A Review of Recent Research Relevant to the Early Years Enriched Curriculum Project

Extended form

School of Psychology
Queen's University Belfast

Sproule, L., Murray, R., Spratt, V., Rafferty, H., Trew, K.,
Sheehy, N. & McGuinness, C.

September 2001

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Executive Summary

1. Introduction and background

Following the first phase of the Early Years Enriched Curriculum Project (EYECP), CCEA considered that it would be useful to draw together and summarise the relevant literature on early years education to serve as a resource for critical reflection on the Enriched Curriculum and to inform its continuing refinement. In agreement with representatives from CCEA, the pilot project evaluation team (the EYECEP team) undertook to examine the relevant research.

This literature review was highly ambitious, extending over research into learning from a very wide range of disciplines and perspectives, each discipline having its own methodologies and criteria for validity. The research areas covered were as follows:

- International comparisons of literacy and numeracy in the context of variations in the curriculum and educational culture.
- Research into early language and literacy.
- Research into early numeracy and mathematics learning.
- The role of emotional and behavioural development in early learning.
- The role of play in early learning.
- The contribution of neuroscience to research in early learning.

The report contains a section relevant to each of these research areas. The EYECEP team uncovered a vast amount of information in each domain. Indeed, each area would have been worthy of a separate review in its own right. In order to present the data in a manner helpful to a diverse audience, the report is presented in a short form and for those who require more detail, an extended form.

At certain points in the report, particular parallels emerged between research findings and the content of the Enriched Curriculum. These points are presented in boxed italics.

Conscious that each reader will interpret the findings from an individual viewpoint, the authors, in the first section of the report, render explicit some of the models of education which may underlie an individual's response to the evidence. These models are the child-centred model, the social realism model and Whitehead's more balanced 'rhythm of education' model.

The idea of a developmentally appropriate curriculum has begun to gain some currency in the literature. It is argued that children in the early years are particularly unable to cope with a developmentally inappropriate curriculum.

In the final part of Section 1, the management of change is addressed. Given the extent of the revolution in the classroom brought about by the Enriched Curriculum, the difficult task is to change practice rather than policy, training, support and sustainability issues are examined.

2. International Comparisons of performance

Seven countries, four of which are English speaking, are examined in detail. England is used as a proxy for Northern Ireland. The other countries are Australia, Canada and New Zealand, chosen for cultural similarity to England, and Hungary, Flemish-speaking Belgium and Japan, chosen for varying degrees of cultural contrast. This set of countries also represents a spectrum of educational culture, particularly in the matter of the age at which formal schooling begins. Hungary and Flemish-speaking Belgium epitomise the 'continental model' of early years education which has strongly influenced the designers of the Enriched Curriculum. The education systems of each country are fully described in the extended version of the report.

Elements of the performance of countries other than the seven named above are considered when it is appropriate.

Main findings on comparisons of performance in literacy and numeracy

- In post-primary groups, it is clear that England is performing below the levels which would be expected in reading literacy and mathematics, given its resources. No data from large-scale studies on very young children are available. Some countries which lack the resources of England, for example Hong Kong and Greece in reading literacy and Hungary in mathematics, are nevertheless producing better performances than England.
- Whilst it is impossible to allow for all the factors which might influence performances across countries, the major studies in both literacy and mathematics show no evidence of detriment to performance from a late start to formal education or from a developmentally appropriate curriculum in the early years.
- In reading comprehension, some countries, including England, appear to perform poorly because of a long low-achieving tail in the distribution.
- None of the countries which delay formal reading until seven years show a long low-achieving tail in the narrative or expository domains of literacy.
- In mathematics performance, the Asian countries are clearly outstanding. Some of these countries have limited resources.
- In mathematics, one may conjecture from the evidence that a class which is relatively homogeneous in attainment may be easier to teach. There is no evidence from international comparisons that this is the case for literacy (although see the section on language and literacy for evidence from other types of study).

3. Early language and literacy

Predictors of success in literacy learning

Social and economic disadvantage are the most important factors in relation to basic literacy skills. This is mediated through parental attitudes and behaviours. The variation in children's pre-school experience of literacy is very wide. However, once children start school, the school can have the greatest impact on progress. If children commence a formal reading programme with little in the way of literacy experiences, they are not well placed to make good progress at reading. This underlines the importance of providing a range of literacy experiences for children prior to them starting a formal reading programme.

Baseline knowledge of literacy is the most important predictor of success at the end of the first year.

Oral language

Good oral language and communication skills are also important predictors of progress in literacy. They are also vital for progress in other areas, including social and behaviour problems, listening and attention. Many children, particularly those from socially disadvantaged areas, have significant language delays on entering nursery school and for a considerable number of children, these language delays will persist into primary school. Yet, early years education in Britain lacks the type of detailed language policy which exists within continental pre-school curricula. Given the evidence linking early language proficiency to later educational success, it is important that oral language work is recognised as a vital part of the curriculum particularly during the period before the formal teaching of reading is introduced. The transition to a formal programme should be as gradual and natural as possible.

Joint picture-book reading has been demonstrated to be a valuable contribution to children's learning, especially in low-income families where it may benefit parent and child alike.

The route to reading

It is important to distinguish between phonetics, phonology, phonics and phonological skills. Phonological skills (awareness of sound structure in a language) *is* important for oral language and phonics (the relationship between written letter combinations and sounds) is important for reading.

Phonological skills are usually taught first, but it has been shown that the effect on outcomes is small if these are taught in isolation from other skills.

Letter knowledge is not sufficient for reading but is necessary for reading. It is intimately connected with phonological skills and the two should be taught together.

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The old debate as to whether children should be taught by code-based means (i.e. phonics) or by means of context and comprehension (i.e. through meaning) is now considered sterile. It is recognised that children need both a code and a purpose. Without a code the child will not be able to decipher the text and without a purpose the child will not want to.

Other findings

Effective learning time on literacy, which really refers to the amount of time when the child is engaged with the teacher, is an important predictor for success. Whole-class teaching helps to maximise effective learning time. Whole-class teaching works best when the variability within the class is low.

Structured teaching is an important contributor to teaching and learning effectiveness. This includes making clear what has to be learnt, dividing material into manageable units, teaching in a well considered sequence, the use of suitable materials, immediate feedback and regular assessment of progress.

All other things being equal, small class sizes are more effective, particularly in the early years of teaching. The gains made in small classes in the early years translate into continued achievement in later years. Clearly, whole-class teaching is likely to be easier with smaller classes.

Early intervention is crucial for children who come to school poorly prepared. (The Enriched Curriculum could be seen as an intervention in this context). Given that the child has had the appropriate previous relevant learning experiences, the formal teaching of reading is most likely to be successful at the first time of trying. A theme which seems to be emerging from the literature is that, if a child is unsuccessful in learning to read when the skill is first taught, subsequent attempts to teach the child to read require increasingly intensive efforts and as time advances, achieve fewer and fewer successes.

4. Early numeracy and mathematics learning

Children are predisposed to develop a basic sense of number. Until this stage is properly completed, further developments in numeracy will be virtually impossible. This is in accordance with the principles of the Enriched Curriculum since the learning of recorded mathematics is postponed until the basic sense of number is acquired.

Many of the activities found in early years mathematics curricula such as sorting and ordering, are really key *thinking skills* rather than purely mathematical skills. Although they are vital for mathematics learning, there is a movement to teach these skills explicitly by embedding thinking skills into the curriculum. This approach has been shown to facilitate transfer across the curriculum domains and to improve grades at General Certificate of Education level. Philip Adey's programme 'Let's Think' (Nfer-Nelson) is an example of application of these principles to the early years. CCEA is currently funding a Key Stage 2 project on thinking skills, and it would be worthwhile to consider how the Enriched Curriculum could adapt to provide a basis for further work in this domain at Key Stage 1.

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For less able children, it may sometimes be useful to separate algorithmic learning from conceptual learning. This is in accordance with the principles of the Enriched Curriculum in that children are taught, for example, the meaning of three before they begin any algorithmic learning.

The teaching of mathematical vocabulary cannot begin too soon. It must be undertaken within a context meaningful to the child.

The understanding of symbolic representations and structure is cognitively difficult for many children. As this is a strongly hierarchical aspect of mathematics, it is very important to assimilate the basics before moving on to higher levels. The basics encompass the meaning of the '+', '–' and '=' signs and their relationship to different English words and phrases.

The findings on older children with mathematics difficulties but normal intelligence present a complex picture. Many of the problems can be traced back to incomplete understanding of lower-level concepts. An exception is the poor memory for number facts displayed by these children.

5. Emotional and social development in the early years

Important early skills

The development of emotional and social skills are of prime importance in a child's early years to ensure not only academic success, but also social and behavioural competence in later years.

