than the researcher and used the final implementation software rather than a specific prototyping tool. In this sense, the process rather contradicted some of the literature on the subject of prototyping, some of which had been written by the researcher himself. The process, however, seems to have been successful because the prototype versions produced by the programmer were developed quickly and skilfully, and, in the true spirit of prototyping, were used for debate and discussion between programmer and the researcher (designer).

The pilot version of the courseware was sufficiently well designed that a hearing-impaired pupil was able to follow the simulation of a transformation and to perform some himself, at least at the easy level of complexity. The teachers of the deaf who evaluated the program were able to overcome their own anxieties about using a computer sufficiently to offer some valid and constructive recommendations for changes. These, however, were not extensive. Similarly, the pre and post-tests only required some minor alterations.
CHAPTER 15

Date Collection & Analysis:
Teacher attitudes towards Computer Assisted Learning

1. INTRODUCTION

This Chapter, and Chapter 16 which follows, answers those hypotheses that can be dealt with by qualitative analysis. Essentially, it examines the hypothesis:

The use of a program dealing with issues of direct relevance to hearing-impaired children will have no effect on teachers of the deaf in terms of their tendency to make use of computer assisted learning in the classroom.

by establishing a 'baseline' of teacher attitudes towards CAL. In doing this it responds to Research question 1 (see Chapter 9, Table 9.1) namely:

- What criteria are most influential in determining whether teachers of the deaf make use of CAL?

Having established this baseline, Chapter 16 evaluates the response of teachers and pupils to the CAL program.

In Chapter 8 it was argued that hearing-impaired children may be a group who particularly benefit from using computer assisted learning (CAL), in part, because of the capacity of the medium for mastery through repetition and its 'non-threatening' nature. As was stated in Chapter 9, the aim of the program is to achieve this mastery through the development of higher level problem solving skills. The program may be successful in developing these because CAL can provide variety and feedback not necessarily available in a normal classroom situation. It was suggested that the extent to which computer assisted learning is used in the classroom, however, is largely dependent on the attitudes of teachers of the deaf to using it. This may be influenced by factors such as the teachers' attitudes towards, and confidence in using, information technology in general, the availability or otherwise of computer assisted learning programs, and teachers' success or failures in using the medium with their pupils (Gray, 1995a). This Chapter, therefore, reports on the research into the attitudes of teachers of the deaf towards computer assisted learning and, in order to assist future developers of computer assisted courseware, identifies the problems these teachers have faced in using CAL, and what features they regard as important.
in the design of learning software for their pupils. This includes subject matter, levels and types of interactivity, the appropriateness of graphics, and factors that are likely to generally stimulate learner motivation.

2. METHODOLOGY

A questionnaire was drawn up (see Appendix 9.1) and sent to a sample of 50 teachers of the deaf drawn from the BATOD Directory (1994). This Directory, compiled under the auspices of the British Association of Teachers of the Deaf, was produced to establish a comprehensive list of teachers of the deaf in Britain, and therefore could be said to represent the population of teachers of the deaf as a whole – or at least as near as it is possible to establish one. The sample for the study was selected by assigning a number to each name in the Directory (with the exception of those designated as being involved in LEA service provision who, it was felt, might not all be involved in day-to-day teaching of hearing-impaired children and who would not, therefore, be appropriate to this study). A table of random numbers was then taken, and numbers generated until 50 names in the Directory had been chosen. According to Kerlinger (1986), this procedure has a reasonable likelihood of producing a random sample, in this case, one that is representative of the population as a whole of teachers of the deaf in the UK.

Two weeks after the issue of the original questionnaire a reminder was sent to all those who had not responded. One questionnaire was returned because the addressee had 'gone away' so an additional name was selected, again by random selection using a table of random numbers. Eventually, 56% of the questionnaires were returned so for the resultant sample N=28.

Oppenheim (1992) has commented that one of the main problems that non-response causes is that of bias. It might be, for example, that most of the non-respondents failed to complete and return the questionnaire because they did not use computer assisted learning or even because they were hostile to it. The returned questionnaires, therefore, might under-represent these attitudes and be skewed towards the views of those who are favourable to the medium. In an important sense, then, there is the danger that the sample analysed could be said to be not truly representative of the population as a whole.

This danger of bias was addressed by selecting (again randomly using a table of random numbers) a sample of 6 non-respondents who were contacted by telephone and questioned about the reasons for their non-response. When contacted, each teacher was asked whether their non-response was due to any of the following (respondents being able to choose more than one item, if appropriate): a) a lack of interest or antipathy towards CAL; b) insufficient access to CAL; c) a lack of time to complete the questionnaire; d) the fact that they had not received the questionnaire. It was found that antipathy to CAL was not a prime reason for non-response amongst any of the sample contacted. The main reasons for non-response included that respondents had not received a questionnaire, they had insufficient time to complete it, the recipient of the questionnaire was ill, and the fact that the school no
longer contained any hearing-impaired pupils. It is contended that these findings suggest that the original sample may not have been skewed towards those who are particularly favourable to CAL and therefore may be fairly representative of the population of teachers of the deaf as a whole.

3. RESULTS

Since this is largely an exploratory study, a level of statistical significance of \( p < 0.10 \) has been accepted for the research. This is because the aim is to discover possible independent variables which may impact on the learning of hearing-impaired children and which may effect the attitudes of teachers to CAL. Setting significance at a more conservative level would not allow these variables to emerge. Nevertheless, on the occasions where greater significance is reached, this level of significance will be quoted. Quantitative data from the questionnaire is presented at Appendix 15.

3.1 Teachers' attitudes to computers

Teachers were asked about the extent to which they made use of computers. Results indicated quite an even division, since nearly half replied that they used computers either 'Very much' or 'Much', while the other half used the technology either 'Not much' or 'Not at all'. Only two respondents were in the 'Not at all' category, and the questionnaire probed for reasons behind this lack of use. It was found that a minimal interest in computers was not a significant reason for this lack of uptake, more important reasons being a lack of training in computer use, followed by a perceived lack of suitable packages and programs, and finally, the unavailability of computers in the school.

Of the reasons given for not using information technology, all but one respondent made some mention of time. Hence, reasons given included a lack of time to undertake training in their use, a lack of time to get to know the programs, and timetabling problems which restricted access to computers. One respondent complained that computers were unavailable because they were located in the mainstream of the school and not in the deaf unit.

Those teachers who made fairly frequent use of computers tended to use them mainly for word processing with most respondents using the computer for this purpose for at least 1–2 hours a week, and over a quarter of respondents working on word processing for up to 4 hours a week. Databases and spreadsheets were also made use of, but this tended to be for short periods of 1–2 hours, or less, per week. Some teachers also used the computer to generate graphics, but most did not use this capability. What is significant, however, is that it was not just the teachers who had access to computers, but pupils also had regular access to the technology as well. It would appear that all hearing-impaired pupils whose teachers responded to the questionnaire, have access to computers for at least part of their timetable, most for only 1–2 hours a week, but a fifth for as much as 3–4 hours and a similar proportion for more than 5 hours. This, however, may be due more to the requirements of the
National Curriculum for teaching information technology than to the enthusiasm of pupils or the encouragement of teachers.

The tendency to use computers did not differ significantly between type of school (First/Infant, Junior/Primary, Middle and Secondary). There did seem a tendency, however, for some secondary schools to make heavy use of computers and a majority of Junior/Primary to make use of them considerably. Computer usage seemed less obvious in First and Infant schools although some did make use of them to a limited extent.

3.2 Teachers' use of CAL

The association between the frequency with which teachers of the deaf make use of computers (for example, for word processing, use of spreadsheets, databases, etc.), and their use of CAL was measured using the Cramer coefficient $C$ (Siegel and Castellan, 1988) which shows the degree of association or relation between two sets of attributes or variables (see Figure 15.1). Calculating for the coefficient found that $C = 0.328$ ($\chi^2 = 3.02; df = 3$) which was not significant (Appendix 17.14, Table 2), that is, it was not found that those teachers who made regular use of computers also tended to make frequent use of CAL.

The association between years as a teacher and use of CAL was also calculated using the Cramer coefficient which found that $C = 0.71$ ($\chi^2 = 13.52; df = 6$) which was significant at the level $p < 0.05$ (see Appendix 17.15, Table 3, and Figure 15.2, overleaf). This suggests that more experienced teachers tended to make regular use of CAL while less experienced teachers did not.

![Figure 15.1](image.png)

**Figure 15.1** Frequency with which teachers make use of computers and whether they make use of CAL or not ($C = 0.328$, $\chi^2 = 3.02; df = 3$)
Examining the relationship between years as a qualified teacher of the deaf and use of CAL found a positive correlation: $C = 0.70$ ($\chi^2 = 14.67; df = 6$) which was significant at the $p < 0.05$ level (see Appendix 17.15, Table 4, and Figure 15.3). Again, like length of service as a teacher, the more experienced teachers of the deaf were more likely to use CAL than their less experienced colleagues.

Examining the use of CAL by category of school, it seemed that most teachers involved with mainstreamed hearing-impaired children do make some use of CAL. This trend was not so pronounced for deaf units where a slight majority did not use the medium. There were only two respondents in the sample who were from special schools. Both of these respondents indicated that they did make use of CAL.
Even amongst those who used CAL, half stated that this use was not particularly regular, and a further 12 per cent regarded their use as irregular. No respondent said that their use of CAL was very frequent. It is perhaps ironic, therefore, that the overwhelming majority believed that pupils actually enjoy learning through computer assisted learning, and most believed that pupils persevere in their learning when making use of CAL. Again, a substantial majority thought CAL encourages pupils to learn a topic, and all respondents believed that the medium gives learners a sense of accomplishment, 21 per cent strongly agreeing with this statement, and none disagreeing.

The questionnaire probed for the kinds of difficulties which teachers have faced, or some of the inadequate design features teachers have come across, in their use of computer assisted learning. A majority of respondents, for example, had found that the pace of CAL programs had not always been satisfactory, while half had found that the navigational tools (menus, buttons, maps, etc., vital for moving around the program) had not always been readily available. While most had found the quality of graphics in CAL programs satisfactory, many felt that the courseware they had seen had not made sufficient use of animation where this had been appropriate.

