# INFORMATION TECHNOLOGY IN SPECIAL EDUCATION

ABSTRACT: This chapter sets out to examine the role that information technology can play in the education of students with special needs. The scope of such needs and the main issues in the field are set out briefly. The theories underpinning learning with information technology are outlined and the aims of integrating computing in special education are discussed. Research evidence supporting the perceived benefits of information technology in special education is assessed and the common applications are considered in the context of their special needs usage.

## THE SCOPE OF SPECIAL EDUCATION

Special education spans many diverse educational concerns and can involve students of all ages, from early childhood through to adulthood. Support will be needed for some students just to enable them to achieve a level of basic communication with people around them. For others it will help to develop the basic literacy and numeracy needed to engage more fully in the world of work. And for yet others, it may help them to integrate normally in society through a process of socialization and the control of unacceptable behaviours.

The degree to which students are 'special' depends on their impairments, or indeed their giftedness, but worldwide trends in dealing with special educational needs have stressed and developed the importance of not exacerbating the 'specialness' unnecessarily. The philosophy of inclusive or integrative education dominates many national systems - if the students can be accommodated in 'mainstream' schools, they should be. Clearly such trends can place considerable strains on schools and the search to support students and their teachers is a major enterprise. Many are turning to information technology as a promising means of supporting special needs.

State funded special schools continue to exist but the impact of the philosophy and practice of integration has made the support of students with special needs the concern of growing numbers of mainstream teachers, schools and colleges. The commitment these groups are having to make, however, is tinged with frustrations arising from a perceived lack of appropriate resources and the limited numbers of staff who have the necessary training.

Staff training and competence in special needs contexts is a problem which besets education systems the world over and by virtue of the sheer variety of special educational needs, it is not set to go away in the near future. Many students find themselves in classroom environments where the teachers have difficulty in giving them the individual support they often need. Their own impairments limit their participation, often without the compensatory interventions or accessories that would assist them, and the cycle of impaired participation, lack of achievement and low self-esteem generates the very antithesis of an integrative approach - a sense of educational and social isolation. In striving to address such problems schools often juggle their resources to provide specialist teaching support, extra classes, classroom assistants, withdrawal units and so on. Even with the best of intentions, however, many such ploys also emphasize the students' specialness and ultimately conflict with their yearning to fit in with their peers.

The panacea schools seek is either a teaching staff that can successfully accommodate all special needs in routine classes or a means by which students with special needs can successfully compensate for their own impairments, without the stigma of withdrawal and with a much-reduced perception of specialness. Tall orders, no doubt, but many special educationalists can point to the fast-developing role which information technology has in delivering the latter. It can be argued that information technology will not only enrich the educational opportunities

open to students with special needs, as is indeed argued for non-special needs students, it will also provide opportunities for education development where participative difficulties or perhaps staff training inadequacies would otherwise deny them.

## STUDENTS WITH SPECIAL EDUCATIONAL NEEDS

Students with special educational needs generally suffer from conditions, singly or in multiple combination, which militate against normal educational strategies. The number of students in society, who may at some point in their education require support arising from special educational needs, is commonly estimated to be 16-18% (e.g. see the UK Warnock Report - DES, 1978) but such estimates are argued not to distinguish between students with requirements for additional educational support and those with milder forms of difficulty with which schools can ordinarily cope. Szaday, Pickering & Duerdoth (1989), for example, suggested that around 10% of the 120,000 students in their survey of Catholic schools in Victoria, had requirements for additional educational assistance.[i]

The variety of problems giving rise to special educational needs is outlined briefly below but it must be emphasized that categorization or 'labelling' is considered to be helpful only at the level of describing possible conditions. Most special educationalists will insist that students should be supported at the level of their individual needs. They should be provided with any additional educational support necessary to enable them to benefit fully from mainstream education rather than be offered a treatment that has been pre-determined for a category of impairment.

### Physical or Health Impairments

Some special needs students suffer from physical or health impairments which restrict movement and coordination. For example, students with cerebral palsy from birth, or those who have suffered spinal injuries, will often have degrees of difficulty which may range from little control over limb movements to no movement at all. Some conditions will adversely affect the student's ability to talk. Students with these types of problems may be very able, intellectually, but cannot perform the physical functions such as speaking, writing or other practical activity which underpins basic interaction and hence learning and achievement. Many will however have some control, even if very limited, over a limb and much success has been enjoyed through the use of physical aids (prosthetics) to interact with the computer. Special keyboards, trackerballs, switching systems etc. enable the student to select operations on the computer (e.g. the selection from a set of symbols or characters on screen for communication) by using head, foot, elbow or mouth etc.[ii] With the assistance of a second person, eye movement may also be used as an indicator of intention and selection of actions on the computer.

Those with profound or severe multiple physical disabilities may not be able to make any form of consistent sound (e.g. laughter) or gestural (e.g. smile or wave) response which might offer a basis for communication and interaction. This drastically curtails their capacity to engage in interactional learning opportunities even with one-to-one tutors who become sufficiently familiar with their physical actions to discern communicable signals. Perhaps a more limiting factor is the low expectations which teachers may have of those with such difficulties. Glenn, Cunningham & Shorrock (1996, p.68) cite a 1987 survey in special care units in the south-east of England where some 80% of students were considered by the teachers to have no communication skills. They suggest that the low expectations arising from this perception will often restrict the efforts of teachers to engage in the interaction necessary for educational development. Computers are however opening up the options for such students through their introduction to

multi-sensory 'snoezelen'-type environments.[iii] By means of computerized switch technology, students may begin to learn very basic control and communication skills which may in turn provide the basis for higher order learning.

**Sensory Impairments**

Much learning is dependent on interaction with objects or other people, and sensory impairments, such as partial or complete blindness or partial or profound deafness, seriously affect a student's ability to learn in a normal fashion. Quite large numbers of a population can suffer sight and hearing impairments and if they are not compensated for in their early years, they can have their acquisition of literacy and numeracy fundamentally undermined. Clearly this may in turn lead to a slower progression than might be expected for otherwise able students. Students with hearing impairments can be helped in a number of ways by information technology and the UK National Council for Educational Technology (NCET, 1993c) has produced a comprehensive overview of the types of support possible. The use of information technology to provide language experience is one such approach and examples might include using HyperCard to record real speech against sentences created and practised by the student, the interaction in a group carrying out structured writing tasks facilitated by a wordprocessor and the use of Logo to facilitate dialogue in joint problem solving tasks.

Information technology also plays a significant role in enabling visually impaired students to compensate to varying degrees for poor or nil sight. For some this will involve a more accessible presentation of existing materials while for others it will involve a more efficient means of translating conventional visual information to speech or Braille output. Microsoft is an example of a major software house which has begun to attend to the needs of users with impairments. Most of their applications are now accompanied by accessibility options (Microsoft, 1994) including keyboard customization facilities for one-handed users, enlarged toolbar icon facilities, enlarged text presentation and facilities to ensure accidental key presses and repeats are ignored. A range of information technology aids including speech output packages for computers and text scanners, electronic Braille writers and scanners, enlarged printed text production and screen magnification systems for computers are discussed in a booklet by Lee (1993).

**Intellectual Impairments**

Intellectual impairments provide the largest diversity in learning problems and range from severe and multiple learning difficulties (often combined with sensory, health and physical impairments) to specific learning difficulties which affect otherwise able students. Severe learning difficulties are often associated with serious mental and physical health conditions including autism and brain disorders.