Development of emotional regulation or control is vital to enable the child to benefit fully from the learning experience and to avoid disruption of the whole class.

Social skills, such as sharing and waiting in line, contribute both to the learning experience and to the child's integration into the peer group.

The development of listening and attention skills is a fundamental preliminary to formal work.

A reasonable degree of compliance is necessary for the smooth operation of the class and for the child's own ability to take advantage of educational opportunities.

Emotional and behavioural problems

Emotional and behavioural problems on entering school are on the increase and these patterns, once established, are relatively stable over time and are increasingly difficult to alter as the child becomes older.

Intervention needs to be early and ideally, should involve the family as well as the school if maximum gains are to be achieved. As far as class teaching is concerned, Nurture Group teachers have found it helpful to regard many behaviour problems in young children as manifestations of developmental immaturity, in other words, behaviours which were appropriate at an earlier chronological age but which are no longer so. The success of Nurture Group teaching has demonstrated that more developmentally appropriate skills and behaviours can be effectively taught to these children. Since it is clear that behaviour problems can interfere with teaching and learning, it would seem best to teach these social skills and behaviours before the commencement of the formal teaching of reading. It is recognised that there will continue to be some children who would need the more intensive and sustained help available in a Nurture Group.

6. The role of play in the early years

Play is regarded as an essential part of the young child's development. Young children learn through play and first-hand experience. The long-term benefits of play are not fully understood. However, there are benefits in physical development including locomotor skills, in social and interpersonal skills, in language and in cognitive development. Gains in cognitive development have been shown to include improvement in planning and problem-solving abilities. Play also promotes creativity and flexibility of thought.

Many researchers have articulated concerns about the early focus on academic skills in Britain brought about by the downward extension of the primary curriculum. In Denmark, early years teachers saw play as 'the paramount consideration for young children' whereas in Northern Ireland, teachers views were more mixed on the relative importance of play and academic learning. Rather than adopting entrenched positions in this argument, it may be more fruitful to consider how stimulation, nurture, work and play can make complementary contributions to a child's early education.

It has been found that teachers may adopt a more formal learning approach because it is actually easier to demonstrate coverage of the curriculum in this manner than when designing a lesson through the medium of play.

Pupils and parents tend to think of reading, writing and sums as work and everything else as play. This highlights a need to educate professionals and parents about the role of play. A possible method of influencing opinion centres on the language used in talking about play, for example 'discovery play' implies a purposeful activity. In seeking to acquaint parents with the Enriched Curriculum, this more informative term could be employed to help explain how play can be used to good effect in the teaching situation.

Unsupervised (or relatively unsupervised) play at breaktime or lunchtime has become less popular because of concerns about behaviour and the demands of the national curriculum. Many of these concerns have not been shown to be justified and there is a danger that the social development value of this play is being underestimated. Young children in particular need a change in their environment and have been shown to pay closer attention after breaks. Schools should aim for a balance between control and independence in the playground.

7. The contribution of neuroscience to research in early learning

Developmental neuroscience is a young discipline. Several authors have drawn attention to the misuse of its findings in the practice of education. At most, developmental neuroscience has uncovered mechanisms which may explain the qualitative changes in children's thinking between birth and puberty which have been observed by leading psychologists working from a number of different perspectives. There is no reputable, peer-reviewed neuroscience research which has application to the theory or practice of education (except in confirmation of some general inferences which were already available from other sources).

The early years are the time of life at which the brain is developing most quickly (post-natally). There is excellent evidence that some aspects of early learning are strongly developmentally driven and are programmed to take place (ideally) at a particular time. The best evidence exists for early motor and early language learning. The *sensitive windows,* that is the times of maximum receptivity for learning in these areas, are subject to individual differences but are always over by the age of four (but typically younger). Children who have not achieved basic skills in these areas by this time need intensive intervention before they can proceed to formal education.

Specific research into subtle neurological deficits which may underlie mild learning difficulties is currently an exciting area of research. Some researchers have postulated a link between learning difficulties and the persistence of primary reflexes into an abnormally late stage of the child's life. Several different systems of exercises to 'retrain' the brain have been proposed by different groups of researchers. The evidence for their efficacy is still somewhat tenuous. However, a system of exercises such as "Brain Gym" does no harm and has benefits in other areas, such as developing listening and attention skills.

1. Introduction and contextual material

1.1 The Enriched Curriculum and the pilot project

The Early Years Enriched Curriculum Project (EYECP) was conceived as the result of a number of different strands of activity undertaken by a variety of groups of people. These groups, each from their own perspective, had become aware of the difficulties experienced by many children in Northern Ireland in coping with a traditional Year 1 curriculum.

In recent years, members of Belfast Education and Library Board (BELB) curriculum planning teams had been taking note of changing attitudes in the wider world. The BELB began, in collaboration with the Northern Ireland Council for the Curriculum Examinations and Assessment (CCEA), to formalise a proposal for joint funding for a pilot project to redesign and test a new Primary 1 curriculum. This 'Enriched Curriculum' would draw on elements of the continental and South-east Asian models and on tried and tested elements from other sources. As a result of these consultations, a consensus emerged between, BELB, CCEA and teachers' representatives that the very formal and traditional Primary 1 curriculum which was in place was not meeting the needs of the children in disadvantaged areas of Northern Ireland. Such children were coming to school with poor vocabulary and articulation, poor social skills, low self-esteem and in some cases, additional difficulties. These impediments rendered them incapable of benefiting fully from the type of education which was on offer in the first year of school.

The input from these various groups was combined to initiate an innovative approach to designing a new Primary 1 curriculum. These efforts culminated in the inauguration of the pilot project in six schools in September 2000. The schools were all situated in the Greater Shankill area and nine classes were designated to take part in the project. Early evaluation reports from independent observers, teachers and parents have been very positive about the programme.

1.2 The rationale and context for this literature review

Throughout the process of formulating the Enriched Curriculum, various groups contributed their knowledge, experience and opinions. Members of each group acquired their views in a variety of ways. These included:

- Research, both through perusal of the relevant literature and by means of trips to investigate systems in other countries.
- Teaching experience.
- Administration experience.
- Analysis of the results of previous initiatives.
- Underlying assumptions about appropriate systems of education (see below).

In the early stages, it was not the primary concern of the designers of the Enriched Curriculum to document the evidence which led to their conclusions. However, as the project goes into its second stage and in view of the recent recognition given to evidence based practice, CCEA considered that it would be a useful exercise to draw together and summarise

the relevant literature to serve as a resource for critical reflection on the Enriched Curriculum and to inform its continuing refinement. In agreement with representatives from CCEA, the pilot project evaluation team (the EYECEP team) undertook to examine the relevant research.

This literature review was highly ambitious, extending over research into learning from a very wide range of disciplines and perspectives. This diversity posed a challenge to achieving a coherent picture. For example, the type of inference which may be made at the macro-level of international comparisons of attainment is qualitatively different from that which may be made at the micro-level of developmental neuropsychology. In undertaking this research, the EYECEP team have drawn on a wide variety of literatures, in which research methodologies and validity criteria differ widely. In addition, this report addresses a diverse audience, in the sense that each reader will be likely to have expertise in some areas of the report but not in others. The research areas covered were as follows:

- International comparisons of literacy and numeracy in the context of variations in the curriculum and educational culture.
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- The role of play in early learning.
- The contribution of neuroscience to research in early learning.

1.3 Structure and presentation of the report

Within the body of this report, evidence will be presented which will enable the reader to consider the Enriched Curriculum against the backdrop of the variety of perspectives described above. At certain points in the report, particular parallels emerged between research findings and the content of the Enriched Curriculum. In order to highlight these points, they are presented in boxed italics.

In addition to an executive summary, the report is also presented in short and extended forms. Within the short form, readers are directed to appropriate parts of the extended report for a comprehensive analysis.

In the remaining section of the introduction, Section 1.4, several important questions which frame a context for the research findings will be considered.

The remainder of the report falls naturally into two main parts. The first part considers international comparisons of performance in mathematics and reading comprehension. This section concludes that England (as the nearest proxy for Northern Ireland), is believed to be performing below expectations in mathematics and reading comprehension. Evidence is presented suggesting that this may be partly due to the lack of a developmentally appropriate curriculum in the early years and to a premature start to formal schooling. The second part examines current research in areas underpinning the changes that have been made in formulating the Enriched Curriculum. These areas have been detailed in the rationale for the report, given in Section 1.2 above.

1.4 Framing the context: Important considerations for interpretation of the findings

1.4.1 Models of education

Though the perspective of the EYECEP team is empirical and makes an appeal to high-quality research evidence, it is useful to consider the philosophical positions which underlie the debate about appropriate methods of education as a way of gaining perspective and distance from the arguments. We should be conscious that even the most rigorously empirical approach is often underpinned by assumptions about what constitutes an appropriate model of education. We shall attempt to define this context with a short resume of these models.