Some strong doubts were expressed by some teachers as to whether CAL is more effective as a medium of instruction than live teaching. The latter was seen as more flexible than CAL, and sometimes the low quality of computer hardware that teachers had to use (some of it quite old), made CAL seem poor by comparison:

*Usually pupils share computers and they are slow..... Children are keen at the start and then get disappointed and time is lost.*

(Secondary school teacher)

The lack of reliability of some software and hardware made it difficult for pupils to get on with their tasks. Another teacher, overall a supporter of CAL, was currently less enthusiastic, having had to adapt to many different computer systems over the past two years. Other teachers, however, commended what they saw as the strong motivational qualities of CAL and welcomed the effectiveness of certain courseware (although few gave details about the titles or content of these programs).

In using CAL, teachers reported various difficulties which had arisen. Respondents indicated the strength of these attitudes to a range of topics by ticking whether they agreed 'Very much', 'Much', 'Not much', or 'Not at all' to the statements. The statements themselves included whether teachers had found sufficient interactivity in the programs they used, to whether programs worked properly. The data was analysed by allocating a value of 4 to each response of 'Very much' down to 1 mark for each response of 'Not at all'. A mean value was then derived by dividing the total score for each question by the number of respondents to that question (see Appendix 15, questions 7–19). These values were then ranked. Analysis revealed that teachers agreed most strongly to the statement that pupils enjoy using CAL and that they achieved a sense of accomplishment from these programs. The latter finding confirms responses to earlier questions about pupil enthusiasm for, and
Hearing-Impaired Children and CAL Data: Teacher attitudes to CAL

perseverance, in using CAL. What emerged as one of the main areas of difficulty was that teachers believed that programs tended to be at too low a cognitive level.

3.3 CAL and hearing-impaired pupils

The questionnaire probed for instances when CAL programs had been amended specifically for hearing-impaired pupils, but found no instances where there was knowledge that this had been done. What the research revealed was that there was also a dearth of programs designed for vocabulary building, a particularly important learning area for hearing-impaired children, most respondents not making use of any programs in this area, and only two indicating use of such programs. The ones cited were IBM Speechwriter and Brickup. As for another important area, syntax development, the vast majority replied that they did not make use of any CAL programs for syntax building, only one responding use of a program called Sentence Sorting.

In using CAL, a minority of respondents indicated that they gave additional help to hearing-impaired learners when using courseware programs. These included the use of coloured symbols placed on the computer keyboard, but in most cases the assistance took the form of signed support.

The research found various factors that would make teachers of the deaf more willing to make use of CAL in the classroom. As with the analysis of difficulties teachers have faced with CAL programs, strongly agreeing responses were given a value of 4 down to strongly disagreeing ones a value of 1. Again, the mean value for each question was calculated by dividing the total score by the number of respondents. Mean values were then ranked, revealing quite a dichotomous stance towards hardware and software, with low ranking responses being the need for faster, more powerful computers and more computer hardware in the classroom. In contrast, highest mean scores were for cheaper and better designed software (Appendix 15, question 28). This supports the earlier finding in the study that teachers regretted the lack of programs in key learning areas and, given the consistency of responses across similar questions, adds some confidence to the belief that the questionnaire itself may have been a reliable measuring tool.

4. DISCUSSION

The low correlation between the frequency of computer use and the tendency to use CAL is rather a surprising outcome. In principle, it seems it is possible for a teacher to make little use of computers for general purposes such as word processing but to make more use of them for CAL. It is probably more likely, however, that those teachers who make frequent use of computers make relatively little use of CAL. The fact that many teachers still make little or no use of computers in any capacity must be a cause of disappointment, and endorses the worries of government inspectors noted in Boyes (1991). It has been suggested by Salter (1985) that this lack of uptake may be due to lack of tuition on teacher training courses, and this view is endorsed by a number of respondents in the study. It is interesting to note
that most teachers who made only sparing use of computers blamed lack of time to undertake training as one of the major contributing factors, a current problem which may be exacerbated by the increased pressures placed on teachers by the demands of the National Curriculum (Gray, 1993).

On the whole, it seems that relatively few teachers of the deaf make use of CAL on anything approaching a regular basis, yet there was widespread belief that pupils enjoy using CAL, gain a sense of fulfilment from it and are motivated in using it. Clearly, this contradiction can be partly explained by some of the difficulties teachers have had in finding suitable CAL programs or their negative experiences with faulty software and hardware.

It is possible, however, that some of this reluctance to use CAL may stem from a belief amongst teachers of the deaf that live interaction between pupils and between pupils and teachers is essential, especially for the development of language. Certainly, there were indications of this view in some of the responses. While in no way contradicting the validity of this belief, it may, in some part, stem from a lack of information about the way in which new technology can help deliver language in a way that is both interactive and motivating. It seems from the feedback received in the questionnaires, however, that few programs aimed at language development exist, particularly in important areas like syntax. The concern, raised in Chapter 8 that a factor limiting the uptake of CAL amongst teachers of the deaf is a lack of suitable programs, is therefore given some support. Ten years after Behrmann's (1984) research, which found that few programs were being designed specifically for deaf children, the situation has hardly changed. Furthermore, this study was able to find only one example of software being modified by a teacher to make it more appropriate to her pupils. Teachers of the deaf also seem keen on CAL programs containing amplified sound (obviously at times when the sound element plays a part in learning). It would appear therefore that teachers believe that a medium using a variety of communication channels such as text, graphics and sound (in practice, what is now termed multi-media) may offer particular benefits to hearing-impaired children. Multi-media, then, might go some way to meeting the need, identified in this study, for better designed software, although it is unlikely to meet teachers' other hope that it should be cheaper.

It seems, therefore, that teachers may be trapped in a vicious circle. Relatively few teachers of the deaf make any significant use of CAL, partly because some teachers have insufficient confidence in using the technology, but also because very little relevant software seems available. What software that does exist appears to have been written exclusively for hearing children, inevitably paying no attention to instructional areas which may be especially important for the successful learning of hearing-impaired children, e.g., the importance of graphics and highly visual forms of communication. A number of teachers, for example, commented on the lack of animation in the programs they had seen.
5. CONCLUSION

The question remains as to what factors would make teachers more willing and able to make use of computer assisted learning. Certainly, access to computer hardware, particularly if it was up-to-date and incorporating high resolution graphics and fast processors, would be an essential starting point. Yet, as section 3.1 suggested, the fact that teachers use computers does not necessarily mean they also use CAL. Hence, access to computer hardware may be a necessary but not sufficient factor for the use of CAL – other criteria are needed. Teachers must also have the confidence to use the new technology, and this means they must have levels of support, including in-school technical support and training, if some are to climb the learning curve to achieve mastery of basic information technology skills. Since lack of time was identified in the study as a key element for those teachers who were failing to make significant use of computers and CAL, it would seem essential that school managers look at ways of creating space in the timetable for staff to have these learning opportunities. Also, since it appeared in the study that less experienced teachers of the deaf were less likely to use CAL than their more experienced counterparts, it may be appropriate for those involved in training courses for teachers of the deaf to examine ways of encouraging confidence in the use of the medium. One approach would be to 'pair' novice and experienced teachers.

There seems little point, however, in giving teachers both the hardware and the skills in using the technology, if the software to run on the computers does not exist. The study found that key learning areas for deaf children, primarily language learning and syntax, were not well served by current CAL courseware provision. Indeed, this view was confirmed by an unsolicited letter (Appendix 15.1) received by the researcher from a teacher of the deaf, written in response to a published article by the author (Gray, 1995b) expressing precisely these views. Furthermore, many programs were not particularly well designed, with improvements possible in features such as amplified sound and feedback on performance.

The next Chapter reports on whether the CAL program designed as part of this project, in the key learning area of syntax, influences the attitude of teachers of the deaf to CAL as an instructional medium.
CHAPTER 16

Date Collection & Analysis:
Teacher and Pupil Evaluation of the CAL program

1. INTRODUCTION

Having established a baseline of teacher attitudes towards CAL in Chapter 15, this chapter takes the hypothesis:

The use of a program, specifically designed for hearing-impaired children, will have no effect on teachers of the deaf in terms of their tendency to make use of computer assisted learning in the classroom.

and examines teacher responses to the CAL program. It also evaluates the hypothesis:

The involvement of teachers in the design and development of the program will not make them more favourable to its integration into the classroom.

To determine some answers to these hypotheses, the Chapter examines the findings related to Research questions 2, and 3 (see Chapter 10, Table 10.1) namely:

- Does the research study CAL program encourage teachers of the deaf to use CAL as a teaching medium?
- Is CAL considered to be more convenient for teachers/learners?

In essence, the Chapter reports on the results of two studies. The first was amongst a randomly selected sample of UK teachers of the deaf (who we will here call the UK study), each of whom was sent a limited, demonstration version of the final computer program and asked for their views. A key question here was the extent to which the program was perceived as relevant to the needs of their pupils, and the extent to which it encouraged them, as teachers, to make use of CAL. The second study was carried out through eliciting the views of the pupils from two Surrey schools who viewed the entire program as part of Research question 5 (see Chapter 17), (who we will call here the Surrey study), plus the views of their teachers. It was felt that it might also be useful to compare the views of the UK and Surrey groups.
and also to see whether the researcher's own observations confirmed or contradicted any of the views of the two groups.

This section of the empirical work proved to be particularly difficult especially in eliciting feedback on CAL from teachers of the deaf. The reasons for this difficulty, however, have some salience to the research at a general level and so it is included although the results per se of the survey are, at best, inconclusive.

2. METHODOLOGY

2.1 UK Study

For the UK study, a questionnaire was drawn up and a sample of 50 teachers of the deaf (drawn from a population of 700 school addresses) randomly selected for its distribution. Random selection was achieved by taking the numbers assigned to each name in the BATOD Directory (1994) and choosing them by selecting numbers from a table of random numbers. Each teacher in the sample was sent the questionnaire (Appendix 9.2), a letter of explanation (Appendix 16.1), two disks containing the demonstration of the CAL program, loading instructions (Appendix 16.2), a teachers' guide (Appendix 16.3), and a self-addressed stamped envelope.

Section 1 of the questionnaire sought out general details about the experience of the respondent with hearing-impaired pupils and the degree of support they perceived themselves as receiving. Section 2 examined how easy the program was to load to see if changes to the issued loading instructions were necessary; it also asked whether teachers had access to IBM-compatible computers. Section 3 asked respondents to indicate their responses to various aspects of the demonstration program according to 4 levels on a Likert attitudinal scale.