Specific learning difficulties are myriad. They include difficulties experienced in basic numeracy and literacy such as recognizing patterns, sequencing, understanding written numbers and spelling. The UK National Council for Educational Technology (NCET, 1993d) identify a series of concepts and processes (e.g. symmetry, orientation, estimation and place value) which give rise to specific learning difficulties in mathematics and suggest that learners exhibiting these difficulties may also have additional problems in:

- moving from concrete to abstract;
- transferring skills;
- assimilating information;

- working systematically and being organized;
- motivation.

The NCET booklet goes on to illustrate teaching strategies to address these problems using programmable toys (e.g. floor turtles) for early years, adventure games (motivation and systematic working), spreadsheets (transferring number skills, moving from concrete to abstract) and thematic approaches for multiple activities.

Neuro-psychological reasons are often put forward to explain specific learning difficulties e.g. a dysfunctional short-term memory which causes students to forget a mathematical solution a short time after they appear to have mastered it or an inability to create associations between entities, thereby preventing them from recognizing spelling patterns among similar words. While they are specific they are no less serious, often going undetected until the damage of sustained under-achievement has eroded the learner's confidence to levels from which it is difficult to recover.

With so many variants, at the individual student level, it is not surprising that information technology approaches to tackling specific learning difficulties involve a wide range of software packages. These include suites of practice problems or tasks which use repetition to improve performance, sometimes with tutorial help built in to assist the students when the machine detects a known type of mistake. Add-on packages, which offer predictions of next words during wordprocessing, or as-you-type spell-checkers, which alert a student to an unacceptable spelling, are also common. McKeown (1992) and Day (1994) have reviewed the use of up to 90 packages of varying sophistication which are available for several platforms including Apple, PC, Archimedes and BBC.

**Situational Factors**

Situational factors may also lead to the low achievement of otherwise able students in normal schooling. Dysfunctional domestic circumstances may, for example, lead to emotional problems which manifest themselves in a range of ways, the extremes of which include the student becoming withdrawn or being aggressively disruptive. Thomas (1992, p.3) suggests that students with emotional and behavioural difficulties often need to develop communication and self-expression skills, to improve their self-image and self-esteem and to develop personal relationships with peers and persons in 'authority'. He identifies the computer's role in supporting cooperative working groups and providing a 'neutral', non-judgemental learning environment as particular advantages in an information technology approach to assisting such students.

A peer culture which cultivates disaffection and negative perceptions of the value of schooling (e.g. in inner-city communities) may also lead to serious under-achievement and behavioural problems in the school and classroom. Underachievers by definition, perform at levels below their capability and very often this arises from a self-sustaining cycle of disaffection, failure, demotivation, loss of self-esteem, more failure, more disaffection etc. (Kaniel & Feuerstein, Israel, 1989). An increased propensity to truanting and to aggressive and disruptive behaviour is not uncommon in such students. Absence from school due to illness or other circumstances (e.g. truancy, inadequate parenting) can be an obvious but no less serious factor in low or under-achievement arising from serious gaps in the student's exposure to education.

Special education policy attracts a great deal of debate throughout the world with the main issues focusing on the integration of special needs students in mainstream education, the early identification of problems and the utilisation of general support facilities in the context of widely differing individual needs. Staff development has also become a major issue, particularly for mainstream schools who have to support students with special needs.

**Integration**

The most important development in organizing and planning for special educational needs in the last three decades or so has been the move towards as full an integration as possible for students with special needs. It can be argued that the sea-change from exclusion and institutionalization to entitlement and integration began when the US Congress in 1975 endorsed Public Law 94-142, the Education of All Handicapped Children Act. Ashman & Elkins (1990, p.16-20) pick out two concepts, enshrined in the act, that have had impact throughout the world. The first relates to the provision of the 'least restricted environment' for the education of students with special needs. Put simply, if any aspect of a student's education can be provided in an ordinary school then the education authorities are more or less obliged to ensure it happens. The students should not be excluded from normal education provision unless their condition clearly demands it. Ashman & Elkins[iv] go on to review trends and legislative developments in integration policies in the UK, Italy, Sweden, New Zealand and Australia, drawing attention to the degree of integration and the obligations on educational authorities and schools in the various countries. In Australia, the Disability Discrimination Act of 1993 underpins the trend towards non-exclusion of students with special educational needs by outlawing the denial of access to education. The following extract from the Act illustrates this:

> "22.
> (1) It is unlawful for an education authority to discriminate against a person on the ground of the person's disability or a disability of any of the other person's associates:
> _ (a) by refusing or failing to accept the person's application for admission as a student; or
> _ (b) in the terms or conditions on which it is prepared to admit the person as a student
> (2) It is unlawful for an education authority to discriminate against a student on the ground of the student's disability or a disability of the student's associates:
> _ (a) by denying the student access, or limiting the student's access, to any benefit provided by the educational authority."

The second concept is the Individual Education Plan, IEP. This aspect of the US act places a legal requirement on the school to consult with parents and to make a written commitment to the supporting programme which the student is judged to need. The primary objectives are to ensure that the provision for the students is meaningful to them and their specific needs and to prevent integration becoming little more than an unproductive location for their schooling. Clearly there is also a need for teachers to consult with parents and guardians in order to extend the programme, if possible, beyond the formal tuition context.

In the UK, the main catalyst for change in the approach to special education was the Warnock Report (DES 1978). Intervening legislation culminated with the 1993 Education Act which confirmed the obligations on schools in England and Wales to provide for all students with special educational needs. The associated Code of Practice (DFE, 1994) set out guidelines for school policies on special educational needs, the role of the special educational needs coordinators (SENCOs) and the use of individual education plans for all students with relevant needs[v]. The Code also makes explicit what is expected of schools by way of an information

technology input to a special needs student's education. In the case of students with emotional and behavioural difficulties, for example, the school is expected to have:

> "Öexplored the possible benefits of, and where practicable secured access for the child to, appropriate information technology as a means of motivating and stimulating the child, for example wordprocessing facilities, painting programs and other software which encourages communication and self-expression, providing training in the use of that technology for the child, his or her parents and staff, so that the child is able to use that technology across the curriculum in school, and wherever appropriate, at home." (UK Code of Practice 3:62.v, p.58)

Similar statements of schools' obligations are set out for specific learning difficulties, physical disability, sensory impairments, speech and language difficulties and medical conditions.[vi]

**Early intervention**

The issue of remediation versus intervention and support also arises. On the basis that prevention is better than cure, there are growing efforts to identify learning difficulties as early in a student's education as possible. The aim of early detection is to prevent problems that would inevitably develop as a result of unsuccessfully learning the basics (Singleton, 1994, p.14). The argument for ensuring successful foundational learning for those with known physical, sensory, intellectual or situational problems follows the same logic - it is better to get it as right as possible in the earlier years than to initiate remedial action in later years. The potential for savings on the costs of remedial programmes, which are no longer or less necessary in the student's future years, is also not lost on educational authorities and government.

**Identification of needs and 'labelling'**

The issue of labelling students, with categorizations of their impairments, is also contentious. Most special education professionals take the view that labelling of students in terms of their needs categories can lead to programmes of support which may have merit at the general level but which may act counter to the students' individual needs. Tension sometimes exists between voluntary groups (very often representing parent and student interests) and the professional sector, an interesting example of which is described by Riddell, Brown & Duffield (1994). Their research, in Scotland, considered the perceptions of dyslexia interest groups and parents of children with learning difficulties in contrast to the views held by the educational psychologists employed by local government agencies. Their findings suggest that the voluntary sector is often at odds with the official view that learning difficulties exist as a continuum and that there is no clear cut-off between those who do have difficulties and those who do not. Instead they believe that dyslexia is a discrete condition which students can be considered to suffer from and that reluctance on the part of the authorities has more to do with their unwillingness to commit resources specifically to such students than to educational concerns.