Historically, two opposing models of education have tended to dominate our thinking, the social interest model and the child-centred model. Each has its advantages and disadvantages.

The child-centred model

The child-centred model has its roots deep in history, in the work of great thinkers such as Plato, Aristotle and Rousseau. More recently, it has received scientifically-based support from major movements in the psychology of learning.

From the child psychologist Jean Piaget (1952) and the constructivist school of cognitive psychology, comes the idea of the child as an *active constructor* of a working model of its environment. This working model of the world, uniquely constructed according to individual experience, serves to make sense of the world for the child and guides its behaviour. In the child's search to make sense of the world, complex ideas are built from combinations and extensions of more simple schema so that the child constructs a hierarchical network of knowledge of increasing sophistication. This process applies to very different kinds of learning. It applies equally to the construction of complex motor processes from the linking of sequences of simpler ones and to the construction of abstract mathematical ideas from the extension of simpler ones. For example, the idea of number is first limited to whole positive numbers and is later extended to fractions, decimals, negative numbers and complex numbers.

The constructivist school also emphasises that concrete operations must precede abstract thought. In younger children particularly, the capacity for abstract thought is extremely limited. Thus, young children learn best by manipulating real objects and often, this may be accomplished through play. The progression from concrete to abstract forms of thought takes place through a prescribed series of stages but the rate of progression through the stages varies from individual to individual. Some persons continue to have difficulty with abstract ideas into adult life.

Unfortunately, a misunderstanding of Piaget's ideas combined with inadequate preparation resulted in the discrediting of constructivist ideas in the late 1960s and the l970s. Programmes founded on *discovery learning* emerged at this time. To many people, these programmes erroneously appeared to suggest that provision of a suitably rich learning environment would enable the child, almost unaided, to construct knowledge through experimentation. The rote learning of facts was downplayed. A failure to explain the

programme fully to teachers or to provide adequate training compounded the problems and many new curricula were found wanting (e.g. Bailey 1972; Davis 1967; Shayer 1972). (Guided discovery learning remains an important component of many modern curricula.)

The child-centred model has also received support from Lev Vygotsky (1962, 1978) and the Russian school of psychologists. This work was relatively unknown in Western educational circles because of lack of translation. Vygotsky conceived the idea of the *zone of proximal development,* that area of knowledge which is just beyond the child's present reach by its own efforts. Progress into that area may be mediated by *scaffolding* on the part of the teacher. Scaffolding refers to the teacher's construction of a learning environment which enables the child to move into uncharted territory. This environment includes appropriate questioning, drawing the child's attention to salient facts and pointing out errors. The scaffolding is gradually removed as the child's knowledge moves forward.

Within the Enriched Curriculum, many of these ideas are given due weight. For example:

- The child is encouraged to be an active independent learner, taking as much responsibility for his or her own learning as possible.
- Material which is too difficult for the child is not presented inappropriately early in the new curriculum. Thus, the perception of failure by the child is minimised. Inappropriate material would be beyond the child's zone of proximal development and would not have a sure foundation of the necessary simpler schema.
- A rich learning environment is provided.

Despite the advantages of a properly designed child-centred approach, it is not possible or sensible to implement it fully in practice. This is because the child is educated not only for the sake of his or herself, but also to serve the wider interests of society. The interests of society are a stronger feature of the social interest model.

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The social interest model recognises that society needs to prepare children for whatever working environment they are likely to meet in adult life. It has gained ground steadily in recent decades since the time of the governments of Baroness Thatcher.' On the other hand, it is not a new model either. In its extreme form, it was parodied by Charles Dickens in 'Hard Times'. A child, Bitzer, who is portrayed as a success of this system of education defines a horse:

> *"Horse: Quadruped. Graminivorous. Forty teeth, namely twenty-four grinders, four eye-teeth and twelve incisive. Sheds coat in the spring; in marshy countries, sheds hoofs, too. Hoofs hard, but requiring to be shod with iron. Age known by marks in the mouth." Thus (and much more) Bizer.*
>
> *"Now girl number twenty," said Mr. Gradgrind. "You know what a horse is."*

Dickens makes it clear that this extensive factually correct definition does not reflect any useful conceptual understanding of horses, whereas Sissy (girl number twenty), whose father is a farrier and horsebreaker, has excellent understanding.

In a more moderate form, the social interest model may achieve many successes. Recent claims of improvement in standards at all levels in England are an example. Although the case is still being argued, the successes of the literacy and numeracy hours in raising standards appears to be achieving increasing recognition (Beard 1999). Social interest models are characterised by attention to:

- The demands of society for a suitably qualified workforce.
- Consequent attention to 'the basics'. Traditionally, this meant literacy and numeracy but other subjects such as science, foreign languages and information technology tend to be included in recent times.
- Specified competencies, skills or outcomes.
- A concern for standards resulting in standardised curricula, specified attainment
- targets and frequent attainment testing.
- Pressure for children to succeed.

The last of these, pressure for children to succeed, only becomes detrimental when it is excessive. When it replaces previous lethargic acceptance of low achievement, it may be valuable.

This model also receives support from major movements in the psychology of learning. This support comes mainly from *information processing* theories of learning. These models frequently use analogies with computers to explain aspects of learning. They stress the importance of attention and memory in learning and the role of training to complement and enhance the maturation of these processes.

Vygotsky (1962,1978) and the Russian school also emphasised the social determination of knowledge and knowledge exchange as a social process. For example, negative numbers are defined as they are because the community of mathematicians agreed that it should be so. Knowledge is passed from one person to another by a variety of social processes, including *modelling* of procedures or other learning activities by the teacher.

The Russian school also stressed the importance of language and Vygotsky has argued that thought and language are almost indistinguishable (Vygotsky, 1962).

Within the Enriched Curriculum, many of these ideas are implemented. For example:

- Good oral language skills are recognised as the basis for progress to written work. Memory is trained in a variety of ways e.g. rhymes, music and the whole-class reading of stories followed by questions which encourage memory skills (and comprehension).
- Attention to instructions and to the talk of other people is fostered. For example, in circle time or news time, each child must listen to all the others in turn.
- The child is encouraged to gradually accept socialisation into the classroom culture.

A marriage of the two models

In the-past, the child-centred enthusiasts have characterised the social interest model as sterile lifeless rote-learning, lacking any encouragement of creativity or sensitivity to the needs of the individual. Social interest enthusiasts have characterised child-centred models as woolly, overly liberal and lacking in proper goals for children. Whitehead (1929) has proposed a *'rhythm of education'* model which recognises the advantages of both approaches. The rhythm model is characterised by a gradual movement from a child-centred approach to a social interest approach over a number of cycles of differing lengths. For example, the teacher may move from one model to the other over the course of a single interaction with a child or over the course of study of a topic with a class. In addition, there is an overarching cycle running over the child's entire education career. For young children, appropriate work is generally child-centred. As the child moves through the key stages of education, the demands of the wider world gradually take assume greater dominance in the curriculum. Hence, the increasing demand for the learning of computer skills in secondary school because of the need for them in the modern workplace.

1.4.2 What is a Developmentally Appropriate Curriculum?

The Enriched Curriculum has been characterised as a developmentally appropriate curriculum. It is worthwhile therefore to consider exactly what we mean by this term. Hitherto, a developmentally appropriate curriculum might have been considered to be entirely child-centred. For example, Blenkin & Kelly (1998) state that education should mirror personal development and that society has a moral obligation to ensure this happens. Alternatively, if we consider the question from the point of view of Whitehead's 'rhythm of education' model, we would argue that the nature of a developmentally appropriate curriculum will change over the span of the child's education. It is already accepted, from the work of Piaget and the constructivists, that it is in the early years that the child's learning is driven by development to its greatest extent. In the section on neuroscience, we will present some additional evidence in support of early learning being dependent on changes taking place in the brain. This body of work implies that education in the early years can and should support learning but argues that, at this stage, education is less able to modify the child's natural path of development: Much early learning takes place in well defined stages and whilst education may be able to accelerate the rate of progress through the stages, it cannot allow the child to progress to a higher domain until earlier domains have been thoroughly assimilated. An excellent example of this limitation is the great difficulty which a child with poor oral language skills encounters in learning to read (Locke, Ginsborg, & Peers (to be published in the International Journal of Language and Communication Disorders, 2002), in press). A child who is forced beyond its natural pace is likely to experience failure and become demotivated as a result (Burts 1991). A desire to avoid this early experience of failure has been described to the EYECEP team by the teachers as one of the fundamental goals of the Enriched Curriculum.