One week after posting the demonstration disks and questionnaires, three sets of disks were returned by respondents. This was an early indication that relatively few schools possessed the hardware (and in some cases the knowledge) to run programs operating under Windows 3.1 on IBM compatible hardware. In all, only 10 replies were received out of the original sample of 50 (one of these being received one month after the data had been analysed, and so had to be discounted). It was therefore decided to follow up non-respondents by telephone with a short questionnaire (Appendix 16.4) which gathered a further 8 responses. So this section of the research achieved a response rate of 34 per cent (N = 17).

2.2 Surrey Study

a) Pupils

Some concerns had arisen at the prototyping stage of courseware production (Chapter 14) about the ability of hearing-impaired pupils to fully comprehend the kinds of questions asked on an evaluation form. A modified form was therefore drawn up (Appendix 9.3) which sought to establish simply whether the children in
the study preferred either live instruction (in the sense that a teacher would be present) using a workbook or computer assisted learning. There was some anxiety that some children's answers might be invalid if they had no experience of computer use. Obviously those who had just engaged in the CAL game would have some familiarity with computers, but those who had engaged in the live instruction were asked whether they had used a computer before. All stated that they had, the question often precipitating a detailed description of the number of computers and the types of games used at home. The researcher took detailed notes as the pupils experienced the CAL intervention which were later transcribed in detail (Appendix 16.5).

b) Teachers

The teacher's questionnaire (Appendix 16.6) was based on the original prototyping questionnaire. The sample involved in the study (only 2 teachers) was not large enough to achieve results of any statistical significance. The evidence gathered here, therefore, should be seen as, at most, possibly indicative of teacher attitudes in general. Any reliance placed on them will only occur where these results coincide with results from the larger UK section of the study.

3. RESULTS

3.1 UK Study

The small size of the return made it impractical to attempt any correlation studies between, for example, the amount of perceived assistance in the classroom and attitudes to CAL. In sum, one of the main factors which emerged from the study was the lack of suitable hardware for running the program. Only three out of the original nine respondents managed to load the program successfully, four who failed to do this stating that they did not have the appropriate computers (IBM compatibles or the Windows 3.1 operating system). The other two teachers made no comment. Indeed, one of the three teachers who was successful in viewing the program only did so because she used her IBM compatible computer at home.

Opinions were fairly evenly divided about the clarity of the loading instructions provided with the program; two respondents found the instructions mostly clear while three found them difficult or impossible. One of the respondents who found the instructions difficult still managed to load the program. The respondent who replied that the instructions were 'impossible' to use, returned the disks, one of which had a metal strip in a mangled state because she had 'difficulty in withdrawing the disk'. It is tempting to hypothesise that some teachers may have basic training needs in the use of information technology. It could also be the case that the researcher's loading instructions need revising.

Few teachers, then, managed to comment on the program itself. Of those who did, one stated: 'Great idea – especially interested as a speech and language therapist.' but there was a strong feeling that the program was too slow. Two of the three
teachers commented that they found the graphics unappealing, one even stating that: 'the rabbit looks like it's unwell'. It does not appear, however, that the program was shown to any of their pupils.

The follow up telephone enquiry revealed that seven of the eight teachers contacted had received the program but four of these had been unable to run it due to lack of suitable hardware. Most schools only possessed Acorn or Archimedes computers or in some cases very old BBC microcomputers. One commented on the lack of time available to try the program.

There was strong support, however, amongst respondents for the use of a CAL program for teaching syntax. Of those who responded to this question, 7 of the 8 stated they were very willing to use CAL for this purpose. Most already made use of computers for word processing with their pupils but were disappointed at the lack of suitable CAL programs available. This corresponds with the findings of the study discussed in Chapter 15. One teacher was currently undertaking a two year teacher training course for teachers of the deaf. When asked if this included a CAL component she replied: 'I wish there was.' One teacher even went as far as specifying the kinds of syntax areas CAL might be useful for delivering and included passive tenses, subordinate clauses and relative clauses. Another teacher offered to help in the evaluation of any CAL program the researcher produces in the future.

On balance, however, there is insufficient conclusive evidence to reject the null hypothesis

The use of a program dealing with issues of direct relevance to hearing-impaired children will have no effect on teachers of the deaf in terms of their tendency to make use of computer assisted learning in the classroom.

Nevertheless, the research did reveal a strong demand for CAL software specifically designed for hearing-impaired pupils, and especially in syntax development.

3.2 Surrey Study

a) Pupils

In analysing the results of the researcher's observations (a full description of which is at Appendix 16.5) there were inevitably differences between the pupils. Nevertheless, specific consistencies did emerge. It was apparent, for example, that few, if any, of the pupils had thought of or been taught any of the structural rules of sentence construction; they were unaware, for instance, that to make a question the auxiliary verb of the sentence has to be transformed to the beginning of the sentence. The novelty of learning about the rules of language enabled the researcher and some of the pupils to have some discussions and even arguments about the structure of sentences. This debate took place with children who were undertaking the live intervention as well as those who were using the CAL program.
It was interesting to note, in some cases, the kinds of glaring misconceptions some pupils held about the structure of questions. What emerged very clearly was that the pupils actually enjoyed using the program and, above all, persisted in using it. One boy, Paul, who was acknowledged by his teacher to be academically able but uncommitted, gave up his break time to complete the program. Many were given the opportunity by the researcher to quit the program but chose to continue. All but one continued to the end of the program. This can be contrasted with the live intervention where only one pupil chose to take a section of additional questions. Hence, observation of pupil performance at the computer suggested they enjoyed the program and using the computer as a learning tool.

The extent to which pupils enjoyed the CAL program was measured by asking for their media preference—live instruction using workbooks or CAL. It can be seen from Table 16.1 that preference for CAL was overwhelming, all pupils taking the CAL intervention choosing CAL as their preferred medium and 10 of the 11 pupils who took the live intervention preferring CAL.

b) Teachers

The two teachers who commented on the program thought that the language level in the tutorial text and practice questions was appropriate for their pupils. This result is not surprising since both teachers commented at an earlier stage of the project on the prototype version of the program. They also agreed that learners coped adequately with the mouse for navigating around the course and for moving text on the screen. There was general agreement that the screen design features of the program were adequate. These features included the layout of material, the amount of text on the screen, the positioning of buttons, and instructions and the use of colour. Both teachers also felt that the game format of the program was motivating for their pupils although one did comment that children usually preferred adventure games—presumably games with more colour, animation and challenge in terms of manipulating screen sprites.

Table 16.1 Frequency of responses of live and CAL groups indicating preference for live or computer assisted instruction, with 6 pupils in each group

<table>
<thead>
<tr>
<th>Type of instruction</th>
<th>Preferences for live instruction</th>
<th>Preferences for CAL</th>
<th>Totals</th>
</tr>
</thead>
<tbody>
<tr>
<td>Live group</td>
<td>1</td>
<td>10</td>
<td>11</td>
</tr>
<tr>
<td>CAL group</td>
<td>0</td>
<td>12</td>
<td>12</td>
</tr>
<tr>
<td>TOTALS</td>
<td>1</td>
<td>22</td>
<td>23</td>
</tr>
</tbody>
</table>
In making these comments it should be borne in mind that on no occasion did either teacher sit down and use the program herself, each preferring occasionally to overlook the participation of a pupil.

Given the small number of teachers involved in this part of the study there seems insufficient evidence to reject the null hypothesis:

*The involvement of teachers in the design and development of the program will not make them more favourable to its integration into the classroom.*

Nevertheless, the research did find that involving teachers in the prototyping process was essential to courseware design. This is evidence which may be of use to future courseware developers.

4. DISCUSSION

The CAL game was produced for IBM-compatible computers because this was the configuration most readily available to the researcher and programmer and the system for which a commercially reliable authoring system, *Authorware Professional*, was tried and tested. The research, however, confirmed those fears raised in Chapter 15 that contemporary hardware platforms and software operating systems (especially *Windows 3.1*) are still unavailable in many schools especially those in the primary sector. The complex pattern of non-compatible hardware of varying ages and functionality may have serious long-term implications for developers of CAL programs, including programs designed specifically for the deaf.

Those teachers in the UK study who did evaluate the program found it too slow. Certainly, the time taken for button-driven events to take place was slower than the researcher had anticipated. This may be a function of *Authorware* itself, especially when it is attempting to handle long data structures. This is probably the price one pays in using an authoring system instead of writing directly in a programming language such as *C* or *C++*. Using a programming language might improve the speed of the program but would also increase its development costs.

In contrast to the views of this limited sample of teachers, the observations of the researcher found that pupils seemed to relish the program both in terms of its challenge and graphics. The speed of the program in most cases seemed appropriate to the reading levels of the pupils, and no pupil commented on the slowness of the program. It did appear from the researcher's own observations, however, that most pupils needed considerable assistance in using the program. The initial introductory simulation proved inadequate, because most pupils did not appear to understand that they were watching a simulation and appeared confused with their lack of success in operating screen buttons (which the simulation itself was controlling). It is probable that this distracted them from the program's attempt to teach them button functions. Those who were prepared to operate and watch the simulation tended to cope better with the screen buttons at an earlier stage, but even some of these learners needed a little coaching by the researcher. (Suggestions for improving the program are made
later in this section.) Nevertheless, in all cases, pupils successfully used button functions within the first five to ten minutes of using the program.

It is acknowledged, however, that some elements of the program need amendment. The introductory simulation, for example, seemed to be understood only by older or intellectually more competent pupils (as measured by the pre or post tests) but not by others. The second simulation (of the intermediate level of difficulty) appeared redundant for two reasons. Firstly, it largely repeated the introductory simulation and was irrelevant to those who grasped the nature of the transformations and was tedious for those who did not. Secondly, as will be discussed in Chapter 17, analysis revealed that the distinction made between easy and intermediate levels of difficulty for question formation transformations by Fyfe et al (1993) may be flawed, so the second simulation may be irrelevant.

Once the data gathering phase of the research was over, several pupils who had taken the live intervention were granted their wish to use the program. Hence, three pupils gathered around the computer at the same time. It was noticeable that these children guided and assisted each other both in terms of how to use the program and also in terms of how to transform sentences into questions. It is therefore possible that more co-operative styles of computer use may be more effective than pupils working in isolation. Co-operative learning with the computer may also be more significant for hearing-impaired pupils because of the importance of stimulating communication and in turn the use of language. This may form a useful issue for future research.

5. CONCLUSION

A result of research discussed in Chapter 15 was that teachers of the deaf would be more willing to use CAL if programs existed which they thought were relevant to the needs of their pupils. The demonstration version of the game was sent to a sample of teachers of the deaf as an example of such a program. Unfortunately the hypothesis could not be tested in any meaningful sense because so few teachers had the hardware to run the program. Nevertheless, the research confirmed the findings of Chapter 15 that teachers are very interested in using CAL even if many currently lack the resources to do so.