Schools therefore often find themselves in the middle of a wrangle between parents pushing them to support their children's needs and the authorities who argue that the resources they will make available must cater for all students with needs and not special interest groups. Riddell et al's research suggests that middle-class parents are particularly adept in using the legislation to compel schools and local authorities to provide support. Students from more deprived backgrounds, which often exaggerate learning difficulties through deficits in home learning, tend to be disproportionately under-represented in support programmes.[vii] In such circumstances

information technology solutions, perceived as having lower staffing overheads and with the potential to serve all students, are likely to become more attractive to schools.

### Staff development

Once a programme for a student's special needs has been identified, subsequent support for them may remain problematic as many teachers will be unable to find the time or perhaps will not have the necessary skills to address them before the student moves on. In today's economic climate this inevitably means schools and local and state authorities having to cope with staff development and resourcing demands within static or reducing funding constraints. Integration measures are unlikely ever to be realized without additional funding for staff development and resources, and, in the search for more cost-effective means of delivery of the necessary support, the spotlight has turned onto information technology. Information technology applications are viewed as an important means of mitigating the problems experienced by the students, their teachers and schools by enabling the students to participate more fully in classroom activity and by augmenting the classroom teaching.

Another issue relates to the perception that many mainstream teachers consider students with special needs to be too difficult to provide for or unlikely to benefit from a normal education provision. The extent of such views among teachers hasn't been assessed but the phenomenon of teachers' low expectations of any out-of-the-ordinary students, and to some extent the consequent neglect of their needs, is professionally recognized. Rostron, Plant & Hermann (1994) criticized low expectations of learning impaired students after positive results from their work with a 22 year old man who had severe learning and communication problems. Using a hypermedia speech aid, EasySpeak, they recorded small but significant learning gains and felt moved to declare that the work seriously challenged 'the common view that IT cannot be utilized by the learning disabled'.

Able students who are low achievers can often remain so because assumptions about their ability are made on the basis of prior performance. Their low achievement may go unchallenged and may be consolidated by failure and neglect. Information technology applications may also have a role in this context in, for example, the use of the assessment, monitoring and reporting facilities of integrated learning systems. Such packages enable the students to work at their own pace and level and provide reports on their progress to their teachers. In some cases students under-achieving in classwork can demonstrate exceptional performance on integrated learning systems, much to the surprise of their teachers who had harboured low expectations of them.

## A Theoretical Perspective on the Role of Information Technology in Supporting Special Education

Before setting out to examine the role of information technology in special education in more detail it is worth considering a brief overview of the theories which can be considered to be relevant to the various trends and developments.

A theoretical underpinning or explanation of information technology developments in special education is as difficult to arrive at as it is in conventional education. The best fit models derive from traditional behaviourism (for drill and practice approaches which seek to inculcate basic literacy and numeracy skills by repetition) and from Vygotskian/Brunerian supported learning. The former still has meaning in certain activities but variants of the latter models currently hold most sway.

The translation of Vygotsky's seminal work, *Thought and Language* (Vygotsky, 1962)[viii] brought the concept of the Zone of Proximal Development into educational parlance. Essentially the theory predicts that new learning will build on prior learning and will progress to the student's next most achievable learning level within a 'zone of proximal development'. The nature and extent of the zone depends on the student's ability and prior learning, and progress is facilitated in a social context of support and intervention by more learned or competent 'others'. If these others can assist the students to reach a level of understanding or skill, which they are not *quite* able to reach on their own, they are considered to be contributing to the students' construction and internalization of the process. In time, the students should achieve the same outcomes through their own solo efforts.

Bruner (1985, p.29) drew on his problem solving work (primarily Wood, Bruner & Ross, 1976) to create the concept of 'scaffolding' as a means of explaining how a tutor (the Vygotskian 'other') supports the student's approach to a solution. Scaffolding describes the tutor's measured interventions which help the students to construct and test their understandings and skills, in an appropriate and timely fashion. Clearly tutors need to be sufficiently aware of their students' state of learning to know when and how to provide the supporting interventions, ensuring they neither over-stretch nor under-challenge them. This principle underpins the development of intelligent tutoring systems and integrated learning systems, both of which aim to develop the computer's role in diagnosing the student's problems and acting as the more learned 'other' to give tutorial support.

These theoretical approaches provide the basis for the importance attached to group and cooperative working (social and interactive) and also to the concept of mediated learning, where the mediation can be human or technological. Bozic and Murdoch (1996, p.2) have used the concept of the Functional System to describe the computer's mediating role in special education contexts. A functional system is the three-way arrangement of the student, assistive technology (e.g. a computer) and tutor in which the key process is interaction. Very often, of course, the computer acts as the actual medium of interactive communication (for those with communication impairments) as well as being a vehicle for learning. As such Bozic & Murdoch (p.5) propose that the learning horizons of students with special needs, or in Vygotskian terms their zones of proximal development, can be greatly extended by the role of information technology.

Bruner (1972, p.158) also provides a basis for understanding some of information technology's other features that appear to support learning, by impacting positively on the students' approach to their work. In relation to several major 'early years' education intervention programmes, he recorded a number of common themes which he considered to be very important in contributing to successful outcomes. The themes included the need to develop learners' confidence, to give them the capacity to control their own environment and to enable them to operate under their 'own activation'.

These theoretical approaches clearly relate to the concepts of mediation, socially constructed learning and empowerment; crucial dimensions of learning which information technology can bring to the support of special needs students. But they also contribute to and reflect a motivational dimension. Many students with special educational needs lack confidence in themselves and suffer from a low self-esteem (Kaniel & Feuerstein, 1989). Under-achievers, particularly those from socially deprived backgrounds with no consistent mediated learning in their early years at home, can be very able and suffer from no impairments except a deficient educational history. Such students may not have consolidated basic literacy and numeracy skills and as a result they develop a pattern of failure which destroys their confidence, undermines progression in their learning and causes them ultimately to lose interest in education. The

potential for information technology to increase a student's motivation to learn, by addressing deficiencies in learning and increasing confidence and self-esteem, cannot be over-emphasized.

## THE ROLE OF INFORMATION TECHNOLOGY IN SPECIAL EDUCATION

The role of information technology in special education can be articulated in terms of three goals, the first two of which are stated in various forms in most national policy statements. These are that:

- students should develop information technology capability i.e. that they should become confident and competent with common information technology applications and that they should be familiar with and have experience of the ways in which new technologies can serve both the individual and society;

- where appropriate, information technologies should extend and enrich the learning of students in all aspects of their schooling.

The third expresses an aim which has particular reference to all special education contexts:

- where information technologies can bridge gaps in students' access to and grasp of learning, they should be implemented.

This third goal, which clearly can apply to non-special education, but in lesser measure, implies that students with recognized deficiencies in their learning profiles should be afforded all appropriate information technology measures to address the gap(s). Interactive video-based presentations of a shopping visit to a French marketplace - something which might not be practical in real life and for which conventional video acts as a relatively passive substitute - might be an effective means for addressing language and culture aspects of the curriculum for non-special education students of modern foreign languages. The interactive context, with high quality digitized video and native speech, can prove motivational and effective in achieving learning objectives and the principle can easily extend to those with special needs. Such students, in a modern languages context, would have the same needs and reap the same benefits. For them, however, the gaps in access to learning can be much more fundamental: not being able to hear the teacher, not having the motor skills to write or participate in practical activities in science or mathematics, having only a blurred view of the class etc. Information technologies can 'level the playing field' for special needs students, and, even though they may remain significantly short of being on a par with their peers, it can enable them to engage more fully in learning activities.