As a child matures, it becomes somewhat easier for him or her to cope with class activities which are a little way beyond its competence. The child learns to adopt strategies, such as rote learning of imperfectly understood procedures, in order to make some progress and strive to keep up with the class (Noddings 1990). The child is able to undertake this effort in the hope that understanding will come later with additional experience. Younger children lack the experience to anticipate future success in this way. On the other hand, it is also in accordance with Whitehead's rhythm model to begin, in the early years, to socialise the child for the more formal classroom culture which will characterise later school life. For example, Whitehead would not disapprove of introducing young children to mnemonic techniques or encouraging them to pay attention or to follow instructions.

1.4.3 Managing educational change

The implementation of the EYECP requires profound changes from the pre-existing curriculum and even more importantly, changes in the way early years teaching is carried out. It is not just a question of changing policy but of changing practice. Although there is a reasonable evidential basis for making this change and although early-years teachers seem broadly sympathetic to such changes, nevertheless the transformation remains quite a major undertaking. Consequently, it would be prudent to take note of what is known about the process of educational change.

Introduction and background

Michael Fullan & Suzanne Stiegelbauer (1991) have established several guidelines for central government based on their wide-ranging review of research in this area. Their first guideline is based on the distinction between the ability or willingness of implementers to comply with rules and on the other hand their capacity to successfully deliver a service. Fullan & Stiegelbauer (1991), drawing upon the work of Richard Elmore (1980), suggest that policy makers should be more concerned with the state of the local capacity for delivery and for providing support and guidance. This points to the importance of training, and the provision of adequate support materials to underpin the initiative.

Fullan & S Tiegelbauer (1991) set out a number of other guidelines which need to be fulfilled:

- Clarifying the nature and expectations of the strategy with local agencies: This requires all staff involved (including those who will manage or lead the initiative) to have adequate training.
- Ensuring that there is an explicit but flexible, written implementation plan.
- Taking special steps to enable the central government agency to develop their knowledge about the policy and its implementation: This suggests a policy implementation group which assumes a leadership, monitoring and review roles.
- Giving priority to 'second order' changes that is in the actual practices of teaching and learning: This includes providing the framework, examples and sufficient detail for change to be realisable.
- An acknowledgement of the complexity of the process of change goes hand in hand with a commitment to persistent application: Fully establishing change at a national or regional level will need development over a period of several years.

The importance of achieving change in the early years should not be under-estimated if we consider the evidence, cited by the Commission on Reading of the USA National Academy of Education, suggesting that a country receives highest returns on investment in education from the early years of schooling when the children are beginning to acquire literacy skills.

The urgency of making change is supported by evidence cited by Crevola & Hill (1998) that schools only have a narrow 'window of opportunity' to make a difference in helping pupils who are at risk of failure in literacy learning. Once this window begins to close, it becomes progressively and quite rapidly more difficult to bring the pupils back up to a satisfactory standard.

2. International comparisons of performance

2.1 Overview

In this section a number of countries' educational policies will be explored in detail. This investigation will detail a number of factors but will have particular emphasis on the age at which formal schooling commences and on certain aspects of the curriculum which relate to the models of education described in Section 1. These descriptions provide the context in which international comparisons of performance may be interpreted.

Seven countries, four of which are English speaking, are examined in detail. England is used as a proxy for Northern Ireland, as Northern Ireland did not participate in the international statistical studies. England is the most directly comparable country to Northern Ireland in terms of culture, age of school entry and the pre-school curriculum.

2.2 Definitions of important terms

Formal schooling: The term 'formal schooling' is used in this report to describe the child's education from the time he or she commences to study a relatively formal curriculum as opposed to a play-based curriculum. Formal schooling does not encompass pre-school, kindergarten or nursery provision. In many countries, formal schooling coincides with the start of primary or elementary school and also with the age at which education becomes compulsory. In Hungary however, one year of pre-school is compulsory before formal education.

Pre-school: This term is an adjective encompassing all forms of provision for children before they have commenced formal schooling. This may be kindergarten, nursery school, playschool, playgroup, child minders, day-care centres or community groups.

Kindergarten: This term is used in most of the countries examined and refers to a type of provision for children below formal school age. Kindergarten classes are seen as necessary preparation for school and take children from around three years of age. Often there are government guidelines for the curriculum. The atmosphere is one of fun and play-based activities are common. Many of the countries analysed aimed to provide every child with a place in kindergarten. These establishments are therefore often funded by local governments.

Nursery care or day care: Nursery care is also a form of provision for children under formal school age. Nurseries are less often given government funding, and take children from birth. Commonly, nurseries accommodate the children of working parents and are seen as more of a child-care facility than preparation for school.

2.3 Countries examined in detail

In order to keep this report to a manageable size, seven countries were chosen for the most intensive comparisons with England (or England and Wales), representing the UK in the major international studies. These countries were selected to provide a reasonable cross-section of factors which might affect educational attainment.

International comparisons

Four English-speaking countries were chosen for comparative analysis; England, New Zealand, Australia and Canada. These countries have broadly similar social structures in terms of language, forms of government, legal systems and cultural values. Whilst England and New Zealand adopt a highly centralised approach to education policy making, Australia and Canada are considered decentralised, giving considerable autonomy to local governments and schools. Australia and Canada also favour a developmentally appropriate curriculum and are useful in comparisons with England, which arguably had a developmentally inappropriate curriculum at the time of these studies.

Hungary, Flemish-speaking Belgium and Japan were chosen as countries with excellent results in literacy or numeracy and contrasting educational cultures. Details of the developmentally appropriate curriculum in the early years and later age of entry to normal schooling in these countries are given below. Culturally, they provide differing degrees of contrast with the English-speaking group of countries. Flemish Belgium, whilst not English-speaking is a Western European democracy. Hungary is a former member of the Warsaw pact group of countries and is gradually emerging from the period of Soviet influence. In terms of wealth and spending on education, it is far below all the other countries examined (Elley, 1994). Japan is a non-European country with a very different culture; it emphasises hierarchical authority, social conformity and respect for elders. Japan can also be contrasted with Hungary and Flemish Belgium in the sense of the relatively abrupt change from a curriculum sensitive to individual development during pre-school years, to a strong social-interest system with rigorous assessment as soon as the child leaves kindergarten.

From time to time, we will refer to other countries from which we found interesting data.

The United States was not selected for direct comparison because the curriculum shows extreme diversity across states, schools and social class: Such a decentralised educational system makes comparisons difficult. Nevertheless, there have been some recent interesting developments and these are described where appropriate.

2.4 Main features of the education system in comparison countries

Unless otherwise stated, the data in this section is taken from the International Review of Curriculum and Assessment Archive (INCA) available on the INCA website at http://www.inca.org.uk. The information on the site is regularly updated. Extensive use has also been made of the Information Network for Education in Europe (Eurydice: http://www.eurydice.org).

2.4.1 Australia

Australia does not have a national system of schooling (Regan, 1998). Compulsory primary schooling for children in Australia begins at five or six years old. In most of the eight states there are 13 years of compulsory schooling with the transfer to secondary education occurring around the age of 12 years.

International comparisons

There is no national curriculum because the states are jealous of their independent rights but there is broad agreement on a core framework since 1993 (Regan, 1998). The framework describes desirable outcomes in eight 'national learning areas' at primary school level. Seven 'Key Competencies' have been described. There has been an increasing focus in recent years on pupil assessment but results for individual schools are not published. These assessments, outcomes and competencies are characteristic of a social realism type model. They have been imposed on a profession which is largely constructivist in its approach to teaching. As in the United Kingdom, teachers have faced large numbers of initiatives and new responsibilities in recent years. This seems to indicate a similar kind of tension between government with social realism goals and teachers with child-centred goals to that found in the UK in recent years. However, because the system is more decentralised, local authorities and teachers have retained more control than in the UK.

Pre-school education is not compulsory in most states in Australia, yet provision is adequate. At four years old, around 77% of children attend pre-school, many at three years. Nursery school places are provided from birth.

Assessment in Australia is considered an important educational component. There are no public exams until Year 12, although due to the National Literacy and Numeracy Plan, students are subjected to continuous evaluation in order to ensure they have reached required benchmarks.

Evaluation of Australia's pre-school curriculum is complex due to variations across states. Tasmania, for example, encourages the 'Flying Start Programme,' which does not advocate a developmentally appropriate curriculum. Queensland, in contrast, adopts preschool curriculum guidelines which promote establishing a 'flexible learning environment' and support play. This could be conceived as a developmentally appropriate curriculum.