Research revealed strong interest amongst pupils for the program even amongst those who clearly had access to sophisticated commercial games at home. The issue of whether this ultimately made any difference to their learning is discussed in Chapter 17.
CHAPTER 17

Data Collection and Analysis:
The impact of live tuition & CAL on syntactic abilities of hearing-impaired children

1. INTRODUCTION

Chapters 15 and 16 dealt with those null hypotheses that could be answered qualitatively. This Chapter examines the null hypothesis (stated in Chapter 9) which requires a statistical response, namely:

There will be no statistically significant difference between computer based instruction and live tuition (both using the same subject matter) in terms of improving the syntactic skills of deaf children.

It also seeks findings to Research questions 4 and 5 (see Chapter 10, Table 10.1) namely:

- Do learners enjoy using CAL, and what is its impact on learning?
- Does the CAL program enhance the learning of elements of transformational syntax? With respect to other teaching media, is it better (for a given time commitment)?

It will be recalled that a program has been produced, based on some of the principles for designing learning materials for the hearing-impaired outlined in Chapter 8. This program, and a set of 'live' instructional materials were taken into schools and used with a sample of deaf children. This Chapter describes how the sample was selected, how the pre and post-tests were carried out, and presents data that resulted from this part of the research. Finally, an analysis of this data is presented along with conclusions and implications.

2. METHODOLOGY

An initial sample of 24 pupils was selected (section 2.1). All pupils were given a pre-test (section 2.2) the results of which, with other variables, were used to select a split sample for the live and CAL interventions (section 2.3). After the interventions
both groups were given the post-test (section 2.4). The time each pupil spent studying the live and CAL interventions was also noted (section 2.9).

2.1 Initial sample selection

It was recommended in Chapter 10, that a stratified random sample of pupils be selected. In practice, for the sake of convenience, two schools in fairly close proximity (about 20 miles apart) were selected where it was known there were hearing-impaired units containing pupils in the age-range required by the study. It was confirmed that the total number of pupils in both schools in this age range was about equivalent to the 20 planned at the research design stage (see Chapter 10, Table 10.1). In order that the results of the study can be generalised, an attempt was made (Chapter 10, section 8.1) to establish that the sample was representative of the population of deaf children as a whole.

2.2 Pre-test

A test protocol was used to ensure that the children were quite clear about the objectives of the pre-test and what was expected of them in terms of completing it (see Appendix 17.1). Most pupils seemed to immediately grasp what they had to do, and undertook the task with enthusiasm. All, except one pupil, completed the test booklet in the appropriate way. In the case of the pupil who failed to do this (he was ticking all the multiple-choice boxes on one page), the problem was noticed quickly by the researcher and the protocol was stated again with the result that he managed to proceed without further difficulty. Most pupils completed the pre-test in about 10 minutes. The test was mostly administered to single pupils but occasionally to small groups of two or three, all working separately. In all cases, the pupils were observed by the researcher to ensure that there was no collaboration or interference from outside agencies. Administration of the pre-tests was mainly completed at one session in each of the two schools used for the study. In one case a pupil was absent on the day of the pre-test so an additional visit was necessary. This was arranged to coincide with the intervention and post-test.

The pre-tests, but not the post-tests, were administered to a group of hearing pupils at one of the schools, as the purpose of this part of the research was to compare their syntactic performance with the hearing-impaired children. They did not, therefore, receive either the live or CAL interventions.

2.3 Split sample section

For assigning the sample into groups to receive the live or CAL interventions, the names of all hearing-impaired pupils who had taken part in the pre-test were taken and assigned a number from 1 to 24, with the intention of dividing the sample into two groups, one to receive live instruction in transformational syntax, and the other to receive the CAL program. The live and CAL instruction groups were selected by choosing 12 numbers from a random number table (Kerlinger, 1986). A number, \( n \), was selected at random, then every \( n \)th number in the random number table was
found until a number corresponded with one of the numbers assigned to the pupils. This process was repeated until 24 numbers had been chosen and marked. Subsequently, on the advice of a teacher of the deaf, a pupil at one school was removed from the sample because his reading age was considered too low. The pupil had been assigned to the 'live' sample so for this sample N = 11; for the CAL sample N = 12.

After this process, care was taken to ensure that the two groups for live instruction and CAL were evenly balanced in terms of important variables, namely: type and degree of hearing loss, and achievement (in the pre-test) – see Table 17.1. To achieve the latter, a t-test was performed.

The t-test was not significant at $p < 0.05$ level ($t = 1.19; \, df = 16$), (Appendix 17.13, Table 4) and so it can be accepted that the two groups are sufficiently similar in terms of test results and that the split samples were evenly matched in terms of achievement. It was accepted that the selection of the sample achieved a reasonably even balance in terms of the key attributes mentioned.

The group of hearing children were chosen with the help of their regular class teacher on the basis that, in her opinion, they were of a broad cross section of ability and of comparable ages to the hearing-impaired children in the sample.

2.4 Post-tests

The test protocol (Appendix 17.1) was repeated before the administration of the post-test, but in most cases the children remembered the pre-test procedure and were quick to proceed with the test. Post-tests were administered immediately after the live or CAL interventions. In only one case did a pupil not seem to understand the purpose of the post-test. She had chosen a variety of response options (a, b, c, or d) in the pre-test, but in the post-test ticked option a for 23 out of the 24 questions; this was despite taking the post-test on the same day as the pre-test and having the nature of the test explained to her several times.

Table 17.1 Data for t-test on achievement levels for live and CAL groups

<table>
<thead>
<tr>
<th>Statistical data</th>
<th>Live group scores</th>
<th>CAL group scores</th>
<th>$T$-test and significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>9.81</td>
<td>12.41</td>
<td></td>
</tr>
<tr>
<td>SD</td>
<td>3.25</td>
<td>6.76</td>
<td></td>
</tr>
<tr>
<td>N</td>
<td>11</td>
<td>12</td>
<td>$t = 1.19$</td>
</tr>
<tr>
<td>df</td>
<td>16</td>
<td></td>
<td>$p &lt; 0.05$</td>
</tr>
</tbody>
</table>
2.5 Interventions and extraneous variables

In order to minimise the effects of extraneous variables (such as the impact of the researcher as a teacher) care was taken to ensure that all pupils who received the live intervention were given identical tuition. A protocol was drawn up (Appendix 17.2) and followed. A similar protocol was drawn up for the CAL program (Appendix 17.3) since it was anticipated that many pupils would be new to CAL and would therefore need support.

2.6 Approach to analysing data

For the pre-test, a pass mark of 10 was selected because, as Figure 17.1 shows, there is a distinct cluster of 9 pupils who scored below this threshold and who constituted about a third of the total sample. It made sense then, to compare the performance of this 'low' group, with the rest, the 'high' group who answered at least 40 per cent of the questions correctly. For the sake of consistency, this pass mark was retained for the post-test (Figure 17.2). Mean scores were lower in the post-test and so 12 pupils constituted the 'low' group.

Figure 17.1 The distribution of pre-test scores ($\bar{X} = 11.17; SD = 5.42$)

Figure 17.2 The distribution of post-test scores ($\bar{X} = 11.30; SD = 6.56$)
2.7 Item analysis

Both test instruments (pre and post tests) were analysed for reliability by calculating difficulty and discrimination indices. The difficulty index gives an indication of how difficult the test was for the pupils as a whole, and was calculated for each individual test item using the formula:

\[
D_d = \frac{U + L}{N}
\]

Where:

U = the number in the upper group getting the item correct
L = the number in the lower group getting the item correct
N = the number in sample

An item is deemed to be difficult if its difficulty index is 0.5 or below, that is, fewer than 50 per cent of individuals are answering it correctly.

A discrimination index was also calculated to see how each test item discriminated between those who should have answered the question correctly (the high scoring group) and those who should have got it wrong (the low scoring group).

The discrimination index was calculated using the formula:

\[
D_I = \frac{U - L}{N}
\]

Where:

U = the number in the upper group getting the item correct
L = the number in the lower group getting the item incorrect
N = number in each group (in this case half of the total sample)

A discrimination index of 0 would indicate a poorly discriminating item whereas a figure of 1 would indicate a highly effective discriminator. Ideally, the purpose of calculating these indices is so that questions that are deemed to be too easy or too difficult, or which fail to discriminate effectively, can be changed. This was not possible with this research due to pressure of time, and the difficulty of getting subjects to trial prototype versions of the tests. The analysis does, however, provide an indication of the general reliability of the tests and highlights questions, scrutiny of which, might yield insights into the children's thinking. These questions are discussed at section 4.6.

a) Difficulty index

For the pre-test, the difficulty level ranged from 0.26 to 0.74 (see Appendix 17.4). Perhaps, as expected, five out of the eight questions in the section designed as 'difficult' had a difficulty index of less than 0.5. Why three questions at the difficult
level should have difficulty indices of more than 0.5 will be discussed at section 4.5 (below). The first question in the pre-test also had a low success in terms of learner achievement with a difficulty index of 0.26; this may be partly by the fact that, as the first question, some learners were still confused as to the nature and purpose of the test.

For the post-test, the difficulty index ranged from 0.09 to 0.65 (see Appendix 17.5). As would be predicted, the difficulty level increased with the level of questions. At the easy level, only two questions had a difficulty index of less than 0.5, while at the intermediate level there were three questions and six questions at the difficult level. Indeed, one question at the difficult level (D9) achieved a difficulty index of 0.09, only two pupils getting it right.

b) Discrimination index

Appendix 17.4 shows that, for the pre-test, one item (E6) had an index of 0.86 but this was the only question that reached such a high discrimination figure. In all, only nine of the 24 questions in the pre-test achieved a discrimination index of 0.5 or better. There were no items, however, which showed negative discrimination, that is, where the low group fared better than the high.

For the post-test, the discrimination index (Appendix 17.5) shows that 11 items achieved a discrimination index greater than 0.5, ten of these being at the easy and intermediate levels of difficulty. It would appear that most of the difficult level questions failed to discriminate between high and low scorers, possibly because even the high scorers were involved in guessing in this section.