The goals above can be linked with three closely dependent concepts and processes: empowerment, interaction and access. In the field of special education these terms are almost emotionally charged, focusing as they do on the very issues that the students' impairments conspire to deny to them. All students are empowered when they are able, in an appropriate manner, to act independently in their learning. Non-special needs students can be constrained by circumstance (e.g. lack of school resources or a teacher who does not subscribe to active or autonomous learning) but where circumstances do allow there is nothing to prevent them engaging in the planning and development of their own learning. Special education students, however, often need a more fundamental level of empowerment. They need to get past their impairments just to get on a par with their peers and become more independent. Information technology, it is argued, can facilitate the empowerment of students with special needs by enabling communication and interaction through a variety of electronic aids, and/or by assisting

in the acquisition of foundational learning in say, literacy and numeracy. Computers *empower* by allowing students *access* to normal learning activities, by enabling them to *interact* with the learning task, their peers and their teachers and by enabling them to play a more independent and active role in their own learning.

## SUPPORTING SPECIAL EDUCATION WITH INFORMATION TECHNOLOGY

Students and teachers who live with the adversities of special needs on a daily basis may be more vulnerable to unfounded 'hype' about the worth of computers in education than non-special needs teachers and students. For the former, the promise of some freedom, however limited, from the deficits of visual, auditory or speech impairments, from the constant failings of learning difficulties, from incomprehensible attempts at communication or writing, is more than a welcome interlude. In many cases it can mean quite simply the difference between a passive and dependent lifestyle and a participative and independent one.

Any claims, therefore, to be made for information technology need that little bit more rigour, to ensure that false hopes are not unduly raised. Teachers with special needs students, and those with the responsibility for resourcing such needs at school, community and state level, need the best available evidence before committing to an information technology provision. For the most part this evidence is provided in two forms: the judgements of experts, and particularly practitioners, and the evidence from research.

### The nature of the evidence

Academic and professional discourse on the benefits of information technology in education has enjoyed a dramatic growth in the past 10-15 years. The allure of computers and the belief that 'computers are good for you' have spawned many, mostly small-scale, research projects and countless opinionated, almost evangelical expositions of the wonder and utility of them. All aspects have been addressed to a greater or lesser extent: impact on learning, impact on curriculum planning, impact on pedagogic practice, impact on society etc.

Research specifically into information technology in special education is one of the areas which is relatively thin on the ground but much useful inference can be drawn from the two sectors separately. For example the benefits (e.g. close attention to individual needs) and disadvantages (e.g. restricted opportunities for social learning) of one-to-one teaching of students with special educational needs would have a reasonable literature base in special education research. It would therefore not be unreasonable to draw a parallel and predict similar outcomes with computer-based integrated learning systems which also offer individualized learning support. In a similar fashion, the benefits of using wordprocessors (e.g. increased length of writing pieces, facilitating creativity) has an established research base and it would not be unreasonable to project similar benefits into a special education context.

In addition to being relatively sparse, research in information technology use in special education suffers the same blight as any other information technology-related area i.e. the constant and rapid advances in the capability of the technology itself. For this reason much research from the 1980s has lost its validity as the machine platforms and software applications they were based on have disappeared or have been superseded by the sophisticated and considerably more powerful machines and software of the 1990s. In an effort to assure the currency of the research quoted in this chapter it is drawn mainly from the 1990s.

Published work in any area of education, including information technology in special education, covers two major types of work: findings from rigorous, primarily evaluative research and the informed opinion of expert practitioners. In terms of an evidential base for proposing any particular benefit of computer usage, a clear distinction must be drawn between the two. While not assuming the quality of proof, the former can contribute to a sense of confidence in the objectivity of the inferences that are drawn and the reproducibility of the proposed benefits in similar circumstances. The latter, on the other hand, is often dismissed as subjective and unable to distinguish between the role of the computer and the influence of likely confounding factors such as the supportiveness of the school environment and the nature and quality of teaching. Can the ordinary teacher be assured that they can generate the same school facilities and can exhibit the same competence which brought about the effects reported by the expert practitioner? Yet it can also be argued that the generalizability of rigorous educational research may be similarly doubtful because every learner or group of learners is a different case and any particular learning activity can be created in as many different ways as there are teachers and classrooms. For these basic reasons, the subjective judgements of practitioners are as valuable to other practitioners as any objective and accessible research findings. The educational community places value on evaluative studies which reflect on the intrinsic or comparative worth of classroom-based practices and resources. In some cases, indeed, they are more valuable than other research approaches, even to academic researchers, when for example they can offer the insights of practitioners to illuminate and explain observed effects.

Whether it is based on subjective judgement or objective inference, all research into information technology and special education aims to find improved ways of supporting students with special educational needs. The areas in which fruitful research has been carried out include:

_ access to communication;
_ development of literacy and numeracy;
_ group and collaborative working;
_ implementation issues and teacher education

and these are outlined below. In each case the relevant information technology applications are also outlined.

**Access to communication**

The view that informational technology devices can offer substantial benefits to special needs students, in the form of basic communication aids, is not in need of research-based backing. For children who would otherwise not be able to communicate or for whom communication would be demotivatingly slow, almost incomprehensible or even painful, the liberating use of electronic aids is a matter of record in many homes and schools. As always, however, the needs of a communication-impaired student may demand an individual solution which in turn may present problems in choosing a suitable augmentative or alternative communication (AAC) device, as they are called. Teachers will find the support of various other professionals, including occupational therapists and educational psychologists, valuable in assessing the best solution for a student's needs.

Criteria to assist in the choice of both electronic and low-tech devices are considered by Sigafoos & Iacono (1993). Recognizing the emphasis on finding an individual solution, they advise careful consideration of a range of features which such devices might have. Among their comprehensive list they include: symbol options (e.g. real objects, photographs, line drawings), message representation (e.g. the length of message that can be stored), message access (whether

by direct selection, scanning or even eye gaze), output options (e.g. screen display or speech generation) and operational demands (i.e. the skills needed to operate the device).

The physical process of communication requires a level of cognitive development which many special needs children have difficulties in reaching without intensive teaching and training. As in any normal educational context, information technology can also have a role in supporting this teaching. Bozic, Cooper, Etheridge & Selby (1995), for example, have reported a single subject case study in which a young girl with serious visual impairment was able to begin to develop communicative skills using a computer. The computer's role was to facilitate tasks in speech therapy sessions in which a number of targeted, specific forms of communication could be encouraged. Mixed success was reported but the importance of the social dimension in the development programme, the joint activity with a tutor, was considered to be paramount.

**Development of literacy and numeracy**

The use of information technology in literacy and numeracy development has attracted a great deal of interest, particularly for students with deficiencies in these skills. In the UK, for example, in a report on the use of information technology with special needs students in schools, Her Majesty's Inspectorate (HMI, 1990) took the view that literacy skills were the skills most widely and successfully supported by information technology. Wordprocessing, and related desktop publishing and authoring packages, probably form the bulk of usage of computers in a literacy context but other content-free approaches (e.g. hypertext and Logo), multi-media information sources (e.g. CD-ROMs and the Internet) and content-focused materials (e.g. computer assisted learning packages and integrated learning systems) significantly broaden the possibilities for classroom activity.[ix] In the context of empowerment, portability is a major concept and much of the high-level work which students with impairments can take part in is greatly facilitated by small portable computers (laptops, notebooks, palmtops etc.).