2.4.2 Flemish-speaking Belgium

Primary education in Belgium begins at six years of age and is compulsory until the age of 12. Many children in Belgium however, attend non-compulsory nursery schools from the age of two years six months. A stated aim of pre-school education in Belgium is to reduce socio-economic differences in attainment among children, so that each child beginning compulsory education at primary school has the same chance of success.

The recommended pre-school curriculum emphasises the importance of *education* rather than *teaching* (Mills & Mills, 2000). Teachers guard against formal preparation for primary school, and see their role as child-centred. At no point is literacy or numeracy mentioned in guidelines for nursery education.

Together with Hungary, Flemish-speaking Belgium represents an excellent model of a play-based, developmentally appropriate curriculum in the early years. No information on Flemish-speaking Belgium is available on the INCA database, but the country was researched thoroughly for the BBC 'Dispatches' programme by David and Clare Mills. The resulting data was presented to a House of Commons Select Committee (Mills & Mills, 2000) and this report confirms that Flemish Belgium conforms to what is known as the 'central European model', which is a synonym for a developmentally appropriate curriculum.

2.4.3 Canada

Children in Canada begin their compulsory schooling at six or seven years of age. Canada's education system recommends nine or ten years of compulsory schooling. Preschool education is compulsory in some provinces in Canada. The policy recommends two years of attendance at Kindergarten classes for four and five year old children.

Assessment arrangements are complex in Canada due to variations across provinces. Some provinces collect evaluations of student performance beginning from as early as Kindergarten.

Due to the highly decentralised nature of education in Canada, there is no formal preschool or Kindergarten curriculum. Analysis across the different territories however, indicates that Canada does generally adopt a pre-school programme that is sensitive to each child's stage of development. British Columbia for example, aims to support the development of children socially, emotionally, intellectually and physically. There is some evidence that there is a shift towards a more utilitarian model after kindergarten, but in view of the diversity between states, it is difficult to specify the degree to which this occurs.

2.4.4 England (and Wales)

There is very little difference between education in England and in Wales except for issues related to the Welsh language areas.

The compulsory school starting age of English children is the term after the child's fifth birthday. In practice, the policy varies across areas and many children begin formal schooling as young as four years. In England, there are now more than two times as many four year olds in reception classes as maintained nursery classes and schools. (Annual School Census, J an 1999). Schooling is compulsory up to Year 12, 16 years of age. Pre-school education is non-compulsory, although many children as young as three years old attend some form of early years provision.

National assessments take place at ages 7, 11 and 14 years. Public examinations take place at ages 16 and 18 years.

The National Curriculum does not apply to pre-school education. However, there are 'early learning goals' defined for this foundation stage. These early learning goals emphasise language and literacy and mathematical development, amongst other aims.

The inception of the National Curriculum and other recent reforms, such as inspection through OFSTED, exhibit many of the hallmarks of a strongly socially realistic model of education such as the setting of standards, frequent testing and the publishing of league tables.

2.4.5 Hungary

Hungary is a prime example of a country whose education policy encourages developmentally appropriate practices. Hungary also featured on the BBC 'Dispatches' programme which helped to draw UK public attention to child-centred approaches to early years education. The producer of this programme, David Mills, and his wife Clare gave extensive evidence based on their research in Hungary to the UK select committee on education (Mills & Mills, 2000). Proposals to reform early years' education in England towards a more child-centred approach are under consideration as a result of the committee's deliberations (Select Committee for Education & Employment: Early Years report, 2001).

Over the last decade, legislation has encouraged a decentralised system with strong school-level, student and parent participation and co-operation.

Primary school education in Hungary begins when the child is six to seven years old. Since 1998, compulsory schooling lasts until 18 years of age (usually corresponding to 12 years of post-kindergarten schooling).

Pre-school education is also mandatory, as every five year old child must attend kindergarten for up to four hours each day in order to prepare for school. Many children however attend pre-school from three years of age. Until the age of five, the atmosphere is extremely relaxed and playful (Eurydice). At age five, it is still strongly play based. A kindergarten certificate is required for admission to the general (primary) school following assessment and observation by expert psychologists and other professionals. A striking feature of Hungary's education system is that parents are discouraged from transferring children to school until they are mature enough intellectually and emotionally to cope with the formality of primary school. Consequently, the first-year primary-school teacher does not have to cope with the wide range of attainment and behaviour which is common in the United Kingdom. More importantly, the child is protected from early experience of failure. Summer born children may also delay. enrolment into primary school. Evidence on the disadvantages of being a young-for-year child will be presented later in the report.

The kindergarten curriculum concentrates on three key aims:

- Encouragement of physical development and a healthy lifestyle.
- Emotional and social education which prepares the child for the later school culture. . Early preparation for intellectual skills through development of language, perception, observation, memory, attention, imagination and creativity.

These aims are implemented through the play-based curriculum, which includes emergent literacy and numeracy activities, music, visual arts and physical play (Mills select committee). Nursery school teachers are well trained to deliver such a curriculum (Eurydice).

Since 1998, a National Core Curriculum has been established. It is not prescriptive. Rather it provides a framework for interpretation at school level. Ten cultural domains rather than subjects are specified. These include physical education, music and the visual arts. Critics of

social interest models of education often bemoan the gradual loss of these subjects to make way for more training in 'basic' subjects. Students attend either an academic school or a vocational school (Eurydice). Vocational schools are increasingly unable to meet the challenges of the labour market and have been losing prestige and these schools are adapting accordingly. This is an excellent example of social realism affecting trends in education.

Before 1998, continuous assessment of students was generally the responsibility of the individual teacher. Since the 1998, provision has been made for the gradual introduction of central testing at Grades 4, 6 and 8 (ages 10, 12 and 14 respectively). This might seem like a move towards greater social realism in education. However, students whose work is inadequate may be asked to repeat the year, thus marking a developmentally appropriate tone within the process. There are compulsory basic public examinations at Grade 10 and a final school-leaving public examination at Grade 12. Examinations are gaining in importance (Eurydice).

On a number of indices, Hungary cannot be classified as a wealthy country and per capita spending on education is very low compared with the other six countries in the comparison group (Elley, 1994).

2.4.6 Japan

Japan is a culture which emphasises conformity, respect for elders and the interests of society. The education system is strongly centralised (Sugimine & Yamamoto, 1998).

Japanese school children begin primary or *elementary* school in the April after the child's sixth birthday. Education is compulsory from 6 to15 years of age. There are statutory maximum class sizes of forty in kindergarten and primary schools: The average sizes are 19.1 and 31.1 respectively.

Non-compulsory pre-school education in Japan comes in the form of Kindergartens or nurseries. Kindergartens accept children from three to six years of age, while nurseries take children from as young as six months old.

Japan has public assessment of pupils in Grade 9 (age 15) for entry to upper secondary schools and at Grade 12 on entry to university. Indeed, some children sit an entrance examination at age six for private elementary school education.

The Kindergarten curriculum framework recommends five domains of study; health, human relationships, the environment, language and expression (Daiichihouki,1989, cf. Sugimine & Yamamoto, 1998). It is strongly influenced by the work of the German philosopher Froebel, who advocated a play-based learning environment (Sugimine & Yamamoto 1998). INCA reports that the overall aim of Kindergarten is to promote intellectual development and qualities of self-reliance and awareness of others through play.

There have been recent changes to the Primary curriculum (Daiichihouki, 1989, cf. Sugimine & Yamamoto, 1998), implemented in 1990, which stress improved teaching of the Japanese language and the pursuit of a more holistic approach to combining subjects. A new subject,

'life environment studies' has also been introduced. It contains elements of science and social science and is designed to encourage self-reliance and self-awareness (Sugimine & Yamamoto 1998). The effects of these changes would have begun to show in testing at Grade 8 in 1999.

Sugimine (Sugimine & Yamamoto 1998) has argued that schooling in Japan has become 'privatised, industrialised and strongly geared towards competition and entrance examinations.' By 1992, the proportion of Japanese children attending Juku or afterschool classes had risen from 26.6% in 1976 to 41.7% (Sugimine 1992, c.f. Sugimine & Yamamoto, 1998). A record of each child's school career is kept. It includes standardised assessment, teacher's assessments and a measure of pupils' effort. These are all characteristics of a strong social realistic system of education. It is evident therefore that in Japan, there is and abrupt change from a child-centred, developmentally appropriate model of education in pre-school years to an increasingly social-interest style model in elementary (formal schooling from age six years) and higher levels of education.

2.4.7 New Zealand

Schooling is compulsory in New Zealand from the ages of six to 16 years. In practice, students begin primary school from their fifth birthday. Early childhood education in New Zealand is non-compulsory although provision in nursery and kindergarten centres is available for new-born children upwards. School-based assessment is an integral part of the curriculum, yet there are no national examinations until 15 or 16 years. There are clear learning outcomes for every aspect of schooling and even a pilot scheme of national tests in literacy and numeracy for children in Years 5 and 7.