2.8 Reliability of test instruments

A way of ensuring the reliability of a test is to design it as two matched halves and to calculate the split-half reliability. The pre and post-tests were not designed in this way so the most appropriate method of determining the reliability of the test instruments is by using the Kuder-Richardson (K-R 20) formula which calculates all the possible split-halves of the instrument. Calculating the K-R 20 gave a figure of 0.85 for the pre-test and 0.91 for the post-test (see Appendices 17.4 and 17.5). Thus is appears that both the pre and post-tests were reliable.

2.9 Pupil perseverance on live and CAL interventions

As part of the research question about whether pupils enjoy using CAL (Research question 4), a careful record was kept of the length of time each pupil took in studying the live intervention workbook and the computer program. In judging the length of time spent, care was taken not to influence the pupils. For both the live and CAL interventions, the pupils were asked on several occasions whether they wanted to terminate the session or continue. Any indicative signs of fatigue, (yawning, loss of concentration, looking at a watch) were noted and the pupil immediately asked if they wished to continue or stop. The times were then to be
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cmpared to see if pupils persisted longer with the CAL game and, if so, whether the length of additional time they spent with the program was statistically significant.

3. RESULTS

Where the statistical significance of data is discussed this will be quoted at the probability level of $p < 0.10$, but, on those occasions where a greater significance is reached, this will be quoted. Quantitative data is presented in Appendices 17.6 to 17.11 and statistical calculations at Appendix 17.13 ($t$-tests), Appendix 17.14 (chi-square tests) and Appendix 17.15 (correlations).

3.1 The effect of deafness: deaf and hearing pupils' test performance

The pre-test results of the 12 hearing pupils were compared with those of the 12 hearing-impaired pupils from the same school, and from the same age group (Appendix 17.6). Mean scores (out of 24 questions) were 11.50 for the hearing-impaired group and 16.92 for the hearing. These differences were significant: $p < 0.05$ (for a two-tailed test; $t = 3.02; df = 22$) (see Appendix 17.13, Table 2, and for a summary, Table 17.2, below). This leads to the conclusion that, for this sample of children, deafness did have an impact on syntactic performance.

3.2 Test performance and deafness: did degree of deafness matter?

Figures 17.3 and 17.4 show the visual relationship between the variables degree of hearing loss (in dB) plotted against scores on the pre and post-tests. Data on scores and degree of deafness are presented at Appendix 17.7, and correlation statistics at Appendix 17.15, Table 1. As both sets of data can be considered interval/ratio the Pearson product moment was used for the analysis of correlations. This revealed a negative and significant correlation at the $p < 0.10$ level for a one-tailed test in each case (for the pre-test, $r = -0.38; df = 22$: for the post-test, $r = -0.363; df = 22$).

Table 17.2 Summary of $t$-test results for comparison of deaf and hearing pupils' performance on pre-test

<table>
<thead>
<tr>
<th>Statistical data</th>
<th>Deaf pupils</th>
<th>Hearing pupils</th>
<th>$T$-statistic and significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>11.50</td>
<td>16.92</td>
<td></td>
</tr>
<tr>
<td>SD</td>
<td>4.60</td>
<td>4.17</td>
<td></td>
</tr>
<tr>
<td>N</td>
<td>12</td>
<td>12</td>
<td></td>
</tr>
<tr>
<td>df</td>
<td>22</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 17.2 Summary of $t$-test results for comparison of deaf and hearing pupils' performance on pre-test
It can be concluded that, for this sample of pupils, there was an association, albeit a fairly weak one, between degree of deafness and test performance. Thus, in general, more profoundly deaf pupils tended to score lower than their less deaf counterparts.

3.3 Gain scores: which teaching medium was most effective?

In answering the null hypothesis that:

*There will be no statistically significant difference between computer based instruction and live tuition (both using the same subject matter) in terms of improving the syntactic skills of deaf children.*

data presented at Appendix 17.8 shows that the live instruction achieved an overall improvement in gain scores ($\bar{X} = 1.64$). For the CAL intervention half of the 12 pupils made either a small gain or no gain, the other half making losses ($\bar{Y} = -1.25$). Comparing the gains made through live instruction and through CAL, it was found that the differences in the gains were not significant (for a two-tailed test, $t = $...)

![Figure 17.3 Scatter diagram showing relationship between degree of hearing loss and scores on pre-test ($r = -0.38; p < 0.10$)](image1)

![Figure 17.4 Scatter diagram showing relationship between degree of hearing loss and scores on post-test ($r = 0.36; p < 0.10$)](image2)
1.62; \( df = 21 \) (Appendix 17.13, Table 3, and for a summary, Table 17.3, below). Figure 17.5 also shows that the distribution of gain score frequencies for both live tuition and CAL overlap considerably, lending credibility to the suspicion that the scores come from the same population. The null hypothesis, therefore, can be accepted, that is, in terms of teaching an element of syntax, there does not seem to be a significant difference between the computer and live tuition as instructional methods for this sample of children.

### 3.4 Live and CAL gain scores at varying levels of difficulty

Table 17.4 shows the aggregate gain scores at the easy, intermediate and difficult levels of transformation. For example, it shows that for live tuition at the easy level, adding the positive and negative gain scores for all pupils gives a total figure of 11. A table of individual gain scores for each pupil at the three levels of difficulty is given at Appendix 17.9. It can be seen from Table 17.2 that the gains for both live and CAL tuition are broadly similar, at least at the easy and intermediate levels of difficulty. These results are discussed at section 4.4.

<table>
<thead>
<tr>
<th>Statistical data</th>
<th>Live intervention</th>
<th>CAL intervention</th>
<th>( T )-statistic and significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>1.64</td>
<td>-1.25</td>
<td></td>
</tr>
<tr>
<td>SD</td>
<td>4.74</td>
<td>3.70</td>
<td></td>
</tr>
<tr>
<td>N</td>
<td>11</td>
<td>12</td>
<td>( t = 1.62 )</td>
</tr>
<tr>
<td>df</td>
<td>21</td>
<td>NS</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Aggregate gain scores at easy level</th>
<th>Aggregate gain scores at intermediate level</th>
<th>Aggregate gain scores at difficult level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Live tuition</td>
<td>11</td>
<td>3</td>
</tr>
<tr>
<td>CAL tuition</td>
<td>9</td>
<td>-2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>-22</td>
</tr>
</tbody>
</table>
3.5 Deaf pupils' performance on test items at easy, intermediate and difficult levels

It has been suggested by Fyfe et al (1993) that when hearing-impaired children attempt to transform sentences into questions (expecting the answer 'yes' or 'no'), there are three levels of difficulty involved (see Chapter 11). The tests for this research project were designed (using Fyfe et al's (1993) criteria) to reflect the three levels of difficulty and so results (Appendix 17.10) were analysed to see if the performance of the pupils in the research sample reflected this three-way split in difficulty level. One would expect, for example, that pupils would perform better at the 'easy' level of questions than at the 'intermediate' level, and better at the 'intermediate' level than at the one deemed 'difficult'. If Fyfe et al (1993) are right, one would also expect these differences to be statistically significant. The data presented at Appendix 17.10 shows that the results of the study were not entirely in line with the categories presented by Fyfe et al's (1993).

In the pre-test, the data reveals no instance of a pupil doing best at the 'easy' level of transformation, then slightly less well at the 'intermediate' level and worst of all at the 'difficult' level; for the post-test there are only three instances of this, out of 23 pupils taking the test. Indeed, mean scores for the intermediate level were marginally higher (\( \bar{X} = 4.39 \) for both tests) than for the easy level (for the pre-test, \( \bar{X} = 3.43 \) and for the post-tests \( \bar{X} = 4.35 \)). The small size of the sample used, however, make it unwise to draw firm conclusions from this data, but suggests that this may be an area which future researchers might like to investigate further.
3.6 A comparison of pupil perseverance at live and CAL interventions

For each pupil, a log was kept of how long they persevered with each learning medium, that is, the live tuition or the CAL program. With the live tuition teaching continued until the main block of exercises had been completed (E1–E8, I1–I8, and D1–D8 in the Making Questions workbook). At this stage the pupil was offered the choice of stopping or studying some supplementary questions (X1–X10). As has been noted, only one pupil asked for the additional tuition. In the case of the CAL program the pupils were allowed to continue with the courseware until their attention appeared to wane. At this point they were offered the opportunity to quit. The data presented at Appendix 17.16 shows that overall, the amount of time spent by pupils on the CAL program was greater than live tuition ($\bar{X}_{\text{LIVE}} = 33.73$; $\bar{X}_{\text{CAL}} = 46.25$). This difference was significant: $p < 0.10$ (for a two-tailed test; $t = 2.70$; $df = 21$) (Appendix 17.13, Table 1, and for a summary, Table 17.5, below).

4. DISCUSSION

4.1 The effect of deafness: deaf and hearing pupils’ test performance

The research tends to confirm Conrad’s (1979) findings that the language development of hearing-impaired children is significantly retarded compared to that of hearing children of the same age. One important note of caution, however, needs to be sounded. As Webster (1985a) has stated, the performance of deaf children in comparisons of this kind may be a function of the design of the test itself, rather than of language difficulties. Nevertheless, in this research, the differences between the hearing and hearing-impaired groups were statistically significant, with mean scores for the hearing pupils being about 50 per cent greater than those in the deaf group.

Table 17.5 Summary of $t$-test results for comparison of pupils' perseverance at live and CAL tuition

<table>
<thead>
<tr>
<th>Statistical data</th>
<th>Live tuition</th>
<th>CAL tuition</th>
<th>$T$-statistic and significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>33.72</td>
<td>46.25</td>
<td></td>
</tr>
<tr>
<td>SD</td>
<td>12.14</td>
<td>10.06</td>
<td></td>
</tr>
<tr>
<td>N</td>
<td>11</td>
<td>12</td>
<td>$t = 2.70$</td>
</tr>
<tr>
<td>df</td>
<td>21</td>
<td></td>
<td>$p &lt; 0.05$</td>
</tr>
</tbody>
</table>
4.2 Test performance and deafness: did degree of deafness matter?

Analysis found a statistically significant negative correlation between degree of deafness and test performance, that is, degree of deafness did matter when it came to achievement on the tests. It would have been surprising (given the strength of literature comment on this matter) if this had not been the case. This is not to argue, as Conrad (1979) has warned, that deafness itself is a determinant of poor performance on tests of linguistic ability. The data shows, for example, several severely and profoundly deaf children in the top quartile of test achievers. Indeed, the top scorer in both pre and post-tests is severely hearing-impaired.