*Wordprocessing*

The role which wordprocessing can play in literacy development has been the focus of much research. In an analysis of some 32 research projects, in which the impact on writing development was compared for non-special needs groups using and not using wordprocessors, Bangert-Drowns (1993) confirmed the common view that the quality and length of writing of students who have been using wordprocessors is improved in comparison to those who have not. Work by Snyder (1993, 1994) showed clear gains in the quality of writing for non-special needs students using wordprocessors compared to a group who had not been using wordprocessors. In another project, James & Hammersley (1993) have used notebook computers for deaf students with a typist creating a running script of the teacher's and other students' interactions, on a machine linked directly to the deaf student's machine. The impact on one student's learning was a substantial leap in performance to bring him into the top ten in the class in all subjects and to first in mathematics. The student himself attributed the improvements to receiving 'over 95% of what was going on'.

The holistic approach to the literacy needs of special needs students is emphasized by Gipe, Duffy & Richards (1993). Working with Arthur, a 33 year old non-speaking cerebral palsied student with no educational background, their paper reports the dramatic progress made over 180 hours of tuition involving computer based reading and writing. In his early assessments the authors had detected his innate ability through an evident sense of humour and were quickly able to harness his clear determination to succeed in reading and writing. The holistic approach deliberately fostered his commitment to learning by focusing on his interests and everyday

events (including enabling him to write a letter of complaint to the bus company he used). The success Arthur and his tutors enjoyed was accomplished despite the use of a relatively low cost synthesizer (with robotic output) and the lack of appropriate input devices, such as a one-handed keyboard or keyboard-configuring software, which could have compensated better for Arthur's restricted motor skills.

Arising from a well established research programme, Newell, Booth, Arnott & Beattie (1992) have reported increased literacy levels for students using a predictive wordprocessing system ('predictive adaptive lexicon' - PAL). Predictive wordprocessors provide a menu of likely next words for the writer, predicted from the letters the students have already typed in and drawn from a specially reduced dictionary which the students can extend with their own most used words. The aim of the package is to develop the literacy of students whose interaction with the computer might be very restricted and slow owing to their physical disability. Predictive wordprocessors such as PAL (MS-DOS) and Co:Writer (Macintosh)[x] enable such students to produce written pieces of work relatively quickly or more efficiently. Newell et al's paper reports a study involving 17 students, all in mainstream schools, ranging in age from 8 to 19 years and having various impairments including cerebral palsy, muscular dystrophy, Down's syndrome, Lowe's syndrome and Fragile X syndrome. Several students had no physical impairment but did have learning difficulties. Using PAL, Newell et al claimed improvement in the students' independence and confidence, in their learning, in their motivation and in their speed of completing work. In addition they noted improvements in vocabulary size, concentration span, presentation of work and spelling accuracy with reductions in the time teachers spent with the students. The effects on reluctant writers were described as 'very dramatic'. Full Phase (Acorn), in conjunction with its Phases theme packs, is a popular and simple wordprocessor which enables students to create illustrated stories. Students with literacy difficulties can use a speech facility which enables them to hear their words or letters as they are typed.

*HyperCard*

Hypermedia or hypertext-type software packages, such as Apple's HyperCard, provide tutors with a relatively simple development system for computer based learning materials. With a minimum of training tutors can develop inter-linked 'stacks' of screens or 'cards' which students can make their way through by 'pointing and clicking' on-screen 'buttons' with their mouse. The cards are linked together on different levels and the user can choose a linear pathway through them by simply clicking a 'continue' or 'forward' button (like turning a page in a book). Alternatively they can choose to branch off (and eventually come back if they wish) by clicking on an appropriate 'hot-spot' on the screen. An example of this linking process in a conventional book might be a superscript character indicating a note at the end of a chapter to which the reader might go, temporarily leaving the page they are reading. In a HyperCard stack it might be a direct link via a highlighted word or phrase which when clicked on leads immediately to another card overlaying the original. This new card may offer, for example, an explanation for the highlighted word or phrase, or even the digitized pronunciation of the word(s). Once the user is satisfied another screen button allows immediate return to the original screen. An example of a multi-media hypertext package which is attracting widespread interest, owing to its claimed ease of use, is HyperStudio. Available on the three platforms Macintosh, PC and Acorn, it enables students (and teachers) to 'author' multi-media projects incorporating graphics, still and moving video images, sound and World Wide Web resources.

The ease of use and the relative sophistication of hypermedia systems mean that they often appear in the literature as a vehicle for student learning. For example, in one small-scale study

Horton, Boone & Lovitt (1990) reported that hypermedia study guides, derived from prescribed study texts and presented in a HyperCard format, were more amenable to learning impaired high school students than textbooks, and could significantly improve performance.

Bottino & Chiappini (1995) have also reported learning effects arising from the use of a HyperCard-based system for communications between deaf students. These effects included the development of anticipated meaning in reading, planning in writing, new writing constructions and seeking clarification or information in a wider variety of situations than usual. Affective results were reported to include eagerness to read and write, motivated by the extended social contact that the computers facilitated. Jones & Selby (1995) have used a package, BubbleTalk (based on HyperCard), to encourage self-expression from students with emotional difficulties. This system creates little cartoon scenarios around topics which the students have difficulty in discussing. They have to create what the people in the cartoons are saying and thinking by typing their dialogue into speech bubbles which appear beside the figures. Jones & Selby consider the computer to act as an effective mediator by providing 'an optimum level of distance and identification in role play'(p.330).

*Logo*

The programming language Logo, and its turtle graphics derivatives, has an important place in the research literature particularly in relation to mathematics learning (see for example, Hoyles, Healy and Pozzi, 1994). Some literature, however, also places Logo in a literacy context. For example Clements (1991) presents evidence from a study of 73 non-special needs eight-year-old children which suggests that Logo can improve not only figural (shape) creativity but also impacts positively on verbal creativity. Mevarech & Kramarski (Israel, 1993) carried out a similar study with eighth-grade students and, in addition to showing similar findings for verbal creativity, concluded that cooperative working with Logo significantly enhanced learning gains. In a discursive review of research, rather than a research-based report, McLeod & McLeod (1994) also argue the empowering benefits of Logo as a vehicle for literacy development for students with language difficulties. They claim that students with communication problems tend to be passive and responsive in learning and that Logo work enables them to be more assertive and successful in attempted communications.

*Multi-media, CD-ROMs and the Internet*

Multi-media presentations can enliven lessons and motivate students to engage in learning that is perhaps difficult to facilitate otherwise. For example the concept of a talking book is a major development. Speech and other relevant sounds can be presented in an animated display as the students make their way through the 'book'. The speech provision is vital for the visually impaired while ear-phones can also enable partial-hearing students to benefit from high-volume speech and sound generation without disturbing others. CD-ROMs in particular can offer ease of access to 'electronic' books where the text and sound are supported by high quality illustrations and animation effects that are considered to add greatly to the potential for motivating most students. 'Talking' books such as those from Discis Kids Books (Macintosh) and Living Books (PC and Macintosh) have a range of titles which the students can choose to read or have the computer read to them. They are highly effective with students who have literacy difficulties and are being marketed in a variety of languages (e.g. Spanish, Cantonese) and even accents (US and UK English). Other CD-ROMs of interest to students with special needs include information sources which allow the student to explore large domains of illustrated knowledge. CD-ROM encyclopaedias will often include digitized versions of original speeches of famous people, video clips of sporting activities, animated diagrams of mechanical processes

and compact disk-quality musical accompaniments. A prime example is the encyclopaedia, Encarta from Microsoft (PC and Macintosh) while a popular example of a thematic CD-ROM would be Microsoft's Dinosaurs (PC and Macintosh).