New Zealand follows a developmentally appropriate curriculum for pre-school education; for example, it is not subject-based and doesn't define key skills. However, on entry to compulsory schooling, pupils as young as five years are subjected to a more prescribed curriculum framework with seven essential learning areas and eight groups of essential skills to develop. Like Japan therefore, there may be a relatively abrupt change to formal schooling at this stage.

2.5 International Comparisons of literacy and mathematics attainment

International comparisons of attainment levels are notoriously difficult to interpret. There are a very large number of variables which may impact on attainment levels in a specific country. Amongst the most important are:

- Resources available for education.
- Percentage of pupils with learning difficulties attending special schools and thus not sampled in the study.
- Age of testing which interacts with the age at which formal schooling begins.
- Percentage of learning time devoted to a particular subject over the school career.
- Culture-specific attitudes to learning.

International comparisons

Nevertheless, reputable international comparisons try to take account of these variables and they provide the best benchmark we have available by which to judge UK performance.

No statistics are available for comparison of the performance of very young children across countries. It is therefore problematical to assess the contribution of early learning. Nonetheless, **evidence will be presented in this section to support the conjecture that neither a late start to formal schooling: nor a play-based curriculum in the early years are detrimental to excellent performance.**

2.5.1 Mathematics performance comparisons

The main source of information on a country's achievements in this domain is from the Second International Mathematics and Science Study in 1995 (SIMMS) and the Third International Mathematics and Science Study in 1999 (TIMMS). Thirty-eight countries participated in this latter assessment which tested pupils with a mean age of 14 . As a number of the countries participated in the SIMMS in 1995 trend data of changes in science and mathematical ability is available.

It is extremely striking that the top five countries in the TIMMS (TIMMS reportl999) rankings are all Asian; Singapore, with a mean score of 604, is followed by Korea (587), Chinese Taipei (585), Hong Kong (582) and Japan (579). England (496) and New Zealand (491) rank only just above the international average of the 38 countries. Of the other countries which are above average, several, such as Hungary, Czech Republic, Bulgaria and Latvia are much less wealthy than England or New Zealand.

The TIMMS study looks at a wide range of variables ranging from calculator use to curriculum content. Only three of these variables seem related to the divide between England and New Zealand on the one hand and the successful Asian countries on the other. In contrast to the Asian countries, England and New Zealand did not have mandated or recommended textbooks, an instructional or pedagogical guide or Ministry of Education notes or directives (at the time of the study). In England and New Zealand, almost all students are still doing number work at Grade 8 (- 14 years), whereas in the Asian countries the proportion is 60% or less. This may imply that students in these countries have mastered number work at this age and require no further tuition in this domain. Finally, and most importantly for the purposes of this report, all the Asian countries and most of the other countries ranked above England and New Zealand have had one year *less* of formal schooling. Finland and The Russian Federation, which are also ranked higher than England and New Zealand, have two years less of formal schooling.

The data for the seven extensively studied countries ranked in order of mathematical attainment is summarised in Table 2.1 below. The international average score for all 38 countries within the study is 487. In reference to Table 2.1, it may be noted that Japan, Flemish-speaking Belgium and Hungary who rank well in the tables, both have developmentally appropriate, play-based curricula in the early years (and one year less of formal schooling). Here is very positive evidence that in mathematics attainment, there is no detrimental effect from a developmentally appropriate, play-based curriculum in the early years or from one year less of formal schooling.

Table 2.1
International Comparison of mathematics achievement (TIMMS 1999)

	Ranking within the TIMMS (1999)	**Average score**	**Years of formal teaching**
Japan	5	579	8*
Belgium (Fl)	6	558	8 *
Hungary	9	532	8 *
Canada	10	531	8 *
Australia	13	525	8*
England	20	496	9
New Zealand	21	491	8.5 – 9.5

- Countries performing significantly higher than the international average.

Trends in Mathematical Achievement – Seventeen countries participated in both SIMMS (1995) at Grades 4 and 8 (–11 years and –14 years) and (TIMMS 1998, –14 years) allowing comparison of trends in these countries both across and within cohorts.

The 1995, Grade 4 cohorts in England and New Zealand improved their performance relative to the average in 1999, whilst still remaining below average for the subset of seventeen countries. On the other hand, the Grade 8 samples for these countries showed a downward trend relative to the average over the same time-span. This suggests that there may have been a small dip in performance in the early nineties which has been partially corrected. On the other hand, both countries remain in a low-achieving group near the bottom of the subset table. At the top of the table, the four Asian countries, Singapore, Republic of Korea, Hong Kong and Japan change places slightly but remain in the top group. None of the trends is statistically significant.

Standard Deviations and spread of scores – It is instructive to examine the relationship between a country's mean score and standard deviation in the TIMMS project. There is a very highly significant inverse relationship between the mean score in mathematics and the standard deviation of the scores {r=–.54, p = .001} which explains 28.7% of the variance in scores on a linear regression model. This suggests that the spread of attainment within the classroom may be one factor which predicts performance. Figure 2.1 illustrates the situation. The observed scores are connected by the solid lines and the regression model is represented by the dotted line. All of the Asian countries perform better than would be expected from the regression line, allowing us to conjecture that in these countries, additional factors other than spread of attainment are responsible for high scores. Flemish Belgium and Hungary, two of the countries which epitomise the developmentally appropriate curriculum, are also performing well above the regression line. It may be that the achievements of the early years in these countries in reducing the heterogeneity in primary classes by keeping children in a developmentally appropriate environment are thus making a contribution to improved standards for all by making teaching more effective. Canada, Australia, England and New Zealand are all very close to the regression line. If the factor of wealth could also be taken into consideration, it is possible that the differences between these latter four countries and some of the rest (for example Hungary) would appear even greater. On a cautionary note, it must be remembered that these conclusions are speculative.

It is also clear from the TIMMS report, that there is no compression of the top of the distributions for high scoring countries: A high mean score appears strongly related to a high score for the 95th percentile. This strongly suggests that high scoring students are not disadvantaged by the teaching environment in high scoring countries.

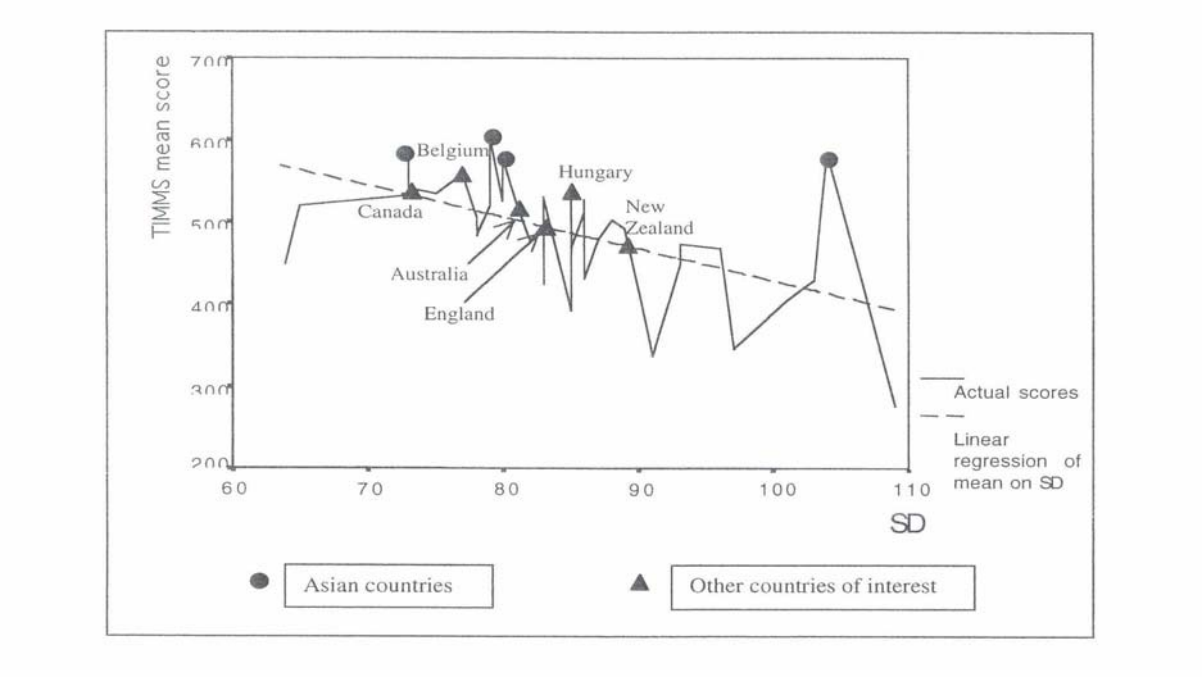

Figure 2.1
TIMMS study: Comparison of means and standard deviations

2.5.2. Reading comprehension performance comparisons

The main source of data for reading literacy was the 1991 International Association for the Evaluation of Educational Achievement study of Reading Literacy (Elley, 1994). This study tested children in 32 countries at age 9 year and age 14 years in the following areas:

- Narrative prose, i.e. continuous text which tells a story.
- Expository prose, i.e. continuous texts intended to convey factual information.
- Documents, i.e. structured presentations such as charts, tables, maps, graphs, lists or set of instructions.