This success can only be explained by other variables. Future researchers may, for example, like to look at variables such as whether the parents of the child are hearing or deaf. It could be hypothesised, for example, that deaf parents 'accept' the hearing condition of their children sooner and may therefore undertake instructional strategies to help their children at an earlier stage of their development. Another variable worth investigating would be whether the child is mainstreamed or segregated. This issue relates to the discussion in Chapter 3 where the benefits and drawbacks of integration were discussed. The issue here would be the extent to which being mainstreamed forces deaf children to interact and communicate with their peers and with teachers and how this helps to develop their language skills.

4.3 Gain scores: which teaching medium was most effective?

Overall, the data suggests that CAL is not intrinsically any more effective as a teaching medium than live tuition. The null hypothesis (Chapter 10, section 2.1) that:

There will be no statistically significant difference between computer based instruction and live tuition (both using the same subject matter) in terms of improving the syntactic skills of deaf children.

can therefore be accepted.

4.4 Live and CAL gain scores at varying levels of difficulty

It appears that CAL may be an effective medium for teaching elements of syntax, but at an easy rather than at the intermediate or difficult levels. These judgements cannot be conclusive as statistical tests used to analyse the data did not reach significance. At the difficult level of transformation, however, there was an alarming and statistically significant reduction in performance following the CAL program. Conclusive answers to this phenomenon are elusive, but may provide the basis for future research. Indeed, it is hoped, in future, to improve the design of this research by increasing the size of the sample (to, say, 50 pupils) and repeating the experiment, unhindered by time pressures, to see if different results emerge.
4.5 Deaf pupils' performance on test items at the easy, intermediate and difficult levels

Results tend to discount at least some of Fyfe et al's (1993) suggestion that there are three levels of difficulty in the transformation of kernel sentences into questions. While the performance level differences between those items termed by Fyfe et al (1993) as intermediate and difficult was significant (at least for the post-test), this was not the case comparing intermediate and easy. Indeed, for these categories, performance at the intermediate level was superior to the easy, although this higher score was not significant. Scores for the easy level of questions were also significantly greater than for difficult questions in the post-test, as the Fyfe et al (1993) results would have predicted.

The data suggests therefore that, contrary to the evidence of Fyfe et al (1993), hearing-impaired pupils do not find sentences containing verbs in the continuous form (running, reading, etc., sentences which Fyfe et al classified as intermediate), more difficult than those sentences where just a standard verb exists. Closer examination of intermediate sentences confirmed the authors' argument that, when errors are made, these include transforming the continuous verb to various positions in the sentence, the most popular place being the start. It may be, however, that the continuous verb, especially for high scoring pupils, is relatively easy to identify and, provided they know the rule about its immobility, it is one less word which may be transformed in error. This may, in part, explain the higher success rate for intermediate over the easy level of transformation. Again, however, the small size of the sample used should suggest caution in accepting these conclusions, and justify the need for further investigation.

4.6 Test items: what do they tell us about syntactic abilities of deaf children?

This section examines examples of sentences from the pre and post-tests and looks at the types of errors made in an attempt to identify any patterns, especially those which may distinguish any differences in performance between 'high' and 'low' scorers (see section 2.6 for definition of these two groups). Only those questions where there is a clear bias towards one distracter will be shown, that is, where at least four pupils have chosen that option. The analysis will also attempt to find differences between the pre and post-tests in the types of errors made, i.e., to identify areas where the interventions have made a difference. In analysing answers, a distinction will be made between what will be termed 'good' and 'bad' miss. At the easy and intermediate levels, a good miss is one where the transformation itself is achieved successfully, but another type of error is made; for example, the sentence The dog is black could be transformed into is the dog black? While the appropriate word is transformed, it is not capitalised. An example of a bad miss is where the sentence is not transformed or the wrong word or words are transformed; for example, My arm is very long could become My arm very long is? At the difficult level a good miss is where the appropriate tense of the verb 'to do' is chosen, but another error is made; for example, the sentence The ship sailed away becomes Did the ship sailed away? A bad error would be where an inappropriate version of the
verb 'to do' is selected, or where no version of this word is provided, as in *Have dogs tails?*

**a) Pre-test**

On the pre-test it is quite clear that high scorers also tended to achieve good misses rather than bad (Appendix 17.11). While there are questions on which the low scorers achieved a good miss (E1, E5, D6) these were very small in comparison to the questions on which they scored bad misses (E6, E7, E8, I1, I2, I3, I4, I5, I6, I7, D5, D7). In contrast, the high scorers achieved a bad miss on only one question (I3). In the majority of cases, therefore, when high scorers made errors these were not random (spread across the three distractors) but tended to be close to the correct answer in the sense that the sentence was at least transformed. Low scorers, however, tended to fail to make a transformation or transformed inappropriate words.

It appears from the data (Appendix 17.11) that at the difficult level of transformation, high scorers tended to make more errors since this group is mentioned each time as a group making an error. In fact, the low scorers made just as many errors but these tended to be spread across a range of erroneous answers. Hence, this under-representation of the low scoring group is a function of the counting method used here of only commenting on when at least four pupils select an item. At least in all cases the misses made by the high scorers were good ones, that is, they made an attempt to supply a 'Do' word at the beginning of the sentence, even if it was the wrong tense. The errors made by the low scorers included the provision of wrong 'Do' words and also the failure to provide a 'Do' word at all. In a sense, their performance was worse because their wrong responses were more random.

The high difficulty index for five questions in the difficult section (see section 2.7) may, in part, be the product of test construction. Closer scrutiny of the difficulty index (Appendix 17.4) shows that there was a tendency, even amongst some of the high scorers, to select the first sentence from the selection beginning with a 'Do' word. With D1, for example, a and b, neither of which contain a 'Do' word were selected by only one high scoring pupil, but c which contains the incorrect version 'Does' was chosen by eight; only five high scoring pupils checked through the list of alternatives to chose the correct response: *Do some fish swim in the sea?* which was the last possible choice, d. This lends weight to Webster's (1985b) concern about the reliability of tests used with hearing-impaired children.

**b) Post-test**

While in the pre-test there were 15 questions on which high scoring pupils (a concentration of at least four in each case) made an error, in the post-test this figure was down to only four instances, all at the difficult level (Appendix 17.13). It is also clear that the type of errors made changed as a result of the interventions. While in the pre-test high scoring children made basic errors such as the failure to supply a question mark at the end of the sentence and the failure to capitalise and decapitalise
appropriate words this is far less prevalent in the post-test. There was no example of a concentration of high scoring pupils doing this. In contrast, the low scoring group continued in the post-test to make the sorts of basic errors mentioned. Furthermore, as in the pre-test, they tended to make far more 'bad' errors such as hopping the wrong word to the beginning of the sentence or even transforming the hopping word to the end. Sometimes the main verb was hopped with the modal verb as in: The cowboys were firing guns to Were firing guns the cowboys?

At the difficult level of transformation the high scoring group improved their performance, with only one concentration of pupils failing to select the appropriate 'Do' word whereas five questions had been incorrectly answered in this way in the pre-test. Perhaps significantly it was the first question at the difficult level that seemed to pose problems for all pupils with only two of the 23 children getting it right. It was in this question that the high scorers failed to chose the correct tense of the 'Do' word; significantly, the low scorers failed to provide a 'Do' word at all.

4.7 A comparison of pupil perseverance at live and CAL interventions

Pupils spent approximately 50 per cent more time studying the CAL program than they were prepared to spend taking the live tuition, a difference which was statistically significant at the $p < 0.05$ level. This, of course, may be more a reflection of the time taken to learn how to operate the screen buttons and the slow speed of the computer program rather than an intrinsic enthusiasm for the game itself. Tuition in the operation of screen buttons, however, focused on how these buttons transformed sentences and hence could be viewed as an integral part of the syntactic instruction itself. Also, the overwhelming choice of the computer as a medium of learning (Chapter 16) suggests that this additional time spent studying the program may also have been a product of genuine interest. Indeed, some of the very positive comments of the pupils themselves (Appendix 16.5) reinforces this notion. CAL, in itself, may be no more intrinsically effective in teaching a subject than live tuition, but if, for hearing-impaired children, time (rather than innate cognitive ability) is the prime factor necessary for learning, then the computer may prove a vital learning tool for this group. This is not to argue that CAL should replace the essential work of the classroom teacher. Rather it means that the computer could be available in the classroom for spare moments when children could log on and undertake preparatory learning, or practice sessions or reinforcement of concepts. It is possible that repeated practice at identifying examples of concepts and applying rules (almost certainly within a meaningful context) is what deaf children require, and it is here that CAL, because of its infinite patience, could be a valuable resource.

5. CONCLUSION

Overall, the computer interventions did not achieve test gain scores that were any more impressive than those achieved by the live interventions; at the easy level, for example, aggregate gains scores were 11 for the live tuition and nine for CAL. Neither live tuition nor CAL produced any statistically significant improvements in syntactical performance. Given the relatively short amount of tuition delivered by
either medium, this is perhaps not surprising. It may be the case, however, that the key to learning for hearing-impaired children is *time* so that the same concepts or rules can be repeated and reinforced. It was noted in Chapter 16 that, for some children at least, the computer seems to hold particular fascination, a result of which is, as Chapter 17 has shown, they seem prepared to spend longer studying what it delivers. Here, the computer could be particularly advantageous because of its infinite patience and ability to present multiple examples of information. It remains to be seen, however, whether this allows hearing-impaired children to acquire knowledge of rules more effectively. While the results of the present study have not produced significantly large gains in learning, it would be interesting to see if CAL was more successful with hearing-impaired children over a longer period of time, say, an academic year. This could be the basis of a future study.
CHAPTER 18
Conclusions, Reflections and Recommendations

1. RESEARCH HYPOTHESES: WERE THEY ANSWERED?

Hypothesis a: There will be a statistically significant difference between computer based instruction and live tuition (both using the same subject matter) in terms of improving the syntactic skills of deaf children.

The research found no significant difference between instruction given through live tuition and that delivered by CAL in terms of gain scores achieved on tests of syntactic ability. The study nevertheless adds to the limited research that has been attempted to quantitatively measure the effectiveness of CAL (Wright and Anderson, 1987; Jones, Torgesen and Saxton, 1987; Wise et al, 1989, Slavin, 1991). With the exception of the Wright and Anderson research (which sought to teach sight vocabulary to children with learning difficulties), none of the others attempted to compare the impact of CAL with teaching a subject using another medium, e.g., a teacher. This study did make such a comparison. The present study also used a larger sample (23 pupils) compared with only 12 in the Wright and Anderson research, but came to similar conclusions, namely, that those using CAL did not perform significantly better than those using live instruction. Outright performance, however, is not the only outcome to be considered (for example, see Research Question 4, below).