The Internet also offers access to multi-media materials, including digitized video, and as the power of typical school machines increases this type of usage will increase. However by far the most common use is the searching of the vast information sources the World Wide Web offers. Students, for example, can copy (download) sophisticated images from museum sources or find out what the headlines are on numerous newspapers throughout the world. In the context of special needs there are many 'websites' offering information and resources for teachers e.g. the Special Educational Needs Coordinator (SENCO) website hosted by the UK National Council for Educational Technology and the more general Schools of the Future - SOFWeb website hosted by the Directorate of School Education, Victoria.[xi] Still others address the social needs of special needs students e.g. the Chatback Trust which links special schools, teachers and students throughout the world and Apple's soon-to-be-launched Convomania site for linking students in long-term hospitalization programmes. In addition there are many sites which offer guidance on software for special education and others which provide information, usually direct from special interest and voluntary associations, on many types of impairment and learning difficulties.

*Computer assisted learning*

Almost all information technology applications in education comprise some form of computer assisted learning but the term itself, or more usually its acronym, CAL, tends to describe packages which are distinguished from other types of information technology applications primarily by their relatively restricted nature. Most CAL packages take a discrete teaching topic such as fractions or spellings and address it exclusively with examples and solutions framed within an interesting context. One of the most widely used of such packages is Math Blaster (PC and Macintosh) which addresses basic arithmetic within a futuristic space theme. Others will present an adventure or simulation context to capture the students' interest while literacy or numeracy activities are woven into the tasks they carry out.

A wide variety of computer assisted learning materials exist and it is probably fair to say that any computer assisted learning package may be used in a special needs context *if the student can access it* and *if its learning objectives match the needs of the student*. Some software houses specialize in packages for special educational needs, adapting various packages for special needs by creating appropriate teaching resources around them. Occasionally a package might develop in the opposite direction and one in particular, My World 2 (PC and Acorn), has now extended out of special needs to penetrate significantly into the wider market. Essentially a content-free package, it allows picture objects and text to be picked up and placed anywhere on the screen, much like the low tech 'fuzzy felt' type cloths which children use to create picture stories with 'sticky' cut-out figures and objects. Well over a hundred content-focused packs for My World 2 have been created for work across the curriculum including mathematics, English, modern foreign languages and science. Its ease of use and ability to captivate the interest has made it very popular with special needs and other students.

Teaching resource packs, designed like those for My Word 2 above to create a focus for the use of content-free applications, are becoming more common. Many resources for numeracy, algebra, graph work and modelling with spreadsheets and geometry and transformations with Logo are now widely available.

*Integrated learning systems (ILSs)*

Integrated learning systems (ILSs) are coming of age some 20, perhaps 30, years after computers first began to provide individualized tutoring to students. In the early days the approach would have been to provide students with repetitive practice on multiple choice, true-false, cloze-procedure and other question-and-answer type systems. The integrated learning systems of today offer much more sophisticated tutoring environments and some of them purport to offer entire curricula to enhance and, in some circumstances, provide the teaching which students receive. Their role in monitoring and reporting student progress is a major selling point and some also claim a measure of in-built 'intelligence' which allows them to adapt to each learner's stage of progression. A review of the literature on ILS systems and their effectiveness has been carried out by McFarlane (1996).

Outside of the United States, where the instructional model that the systems espouse is culturally more at home, two major studies of their efficacy have recently been completed. Fitzgerald, Hughes & Fitzgerald (1996) have evaluated their use in schools in Victoria (Australia) while the National Council for Educational Technology (NCET, 1994 & 1996) has completed a range of studies into their use in the UK[xii]. Fitzgerald et al reported (p.29) very positive responses from the two special schools in their study in relation to the Computer Curriculum Corporation (CCC) SuccessMaker system. This is a very comprehensive integrated learning system (some estimates quote over 600 hours of built-in student activity) and was also the main focus of the studies carried out by NCET. The teachers rated a number of the system's features quite highly:

_ learning modules linked to key learning areas;
_ modules for providing remedial and enrichment activities;
_ the provision of 'game like' learning modules;
_ availability of a management system for keeping track of student progress;
_ immediate feedback of performance to students; and
_ diagnostic procedures for identifying weaknesses in learning. (Fitzgerald et al, p.29)

NCET also looked at issues relating to 'special' students and in a series of small scale studies reported positive impacts on the learning activities of special needs students (Lewis, in press), able 'fast track' students (Rodrigues, in press), underachievers (Gardner, in press) and students with English as a second language (Harrison, in press). Passey (in press) also made a preliminary evaluation of the use of another sophisticated US system (Jostens) with students in hospital schools. SuccessMaker explicitly sets out to motivate users by contriving to ensure that the students experience a high degree of success in each session they participate in. In general these studies added weight to the motivational effects claimed for the systems with the majority of students expressing their enjoyment in using them.

In the small-scale study of underachievers carried out by Gardner, teachers were able to identify underachievement in students they had previously presumed to be very weak, through SuccessMaker reports which indicated much improved levels of performance. Other impacts which were suggested by the teachers in the underachievement study included increased confidence and risk-taking (asking questions, proposing answers), improved self-image, more sustained attention to task and, in relevant cases, some degree of improved behaviour. The students themselves expressed their appreciation of the structured practice, non-judgemental and rapid feedback, autonomy and privacy of the learning and, surprisingly perhaps for students prone to being disruptive, a relatively quiet environment free from the distractions of normal classroom work. Hopkins (1991) had earlier also reported teachers' perceptions of the

motivational and settling effects of information technology-related activities with students who have emotional and behavioural difficulties.

Although it might be reasonable to expect an increase in self-esteem arising from the built-in success design of SuccessMaker, Lewis did not detect any for the special needs students to whom she had access. In addition to cautioning about the time-frame of the study and the sensitivity of the self-esteem instruments, she suggested that it was possible that the lack of an increase in self-esteem was due to the students perceiving the positive reinforcement as deceptive. While several of the studies (Harrison, in press; Gardner, in press; and Lewis, in press) noted improved learning outcomes, the authors stressed that these were within the measurement system of the ILS itself (in these cases SuccessMaker) and were not externally validated. Evidence for improved learning outcomes as a result of ILS usage, but assessed in a context external to the ILS, is available in Fitzgerald et al (1996) and Underwood, Cavendish, Dowling & Lawson (1995). The clearest results in these studies have related to improvements in performance in some aspects of basic numeracy (e.g. number, measurement, money - Fitzgerald et al) with some indications of improvements in reading for inference (Fitzgerald et al).

*Portables*

The attraction of portable computers is that they can be carried around, albeit some (e.g. wallet-sized 'palmtops') more easily than others (e.g. 6lb/3kg 'laptops'). Empowerment clearly takes on a more personal dimension if the students are able to carry their system with them, to each class and home. Sallay (1995) recounts an interesting case study of a year 7 New South Wales student with a high verbal and reading age. Owing to difficulties with fine motor skills, he had a low self-image, was a very reluctant writer and was underachieving in all areas. As part of an 'armchair travel' assignment his class had to create a journal of an imaginary trip from Adelaide to Darwin and fortunately he had the opportunity, during his holidays, actually to make the journey. He took a portable computer with him and created the journal on a daily basis as he travelled. As a result, he submitted a 200 page report and subsequently showed improvement and confidence in all areas. Clearly it is possible that many unrecounted influences could have contributed to the changes but there is little reason to doubt that the computer enabled the student to overcome a writing difficulty and contributed to his raised motivation. The production of a piece of work, which clearly impresses people the student respects (in this case his teachers), is also an accomplishment which may generate a better self-image and a more positive approach to other aspects of study.