The average of the three scores gave an overall score for each country. The IEA tests do not take into account reading accuracy.

A representative selection of the results of the IEA (Elley, 1994) study on nine-year olds may be found in Table 2.2. England and Wales, Flemish-speaking Belgium and Australia did not participate in this study because of reservations about the limited nature of the domains sampled and the multiple-choice format. In order to provide a basis for international comparison, in 1996 The National Foundation for Educational Research and The Open

University conducted their own study on nine-year olds in England and Wales (Brooks Pugh & Schagen, 1996). Both IEA items and items designed for the new study were used. The team were thus able to produce scores on the IEA test items for the purposed of comparison. The score for England and Wales derived from this study is included in Table 2.2.

Table 2.2
International Comparison of reading literacy

	Ranking within the IEA (1991)	**Average score**	**Years of formal teaching**
Finland	1	569	7*
United States	2	543	8*
New Zealand	5	524	8.5–9.5*
Hong King	9	517	8*
Canada	11	514	8*
England & Wales (1996) (NFER/ OU)**	16	507	9*
Hungary	18	506	8*

- All of these countries performed higher than the international average of 500 (Rasch scores).
- ** Data reproduced by kind permission of National Foundation for Educational Research.

The point was made in the NFER/OU report (Brooks Pugh & Schagen, 1996) that the mean age of the English sample was lower than any other country except Canada. On the other hand, the IEA study produces evidence that mean age makes only a small difference to average scores. It is true however that England has a much smaller proportion of children attending special schools than many other Western democracies. This may account for one of the other key findings of the NFER/OU (Brooks Pugh & Schagen, 1996) report; the mean score for England and Wales was affected by a pronounced low-achieving tail in the distribution of scores.

Unfortunately, of the Asian countries, only Hong Kong and Singapore participated. Many children in Hong Kong use a variety of languages (Mandarin, Cantonese and English) in different situations (formal contexts, home, school) and it is not clear from the report whether this is suspected to have had an effect. In any case, reading is clearly a very different type of learning process in countries with no alphabet although the IEA report (Elley, 1994, p 178) states that the importance of phonics in Chinese can be underestimated. Comparison with Asian countries mayor may not therefore tell us anything useful in the case of literacy.
In Table 2.2, Finland and The United States were included as countries which performed particularly well. In the IEA study, a Composite development Index was calculated to take account of the wealth and state of development of the countries. When scores were corrected for this index, Finland was seen to have performed particularly well above the expected level for a country with that level of resources, in spite of beginning formal schooling one year later. Sweden also did well, despite a more diverse language context and a starting age of

seven. Here again is evidence that a later start to formal schooling has no detrimental effect; we now have data which show no detrimental effect in either the domain of mathematics or the domain of literacy. Elley (1994) has done further analysis on the data. The ten highest scoring countries began teaching reading at a mean age of 6.3, and the lowest ten at 5.9 years. Finland, Sweden, Norway and Iceland are countries that begin formal instruction at 7 and these countries all notably performed within the top ten scoring countries for reading literacy.

As well as having the highest mean, Finland has the lowest standard deviation of any country. The IEA (Elley, 1994) study speculates on the reason for the success of Finland. Some of the factors which might help to account for its success are:

- 'Literacy is highly valued in Finland.'
- 'The Finnish language has a regular orthography'; that is, there is one symbol for each sound and vice versa.
- 'Finnish teachers describe their teaching methodology as eclectic.'

The issue of orthography is often put forward as a factor in international differences. Unlike Finnish, English is recognised to be extremely complex orthographically. However, the USA also has English as its main language, and its place in the table is much higher. This question is further discussed in the section on literacy.

Although the ranks are not directly comparable, New Zealand's high performance in reading comprehension in contrast to its low mathematical ranking is notable. The IEA report attributes this partially to high emphasis and high spending on reading literacy compared to other subjects (Elley, 1994). Conversely, Hungary appears to rank much lower in reading than in mathematics. This is partially attributed in the IEA report to the low average age of the sample, but as we shall see below, Hungary does much better at fourteen years.

Standard Deviations and spread of scores – It is instructive to examine the relationship between a country's mean score and standard deviation in the IEA project. When Denmark" which has a standard deviation anomalously higher than all other countries, is removed from the data, there is a significant positive correlation between the mean score in reading literacy and the standard deviation of the scores {r= .40, p = .04} which explains 16.7% of the variance in scores on a linear regression model. In direct contrast to the case of mathematics, the spread of scores increases with the mean score, as shown in Figure 2.2.

The distributions for each country demonstrate that the high-scoring children in the narrative and expository domains show much less variation between countries than those in the lowest percentiles. (This is not so marked in the document domain but it could be argued that slightly different skills are required here). It would seem that much of the deficit in performance in some countries arises from the length of the low-achieving tail, as is the case for England. None of the countries, which begin formal reading at the age of seven shows this long low achieving, tail.

It is difficult to account for the contrasting relationship between means and standard deviations in mathematics and literacy. From this evidence, there is some reason to think that a large spread in attainment may not make it difficult to attain high standards in reading for

the top pupils. One possible explanation may lie in the different nature of the two subjects. Two students of different ability may study the same text at differing levels, even within a whole-class-teaching situation. Teaching two students mathematics, when one is ready to learn fractions and the other cannot subtract reliably, may present the teacher with a qualitatively different problem.

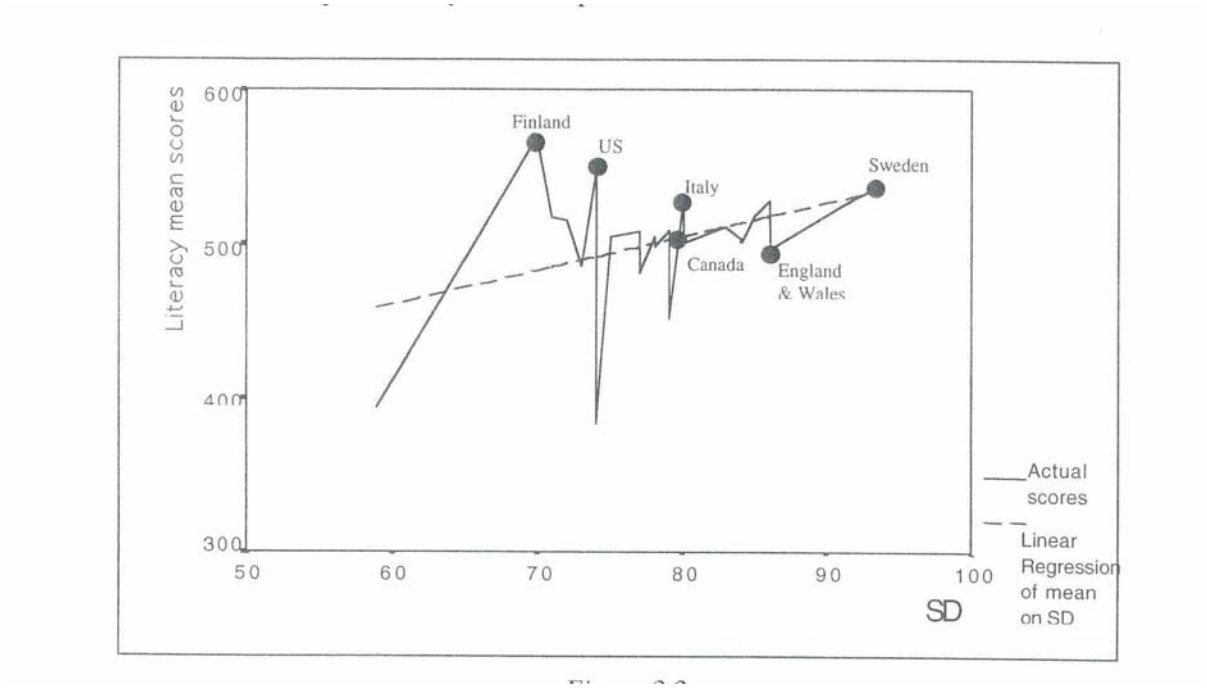

Figure 2.2
IEA and NFER/OU reading studies: Comparison of means and standard deviations

Summary of literacy findings

Whatever the reason for the relationship between mean and standard deviation, England and Wales fall below the regression line as well as falling just below the international average. Countries such as Finland with a starting age of seven years for formal reading, perform well above the standard predicted by the linear regression model. It is possible that England's long low-achieving tail is one of the major factors in its poor performance.