Hypothesis b: The use of a program specifically designed for hearing-impaired children will have an effect on teachers of the deaf in terms of their tendency to make use of computer assisted learning in the classroom.

Given the problems teachers faced with running the demonstration program and the small proportion of the sample who succeeded in evaluating it, this part of the research did not achieve any conclusive results. Nevertheless, the research did reveal a number of important factors which might be of interest to future researchers, courseware developers and policy makers. Firstly, there was considerable support amongst teachers of the deaf for CAL as a medium even amongst those who currently make little use of it. This low level of utilisation is largely linked to the lack of suitable hardware, the inadequacy of training in computer use and the lack of suitable software programs. This shortage is particularly problematic to the area of language development. Secondly, while there are some programs that help in
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vocabulary development (although most of these seem to be designed specifically for hearing children), there appear to be none in the vital area of syntax. This is a gap which future courseware developers might seek to fill (see section 6).

Hypothesis c: The involvement of teachers in the design and development of the program will make them more favourable to its integration into the classroom.

The small number of teachers involved in the study do not make it possible to draw firm conclusions from the evidence. It does appear, however, that the involvement of teachers in evaluating early prototypes of the CAL program heightened their general interest in the project and made them more amenable to its overall aims. Above all, however, the involvement of teachers produced benefits such as improvements to the design of aspects of the courseware and a greater accuracy in courseware materials (for example, data structures). The involvement of some pupils at the prototyping stage also generated an interest in CAL as a medium and an impatience for receiving delivery of the final course.

2. RESEARCH QUESTIONS: WERE THEY ANSWERED?

Research question 1: What criteria are most influential in determining whether teachers of the deaf make use of CAL?

The research revealed that key learning areas for hearing-impaired children, which include language learning, are currently inadequately served by CAL courseware programs. Those programs that do exist do not contain features that may be particularly beneficial to deaf children such as a strong reliance on visual images to support the text. Indeed, there appears to be little research evidence of what instructional strategies in CAL programs benefit hearing-impaired children. In a sense, this research project is fairly unique to this field.

It appears also that teachers of the deaf are insufficiently trained in using computers in general, and CAL in particular. One recommendation of this research, therefore, is that the seriousness of this matter be highlighted in the literature and strategies suggested for addressing it. The British Association for Teachers of the Deaf could be encouraged to take up this issue and to evaluate the quality of computer tuition given on courses for teachers of the deaf, and to investigate how this provision can be improved.

As noted in section 1, many schools do not have modern, fast computers capable of running high resolution graphics and animation. This situation may change, but with the devolution of power through local management of schools, there does not appear at this time to be a national policy-making body capable of initiating these changes.
Research question 2: Does the research study CAL program make teachers of the deaf more willing to use CAL as a teaching medium?

It was hypothesised that significant reasons for teachers of the deaf not using CAL was the lack of suitable programs available, therefore it was supposed that if such a program was developed, this would begin to stimulate a general interest in CAL. As reported in section 1, very few of the teachers who received a demonstration version of the program were able to run it on their existing computer hardware. This part of the research did serve, however, to confirm some of the results stemming from Research question 1, about the problematic state of computer hardware in many UK schools. Nevertheless, there was strong support amongst a broad range of teachers for a computer program dealing with areas of syntax development. In this hypothetical rather than practical sense, the research question was answered. Amongst those teachers who did view the program there was some reservations that it was too slow, which is indicative of development problems encountered in a new learning technology. Indeed, this concern was shared by the researcher and various ways of improving the game are discussed at section 3.2.

Research question 3: Is CAL more convenient for teachers/learners?

Given the lack of suitable hardware in schools for running the program, the issue of convenience for teachers was not solved satisfactorily. It would appear that CAL has the potential for providing a convenient resource but only if it can be effectively integrated into the curriculum. As far as learners are concerned, pupils seemed most satisfied with the opportunity to learn using a computer, a tendency revealed both by the time spent on the program (Chapter 16), and by their selection of the computer as a preferred medium over live tuition (Chapter 17). This factor was an important finding of the research and may give some confidence to prospective courseware developers.

Research question 4: Do learners enjoy using CAL, and how does this impact on learning?

Almost without exception, pupils enjoyed the CAL program. Many of those in the 'live' intervention group begged to see it and were as enthusiastic as the CAL group in using it. The uninterrupted time they also devoted to using the game was testimony to their interest, although it is also conceded that the enthusiasm of the 'live' group for CAL may partly stem from jealousy at seeing their friends using the medium. Nevertheless, this enthusiasm for CAL may, in the future, allow the medium a more extensive role in the classroom. As noted in Chapter 3, teachers have only limited time to deal with individual needs of their pupils; given their popularity with hearing-impaired children, CAL programs may provide a useful resource for learning that reinforces the efforts of teachers, especially where the repetition of concepts is important to that learning. This high level of perseverance may also help to overcome the low attention span which is a characteristic of some hearing-impaired children.
It is interesting, though, to compare the general positive response of pupils with the more reserved attitudes of teachers themselves. In one sense, the teachers' view may be more objectively critical, being based on a perspective, and practical experience, of what learning strategies are most effective for their pupils. It may also result, however, from their irritation with the program's loading difficulties, and a general mistrust of new technology.

**Research question 5:** *Does the research program enhance the learning of elements of transformational syntax? With respect to other teaching media, is it more effective in producing planned learning outcomes (for a given time commitment)?*

It would appear from the evidence of this research that the computer is no more effective than the live instruction of a teacher in transmitting the rules of transformational syntax. It may, in general, therefore, not be the instructional panacea that some of the research has suggested (Chapter 8). Yet if children enjoy using the computer as a learning tool (Research question 4) and are willing to spend time using it (Research question 3), then the use of CAL in the classroom may be a valuable additional learning resource for teachers. It may allow some children to work on their own for a while as the teacher gives additional attention to others; it may allow for the introduction of topics in preparation for personal tuition from the teacher; it may also allow for the reinforcement and repetition of topics to aid learning and retention. The problems that hearing-impaired children have with language have been noted (Chapter 6). The 'learning curve' for many of these children can be a steep one, and the importance of intensive tuition vital. Yet, as was noted in Chapter 3, hearing-impaired children, especially if they are integrated into the mainstream, may not receive the intensity of tuition that teachers would like to give them. CAL, then, may provide a very useful additional learning resource.

In summary, ways must be found of producing more computer software that is of direct relevance to deaf children, especially in the area of syntax development. Teachers of the deaf also need more training in the use of CAL and computer hardware. The computer is enjoyed as a medium of learning by deaf children and, although it does not seem to offer any short-term instructional benefits over other media, there is a tendency for deaf pupils to persevere when using it. Given the need for repetition and reinforcement of concepts, this may be of considerable benefit to hearing-impaired children in the long-term. There is the additional benefit that the computer may free teachers for more 'quality' time with those who need it.

3. **CHANGES TO COURSEWARE DEVELOPMENT & DESIGN**

3.1 Courseware Development & Implementation

It was found that *Authorware Professional* had certain deficiencies as a development tool. Each item on the screen is a separate object. In programming terms this is quite advantageous since it is relatively easy to control individual screen parts, for example, turning a button on and off for different screens. The penalty paid for this
flexibility is that each object has to be 'painted' onto the screen making screen refreshment, and therefore the program, quite slow. Authorware was also slow in performing item analysis. In future, the use of Pascal for Windows or C++ for Windows might be considered as development tools. The disadvantage of these tools is that the development times and therefore costs of production would almost certainly be greater. This itself may not be a disadvantage. CAL software has often been developed as part of a 'cottage industry' of individual designers and programmers – often teachers. Children, as this research has served to confirm, are increasingly sophisticated in their software tastes. Programs must not only be educationally valid, but stimulating, lively and fun.

Multimedia platforms offer tremendous possibilities here, but multimedia software, with its graphics, sound and video, is very expensive to produce compared with traditional CAL. This has potentially important implications for the production of software for the deaf. As a minority group, deaf children do not constitute a financially lucrative market for software developers. Two possibilities, therefore, present themselves. Either language development software must be developed that meets the needs of both hearing and hearing-impaired children, or charitable or government funding is needed to underwrite the development costs. The former path is problematic because, as was shown in Chapter 6, hearing-impaired children have particular and complex learning needs. It is likely, therefore, that some sort of external pump-priming is necessary to improve the availability of CAL software for hearing-impaired children. This is an area that the British Association of Teachers of the Deaf may like to consider.

3.2 Software changes

From using the program in the field, a number of errors and inconsistencies emerged which require amendment for any future version of the program (see also Appendix 18 for 'known bugs'):

a) If the child logs onto the program for a second time, s/he should be able to pick up where they left off rather than having to repeat the introductory section to each unit. Thus, when starting, there needs to be an introductory page giving two options.

b) The hopping word list should be available at all times for reference. This could be a paper-base format or through an on-screen pull-down menu.

c) The speed of program should be increased. This could partly be achieved by omitting the scrolling portcullis and flashing arrows.

d) There should be more examples in each of the help sections so that there is less chance of a graphic and sentence being repeated.

e) The pupil should be able to click on a room in the map section to return to the game rather than the castle button (all the children tried to do the former).
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f) The intermediate level simulation should be eliminated.

g) The red forward pointer needs 'click on this' message (after a time delay) if the pupil has failed to press it.

Overall, the quality of graphics was not what was planned, and, generally, were not liked by some teachers of the deaf, possibly because they were too detailed. This problem arose because of difficulties in the project-management of the courseware development process. Specifications to the graphic artist were given in the form of verbal descriptions. On reflection, a better idea would have been to have sketched out some draft pictures as illustrations, possibly in software form, to have made the plans of the researcher more specific. Even though the children themselves seemed to approve of the graphics, courseware developers need to consider the views of teachers very carefully because it is they who select or reject programs and who decide what software to use in a learning situation.

4. LESSONS FOR FUTURE RESEARCH DESIGN

One of the key weaknesses of the research design, which became obvious on reflection on practice, was the fact that the length of interventions was so short. One of the areas which could be examined in the future is the extent to which CAL can improve syntactic knowledge over a longer period of time (say, an academic year) and the extent to which this improvement can be maintained. It is not known, for example, whether any of the gains made by pupils in this research project could be repeated even only a short period after the interventions. As was discussed in Chapter 11, one of the purposes of the research project was to teach language skills at a higher cognitive (rule learning) level. If the research found that live and CAL interventions made no significant difference to syntactic performance this may have been the result of this weakness in the research design itself.