**Group and collaborative working**

As in general education, mediated learning is a key concept in special education. Clearly the main mediators in student learning are the teachers whose role it is to facilitate and challenge them to reach new levels of learning. Computers can also act as a mediator, whether in quasi-tutorial form in integrated learning systems or in stimulating learning through Logo problem solving etc. They can act in limited fashion as a more competent 'other' but they cannot directly offer the social interaction between teacher and student and between student and student which most educational theorists believe is a major feature of the most successful educational environments (c.f. Vygotsky). However, they can *facilitate* socially constructed learning by acting simply as a means of communication e.g. through e-mail and Internet discussion groups, or by acting as a focus for collaborative working in peer-groups.

A study by Hoyles, Healy & Pozzi (1994) has shed considerable light on the way in which such groups function without a teacher and how they perform in complex tasks. Using three specially designed tasks (two with Logo and one with a database) they carried out a multi-site case study involving eight groups in six schools with each group having two non-special needs students in the 9-12 year-old age range. Their report details highly rigorous methods of analysis, to ensure the validity of their inferences, and these allowed them to conclude that groupwork with a computer does significantly facilitate learning in mathematics.

In a special education context in Baltimore, Wizer (1995) also looked at the effects of collaborative working in a study of 24 pairs of 14 year old students (16 with learning difficulties, 16 with emotional difficulties and 16 in a comparative non-special education category). Working on mathematical word problems, mutual keyboard usage and giving explanations were significantly related to achievement for the non-special needs students. However his findings indicated no relationship between interpersonal factors and achievement for the learning difficulties students and only 'receiving agreement' appeared to relate the achievement of the emotionally impaired students. It is possible that the social skills necessary to benefit from collaborative learning may not be as developed for students with learning difficulties and in an earlier study, Kutnick & Marshall (1993) had indeed concluded that young children in particular might need some form of social skills development to enable them to contribute to and exploit the cooperative features of group working. In relation to special needs students, and in particular those who have to spend much or all of their time out of mainstream education, any cooperative learning with their peers has a 'socializing' dimension and the potential of computers to facilitate such interaction offers considerable additional benefits.

**Implementation issues and teacher education**

The greater integration of students with special needs is in itself a major staff development focus for schools as is the greater integration of information technology in teachers' teaching repertoires. The two issues obviously overlap in the context of supporting special needs students with appropriate information technology teaching approaches. The first problem a teacher might be presented with is to decide whether an information technology solution is actually appropriate. In an attempt to address this problem, Leigh (1990) sets out a series of questions teachers should consider before arriving at a decision. She bases her analysis on the premise that an over-emphasis on integrating computers into the education of special needs students may, as a result of competition for student time for example, undermine or ignore community based activity or instruction in everyday life-skills. Drawing on earlier work (e.g. Brown, Nietupski & Hanre-Nietupski 1976) she presents questions in relation to eleven critical characteristics for designing educational programmes for students with intellectual disabilities. These questions (reproduced as written in the original with the critical characteristics issues in parentheses) include:

- Will use of computers give the student the opportunity of working with a non-disabled chronological aged peer, on the same activity, at the same time? (Integration)
- Will the use of computer based instruction complement the preparation of the student to participate in integrated community activities and environments? (Life Space Oriented Curriculum)
- Will the use of computers assist the student to be able to perform an activity that he/she would otherwise need to have someone else do for them? (Functional)
- Is the task one that non-disabled peers of the same chronological age would be involved in? (Chronological Age Appropriate)

_ Will other significant people in the student's life (e.g. parents, friends) allow and encourage the use of computers? (Skill Transfer Verification)

The other characteristics of individual programmes, which Leigh attaches guiding questions to, include: Practice (opportunities for independent practice), Parent/Guardian Involvement (consultation with parents/guardians on choice of software), Non-School Instruction (incorporation of computer based activities in instruction outside of school), Partial Participation (the degree to which the student is able to participate individually), Individualized Adaptations (the need for individualized augmentative devices)and Individualized Transition Plans (incorporation in the student's integration activities and plans).

Zammit (1992), in a survey of mainstream teachers in seven Melbourne secondary schools, identified a hierarchy of factors which facilitated or hindered the teachers in using information technology in their teaching. In essence the barriers focused on the paradox of funding being made available for the purchase of hardware and software but not for buying the time teachers need to appraise what is available and become competent with its use. Time was the crucial factor but other important issues included problems associated with access, a lack of pedagogical support for integrating the software into their teaching, the quality of software and its appropriateness to Australian schools. Such issues find echoes the world over, most notably in the US (see for example the report of the US Congress Office for Technology Assessment - OTA, 1995) and the UK where Sepehr & Harris (1995) reported similar barriers from a small-scale study involving teachers of children with special educational needs.

In a larger scale study involving responses from 362 mainstream teachers across Australia, Sherwood (1993) felt that little had changed in the integration of information technology in teacher education since an earlier 1985 survey by Fitzgerald, Hattie & and Hughes (1986). She argued that teacher education was focused too much on the computer and not enough on its integration into classroom teaching. In the US, Cohen & Spenciner (1993) surveyed 381 rural special educators and concluded that there was little integration of computers in reading, or writing curricula. The use of the computers tended towards 'traditional' drill activities and the lack of available assistive devices made wider usage less accessible. Lewis, Harrison, Lynch & Saba (1994) drew more or less the same conclusions in a state-wide survey of Californian special educators and also reported that special needs students had the same level of access to the technology, less than one hour per week, as their non-special education peers.

Bailey (1992) recognizes the dominance of the drill and practice usage of computers in special education and issues the challenge to special educators to take on board the concept of computing as an environment providing 'rich opportunities to increase motivation, overcome passive learning and grow in social cognitive development' (p2). Teacher education will inevitably be a key factor in any progress towards meeting this challenge and Sherwood's criticism of teacher education's role in the integration of computers is often echoed throughout the education community. Oliver (1994), for example, argues that the information technology content of such courses should more closely reflect the model which schools have to follow i.e. integration of information technology throughout the teacher education programme and attention to the development of key competences. He particularly targets pre-service courses on the basis that new teachers will use what they have been taught to use. However, other educators (e.g. Veen, 1993) would argue that with the worldwide trends to more school based practicum, pre-service courses no longer offer the time to cover information technology in sufficient depth. Veen argues that a more fruitful approach to greater integration would be to address in-service education with a view to developing positive perceptions and beliefs in relation to information technology among teachers who have already mastered conventional pedagogical techniques.

Teacher education in special education contexts will remain problematical if only because of the sheer cost of any level of staff development. For the most part it will involve in-service teachers as it would not be reasonable to expect mainstream beginning teachers to take on the additional challenges of information technology use in special needs contexts. Yet for experienced teachers it is very important not to lose sight of the fact that many are very successful in what they do normally. Yes, they will appreciate the potential for motivation and learning gains which information technology offers but for the many reasons alluded to above they may stick with their tried and tested traditional methods. Winning them over to using information technology requires evidence that they can do what they normally do better or that the students will reap significant benefits. They can of course be obliged to integrate the use of information technology in order to comply with the aim of developing students' information technology capability but such an imperative approach may actually encourage a lip-service or perfunctory response.