If the research was to be repeated, several more improvements to the research design would have to be made. Firstly, the size of the sample, 23 children, was inadequate and resulted, for example, in test results which were not normally distributed. The sample size also made the finding of statistical significance difficult, and hence the generalisation of the findings more problematic. Another fault of the research design was the failure to include the sample of hearing children in the interventions and the post-test. This would have allowed a broader comparison between the results of the hearing and hearing-impaired groups. One possible result of this would have been the ability to see whether the eventual low gain scores in the deaf group were the result of inherent intellectual problems or the fault of the instructional programmes (and the inexperience of the researcher as a teacher of deaf children). For example, if the hearing group, in contrast to the deaf pupils, had made strong and significant gains, then it might be deduced that the lack of progress amongst the hearing-impaired group was probably the result of inherent language problems that were resistant to improvement. In contrast, if both groups had made insignificant changes in gain scores there would be concerns about the quality and
effectiveness of the instruction itself. In general, variables in the research needed better control, but were not always obvious at the start of the investigation.

Another change to research design that could be implemented would be improvements to the reliability of the pre and post-tests. Although difficulty and discrimination indices were calculated for both tests, there was insufficient time to trial these instruments with a group of learners from the same population but independent of the research sample, in order that unreliable questions could be highlighted and eliminated. It may also have been possible and, indeed, prudent, to examine sentences for a problem which Cooper and Arnold (1981) claimed is common amongst hearing-impaired children, that is, figure-ground perception (Chapter 4).

It can be claimed, however, that using this design approach with hearing-impaired children has, itself, been a contribution to knowledge in that it has helped to establish a possible pattern for future researchers.

5. REFLECTIONS ON THE ENTIRE RESEARCH PROCESS

One lesson of the courseware development process was the difficulty of finding funds for the project. In future, it would be wise to begin the process of seeking funds at a much earlier stage in the courseware development cycle so that the scale of the project can be planned for — and not be determined, at least in part, by the size of funding that emerges.

Once the funding arrived and the research move forward the next difficulty was the project management of the courseware development process. Here the advice of Andersen et al (1988) on the planning of milestones, and the inter-relationship between them, was most useful (Chapter 13). It was realised, for example, that the timing of deliverables from the graphics artist had to coincide with screen designs and coding from the programmer so that graphics could be imported into the program. Above all, the software itself had to be delivered by a specific date in order to give the researcher the time to use the courseware in classrooms and gather data before the arrival of the school summer vacation. Timescales were always very tight and often nearly missed. The programmer, for instance, had only a four week 'window' (working part-time) in which to implement the program designs. With these timescales in mind this often meant that compromises were made in the final design of the program to 'hit' delivery dates. There was a discussion with the programmer, for example, about eliminating the portcullis effect (to speed up the program), but changes were abandoned because time was running out. All these issues relate to the difficulty of controlling the work of a team involved in a collective endeavour.

The tight timescales also meant that some, albeit a small, proportion of the data gathering took place in the penultimate week of the summer term when the minds of the children seemed more focused on holidays than on school work. The data gathering occurred at this time because of the need to process the information over
the summer months. It may be by chance that two of the worst negative gains in test results occurred amongst the two children given the intervention and post-test at this time. Researchers might be advised to plan intervention times that are commensurate with school activities and not with vacations. These tight timescales might be avoided by building more contingency into the project planning process or considering the use of contractual constraints when commissioning the work of others.

In terms of carrying out the interventions it had been hoped to purchase a camcorder so that the teaching (and testing) sessions could be recorded for analysis. Lack of funds prevented this. One negative result was that a set of notes on pupil comments at one of the CAL sessions was mislaid (thankfully, the only data that was lost during the project). Hence, the case studies containing observations of pupil performance on the CAL program (Appendix 16.5) contained only 11 studies not 12. It is felt that video-recording the research would both avoid this problem but also enrich the research process. The researcher is not always the best observer, particularly when having to focus simultaneously on the teaching process itself. In this instance, an observation schedule was not used but should have been, in the interests of consistency.

One of the least successful elements of the research was feedback from teachers to the demonstration version of the CAL program. As Chapter 16 reported, this was partly the result of incompatible hardware in the schools. This itself was quite an important finding of the research. It is felt, however, that the response rate could have been improved if the loading instructions for the program had been clearer. In a sense, this ambiguity stemmed from the way in which the program was launched through sliding one file onto another (a difficult mouse operation for a computer novice). The programmer was asked to simplify this to, say, getting the teacher to type 'Go'. The programmer, however, claimed that the method used was the only one possible. Tight timescales, and the fact that the researcher knew insufficient about the authoring system used to implement the program to contradict this assertion, meant that the launching instructions remained unchanged.

One of the more positive aspects of the project was the relationship built up with the teachers of the deaf involved in the research. Some of these teachers were initially suspicious because of their experience with a previous researcher who had started a study, built up a relationship with the children, but had not carried through her observations, to the obvious disappointment of all. Chapter 10 discussed the importance of the 'subjects' of research becoming involved in the process and direction of the research itself. For this project, this was not strictly adhered to in the sense that the children were not involved at this level. Their parents, however, were contacted and asked for permission for their children to be involved. Furthermore, the researcher took care to discuss the objectives and methodology of the research with the children's teachers. One of the most rewarding aspects of the research was overhearing one teacher of the deaf talking to another and referring to the researcher as 'one of us'. In line with the approach of involving teachers, a summary of the results of the study were sent to those teachers of the deaf who helped. It is important that researchers are open and honest with teachers of the deaf.
about the purpose of their study – especially where teachers may be somewhat reserved about using new technology.

6. FUTURE RESEARCH

A number of issues emerged from the research which might benefit from further exploration. It was noted in Chapter 16 that hearing-impaired children have a strong preference for CAL compared with learning through live instruction. The small size of the sample means that this result should be treated with some caution, but, nevertheless, it would be interesting to compare these findings with the attitudes to CAL of hearing children. It might be, for example, that deaf children have a stronger leaning towards CAL than their hearing counterparts, possibly because it reduces the stresses of communicating within a normal classroom. In this case CAL could be seen as a benefit (a non-judgmental learning 'partner'), but also a diversion from the important task of learning to communicate with people. It may also emerge that hearing-impaired children and hearing children are both equally enthusiastic towards CAL merely because the computer has now become an accepted part of 'the culture'. This, again, though, adds weight to the argument that teachers of the deaf should make more use of CAL in their classroom.

Another area for future research could be to investigate further the puzzling discrepancy between live gain scores at the difficult level of transformation and the large fall in gain scores using CAL. A closer look at the design of the CAL section dealing with difficult transformations may find a discrepancy which may throw some light on deaf children's understanding of sentence structures at this level of transformation.

Ainscow (1989) has stressed the importance of co-operative learning for special needs children (Chapter 2), while Adams (1985) has suggested how the computer can be used in language development to stimulate 'collaborative talk' (p. 49). This research also reported interest in groups of pupils using the same program simultaneously (Chapter 16). The impact of collaborative learning amongst hearing-impaired children using CAL might, therefore, be explored.

Rather than measure the language attainment of children through formal tests (as has been the case in this research), ways might also be examined of assessing their performance within the more meaningful context of their normal, everyday classroom work. Certainly, a concern about using formal tests was expressed to the researcher by a teacher of the deaf (see Appendix 14.4). Methods of assessing linguistic developments may include both written and oral language.

7. FINAL EVALUATION OF THE RESEARCH

The direction of the research changed during the course of the study from a concern about how hearing-impaired children can be successfully integrated into mainstream classrooms, to how CAL can be integrated into the curriculum. It was believed initially, for example, that providing mainstream teachers with additional resources
such as CAL would make them more positive to having deaf children in their classes. It emerged, however, that it was going to be difficult to implement this as a research project because most hearing-impaired children are only partially mainstreamed, many spending the majority of their time in special units attached to ordinary schools. Those subjects they are integrated for are often of a non-academic nature. The focus of the research therefore changed into how teachers of the deaf (i.e., those teaching in the deaf units) could be encouraged to use CAL, as well as the effectiveness of CAL as a medium of instruction.

It is contended, however, that this research project has been successful in documenting the process whereby a CAL program for hearing-impaired pupils can be designed, developed and implemented. As part of this process, it has shown how teachers of the deaf can be involved in the design of such programs and what obstacles need to be overcome in getting these teachers to make use of CAL in their classrooms. The research has provided one of the few quantitative studies into the effectiveness of CAL as a teaching medium and has therefore contributed to the research in this area. Above all, it has provided evidence to contradict some of the research studies discussed in Chapter 8, that CAL is an instructional panacea. Conversely, it has also provided evidence of the popularity of CAL amongst hearing-impaired children – potentially an important research finding. Given the significantly longer time spent using CAL than live tuition, the research called into question Webster's (1988c) assertion that the concentration span, motivation and attention of hearing-impaired children was limited. This, of course, may partly have been the result of the relative novelty of using CAL in the classroom. Future researchers may need to measure whether this enthusiasm and concentration with CAL is a long-term phenomenon.

The research has also added weight to the growing body of knowledge which describes the scale and depth of learning problems faced by many hearing-impaired children. It tends to confirm, for example, the work of Webster (1988a) that there is a 'learning plateau' faced by deaf children, especially in the important area of syntax development. Few of the gains made by the hearing-impaired children in the sample were significant, and many did worse in the post-test than in the pre-test. This, of course, may have been, at least in part, the product of the inexperience of the researcher in teaching children with a hearing impairment.

In Chapter 4 there was concern over Kyle's (1980) assertion that deaf children have problems with syntax due to short-term memory constraints. The gains made by some hearing-impaired children in the study suggest, however, that Conrad's (1979) contention may be more accurate – that deaf children should not be treated as a homogenous group and that some hearing-impaired pupils, at least, may be able to overcome their problems. The question remains, of course, as to precisely which variables are significant in helping children to achieve this improvement. A teaching strategy which tries to explicitly teach the rules of syntax may be one such variable for some children – as has been shown for some hearing-impaired children in this study. Rule learning delivered via a CAL program may also be another important variable – given the seeming popularity of this medium amongst hearing-impaired children.
It is hoped, therefore, that future researchers will be able to examine the long-term gains that deaf children may be able to achieve using CAL courseware. It is contended that this research project has laid some solid foundations for such a program.