Compared to non-special needs contexts, it may actually be easier to convince teachers of the worth of an information technology approach to special educational needs, simply because many of the potential benefits - improvements in communication, participation, presentation of work etc. - are that much more visible. However teacher education still has the problem of making it visible and no amount of talking about it during in-service courses will substitute for the real thing. In this respect Gibson & Gibson's (1995) novel approach to providing pre-service students with opportunities to observe good practice (in the context of multi-grade teaching in rural classrooms) might be worthy of extending to in-service courses in the use of information technology for teachers with special needs students. Gibson & Gibson used an in-class camera system to broadcast 'live' lessons to the students on the course and reported that the students rated highly the unobtrusiveness of the observations, the linking of the course material to real-life classroom practice, insights into pedagogical skills and immediate feedback from the expert practitioners during interactive parts of the broadcasts. Distance education approaches, whether via the Internet or via broadcast television (e.g. interactive video-conferencing), present many opportunities to extend approaches to teacher education in special needs but some caution is in order. Howard, Ault, Knowlton & Swall (1992), for example, are quite positive about the potential of distance education for teacher education and, in some circumstances, meeting the needs of students at home or in distant rural locations, but they also raise concerns that distance education can quickly become a form of exclusion.

Although there are no real shortcuts to competence, many of the voluntary organizations involved in special needs[xiii] have ready expertise in information technology developments in special education and are therefore well worth approaching for advice. Other possibilities for generating the interest and awareness of teachers in information technology for special needs are likely to develop through the Internet (c.f. the SOFWeb sites of the Directorate of School Education, Victoria). Sites offering facilities for teachers to discuss problems and seek advice on how to deal with various special needs are becoming established and may become a major way of facilitating professional contact and personal development.

## SUMMARY

In considering the role of information technology in supporting special educational needs, a number of key concepts, processes and issues require to be recognized and addressed. A selection of these important matters is summarized briefly below.

- *Entitlement*. Students with special needs are entitled to the same quality of educational provision as their more advantaged peers.
- Where feasible they should be *integrated* into normal schooling and classrooms (*mainstream* education) with as much *de-emphasis of their specialness* as possible.
- Entitlement extends to the achievement, for students with special needs, of the main goals of information technology in education: the development of students' *information technology capability* and the *extension and enrichment of their learning*.
- *Empowerment.* A third goal for information technology in special education is its use to enable students with special needs to *compensate for physical and sensory disabilities*, which restrict communication, and to *address learning difficulties and deficiencies*.
- Information technology empowers special needs students by enabling them to *access* learning opportunities and activities in which their more advantaged peers engage.
- Access to learning is in turn enabled through the use of information technology as a means of communication to *interact* with objects and people in the learning context. Access is achieved using a *wide range of input* (e.g. keyboard, joystick, switch assemblies) *and output* (e.g. speech, enlarged screen text, translation to Braille) *devices* and is particularly enhanced by the use of *portable computers*.
- *Motivation.* Students with special educational needs often have a lack of self-confidence and a low academic self-image, brought about by a combination of learning difficulties and failure over time, and information technology approaches can generate renewed motivation.
- Information technology use in special education contexts is considered to motivate students through *increasing their self-confidence and self-esteem*. This is accomplished by a variety of factors, acting singly or in combination, including an enjoyable context, individualized or group working as appropriate, non-judgemental feedback and success and pride in the presentation of output. The high presentational quality of output from wordprocessing-type systems gives no hint of the nature of any physical or intellectual difficulty the author might ordinarily experience in writing and its impact on students' motivation and pride in their work can be considerable.
- *Mediated learning.* Information technology can act as a passive mediator in learning by facilitating students' exploration and research in new learning domains (e.g. CD-ROM and Internet information sources) or by assuming an active, albeit limited, mediation role in tutorial learning contexts (e.g. *individualized learning* with integrated learning systems).
- *Socially constructed learning.* Information technology can act as an effective focus for g*roup and collaborative learning* (e.g. in Logo problem solving, in adventure games and in thematic project writing).
- For some groups of special needs students, isolated by serious disability or hospitalization for example, information technology can provide a *social dimension* which they could not otherwise enjoy (e.g. *networking* through e-mail and the Internet).
- *Curriculum extension and enrichment.* Information technology can introduce new types of learning or more sophisticated approaches to conventional learning (e.g. *resource-based learning* with CD-ROM and Internet sources, *modelling* scientific, mathematical and environmental processes with spreadsheets and *problem-solving* with Logo).
- Any information technology application which has merit in mainstream education should have similar merit in special education. There should be no need to modify the learning objectives or content of existing materials (these should be no different for special needs students) but there may be a need to modify or create a means of accessing them as a result of particular students' impairments.
- The choice of any information technology approach to support special needs should be based on *careful assessment of the student's needs* and *the appropriateness and ability of the*

*information technology application to meet them*. A general approach which provides a pre-determined package in response to a particular category of impairment is to be avoided.

- Staff development for teachers should address the benefits of integrating information technology in their teaching and should not imply that their established teaching methods are less successful or appropriate. The potential for *low expectations* in relation to special needs students' learning should be addressed.

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[i] Readers wishing to assess the prevalence of the main categories of impairments experienced in Australian schools should refer to Ashman & Elkins (1990).

[ii] Booklets illustrating the types of peripherals to support physical disability and the use of symbol systems are available from the UK National Council for Educational Technology (NCET 1993a, 1993b respectively). Readers will also find the following references useful in assessing what types of peripheral devices might meet special needs: *'Tackling technology with special needs students'* by Bailey & Williams (1989), *'Computers in special education: getting the most from your Acorn BBC computer'* by Dyson et al (1988), *'Microcomputers and the physically disabled'* by Jones (1990) and '*The Apple Australia special education resource directory'* by Piper (1988)

[iii] Snoezelen multi-sensory environments were first developed in the Netherlands in the 1970s. They provide children with a variety of stimulatory objects (e.g. tactile walls) and effects (e.g. sound and lighting effects) in an attempt to foster therapeutic play, often designed by the teacher. Low and high-tech (computerized) switching systems can now provide an interactive dimension which can also be tailored by the teacher to promote some degree of learning or which can enable the child to manipulate the environment.

[iv] Readers wishing to inform themselves about the development of special education and the range of conditions giving rise to special educational needs will find the Ashman & Elkins book a useful and readable introductory text.
[v] In traditional British fashion these are not statutory requirements, as some of them are in the US, but any school not 'having regard' to them would find it difficult to defend actions from litigious parents.
[vi] Day (1995) addresses the implications of each aspect of the code that has an information technology dimension. Using 20 illustrated case study-type presentations she offers suggestions on how a range of special needs may be met with information technology applications and includes listings of suppliers, publications and specialist organizations.
[vii] It is worth noting, perhaps, that in her review of research into the use of computers in education, Sutton (1991) concluded that schools serving disadvantaged students tended not to be as well resourced with computing facilities as perhaps more affluent schools were.
[viii] Vygotsky died in 1934 and his work, which contested the behaviourist tenets of learning dominant at that time, was suppressed by the Soviet authorities for some 20 years. It was translated into English in 1962 and was read by Jerome Bruner (Bruner, 1985) 'not only with meticulous care but with growing astonishment. For Vygotsky was plainly a genius'. It stimulated a huge literature of interpretation and re-interpretation of his thinking and has underpinned much of modern learning theory.
[ix] Abbott (1995) uses a series of illustrated case study-type presentations to suggest how information technology applications can be used to support basic literacy and numeracy skills.
[x] McKeown (1996) offers a brief overview of predictive wordprocessors with details of sources.
[xi] Website 'addresses' are not offered as references as, unlike paper documentary sources, the details may change over time or the sources may even be discontinued. Readers interested in using the Web in relation to special needs in general or any site in particular will, however, find the information searching systems (so-called 'search engines') quite easy to use.
[xii] At the time of writing (July 1996) NCET have entered into a third phase of commissioned studies focusing on the impact of ILSs on learning.
[xiii] For example, the Spastic Society of Victoria (PO Box 381, St Kilda) and the Yooralla Society of Victoria (PO Box 88, South Melbourne)