Within-country patterns in the IEA (1991) study

Lundeburg (1994) performed multivariate analysis of the effect of within-country variables on scores. Fifteen factors in the domains of proximal teaching conditions (e.g. instruction time), teacher characteristics and teaching practices and methods were found to be significant in five or more countries. Rather than detail this complex analysis, it may be more useful to reproduce the Lundegburg's resulting portrait of the good reading teacher of a nine-year-old:

International comparisons

> *The good teacher has many years of teaching experience. Outside of school, the good teacher reads a lot, both professionally about education and also literature. She or he has stayed with the class long enough to get to know the children well, and has followed their progress by informal as well as more formal methods. The good teacher gives the students many opportunities to do independent, silent reading in a library which is richly stocked, and she or he often holds discussions with the students about the books they have read. The children of the good teacher are encouraged to read outside school and to interact actively with the text by relating their own experiences, to what is read, by making predications of upcoming events during reading, and by making generalisations and inferences. The good reading teacher also takes the students' interests into account when selecting reading material. The student-oriented approach with a clear focus on strategies for understanding does not prevent the good teacher from using phonics elements now and then in her teaching to meet particular students' needs or when unknown long words, like names, are encouraged.*

Although the above portrait relates to slightly older children, it will have many echoes for those dealing with the early years.

Many of the above attributes of the good reading teacher are fostered within the Enriched Curriculum project.

Results at age 14 *years*

Unfortunately, there are no data for England and Wales available for comparison with this age group. However, some points of interest emerge from the older population, especially related to countries following a developmentally appropriate curriculum.

Hungary, which comes a little below England in Wales in the table for nine-year olds, lies second in the table for fourteen-year olds after correction for age and wealth of the country. Hungary also reduces its standard deviation slightly.

Denmark, which also has a developmentally appropriate curriculum, also improves its standing at 14 years and considerably reduces its standard deviation.

2.5.3 The case of literacy within the USA

Notable throughout the IEA statistics is the improvement in ranking of the USA in reading literacy. In 1972, Thorndike reported The United States falling well below the international average of fifteen countries. However the recent IEA research ranks the USA behind only Finland. The USA's considerable leap in the ranking order may be in part explicable under the USA emphasis upon 'Kindergarten Readiness', which is spreading consistently across all states despite differences in curricula. This is receiving much focus in America and opinion is supporting the repetition of kindergarten before progressing into formal schooling when appropriate. However, the US did exclude a high proportion of pupils from the study (Mills 2001).

2.6 What may be deduced from international comparisons?

It is clear that England is performing below the levels which would be expected in reading literacy and mathematics at nine and fourteen years respectively. No data from large-scale studies on very young children are available.

Some countries which lack the resources of England, for example Hong Kong and Greece in reading literacy and Hungary in mathematics, are nevertheless producing better performances.

Whilst it is impossible to allow for all the factors which might influence these performances across countries, the major studies in both literacy and mathematics show no evidence of detriment to performance from a late start to formal education or from a developmentally appropriate curriculum in the early years.

In reading comprehension some countries, including England, appear to perform poorly because of a long low-achieving tail in the distribution. None of the countries which delay formal reading until seven years show a long low-achieving tail in the narrative or expository domains of literacy.

In mathematics, Asian countries dominate the top of the league tables. As some of these countries are relative poor compared to European countries, one must suspect that cultural influences are at work.

In mathematics one may conjecture from the evidence that a class which is relatively homogeneous in attainment may be easier to teach. There is no evidence from international comparisons that this is the case for literacy (although see the section on language and literacy for evidence from other types of study).

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3. Early language and literacy

3.1 Overview

This section will review aspects of children's literacy development starting with the child at home and indicating how the first years in primary school build on the child's previous experience of language and emerging literacy. The significance of the overlap between home and school experiences will be indicated, as well as the vital importance of success in the first years of primary school. The role of oral language is highlighted, as is its relationship through phonology and phonics to reading. Yet is made clear that this does not take away from the crucial role of reading for meaning and enjoyment. It is pointed out that children need a purpose to read as well as a way of deciphering the print. In school the importance of time spent on literacy experiences and structured teaching, as well as the effects of class size and teaching approaches to literacy development will be discussed. The final section will deal with the development of the child's idea of himself or herself as a learner. It will be suggested that this idea of self as learner is built on the cumulative experiences of early years classes, and it forms a disposition and orientation to learning which is vital for future educational success.

3.2 Literacy and the pre-school child at home

The National Child Development Study by Robinson & Hilton (1998) concluded 'social and economic disadvantage were the most important factors in relation to basic literacy skills'. A longitudinal study by Weinberger (1996) in America noted the long-term implications of the absence of early literacy experiences in the home.

The impact of family background is clearly very important, not only for literacy development but cognitive and emotional development through interaction with adults (Bishop & Leonard, 2000). However it seems clear from a wide variety of studies that the impact of socioeconomic factors on children's experiences is mediated through parental attitudes and behaviours. This can be demonstrated by reference to a small-scale study carried out in low-income homes in San Diego by William Teale (1986) who carefully measured the literacy experiences which were presented to pre-school children over a period of time. In three of the twenty two homes, children were read stories on average four or five times a week, while in the other nineteen story book reading averaged little more than five times per year. Nor was this extreme distribution of children's experience confined to storybook reading, as other educationally relevant experiences were as widely spread. It seems that some children will enter primary school with a very small amount of literacy experiences while other children will have had a vast range and amount of such experiences. Yet we also know that when children enter the first year of a formal reading programme, the best predictor of their success at the end of the year is the amount they know about literacy at the beginning. So if children commence a formal reading programme with little in the way of literacy experiences it can be predicted that they will have made relatively little progress at the end of one year.

Early language and literacy

The Enriched Curriculum recognises the disparity in literacy experiences between children when they enter primary school and the significance of this for their progress when they undertake a formal reading programme shortly after starting primary school. Accordingly the Enriched Curriculum attempts to establish a curriculum which is developmentally appropriate and which provides early literacy experiences for children as a preparation for the more formal teaching of reading.

Recent research suggests that though social factors have considerable impact on pupils before school, once pupils have started school, then the school itself can have a significantly greater impact on pupil progress (Sammons, Hillmore & Mortimore 1995).

3.3 Literacy and early language

Early language development is believed to be of paramount importance to later educational achievement. 'Children who are unable to communicate effectively are at significant disadvantage to their peers in accessing many aspects of the National Curriculum' (Coulter, 2001, p 10). Almost every educational skill presupposes the use of language and children's early communication skills are regarded as the single best predictor of future cognition and school performance (Rossetti, 1996). For instance Coulter (2001) identifies weak vocabulary skills, poor comprehension of language, poor rhyming skills, poor narrative ability, poor syntactic development and phonological difficulties as risk factors in the development of literacy skills.

The idea is widely supported that early language is considered a good indicator of later success in not only communication, but also learning to read, education and social and emotional development. Oral language is a vital prerequisite for listening and understanding instructions and the capacity to pay attention in a pre-school or early years classroom. By mastering oral language and related skills, the young child is at a reduced risk of developing behaviour problems later in childhood or adolescence and improving their social skills. However it is clear that a substantial number of children start nursery school and primary school with language delays. Locke, Ginsbourg & Peers (to be published in the International Journal of Language and Communication Disorders) found that over half the children in a socially disadvantaged area had a significant language delay on starting nursery school. A problem of this size should give us cause for concern and points to the necessity for a well-defined, oral language curriculum in nursery school and in the early years of primary school.

Locke et al (ibid) point out the lack of a detailed language policy (covering aims, strategies and techniques) within the British pre-school language curriculum compared to that which is widely available within Continental pre-school curricula. Locke emphasises that teaching programmes should derive from what is known about normal child development and should not be solely based on pedagogical principles.

Bishop & Adams (1990) discuss studies which claim that children with poor literacy scores had been identified as having a language delay in the pre-school period. These authors conclude that success in learning to read depends, first upon linguistic ability in general and, second, upon the ability to make one's knowledge of language explicit (see the section below on Language Analysis and Reading).

Early language and literacy

Given the evidence linking the importance of early language to later educational success, it is important that oral language work is established as an important part of the curriculum in the first years in primary school: It is clear that a substantial and extended period of early language work is required before the introduction of a formal reading programme. The value of symbolic play among peers has a distinctive role in encouraging children's use of language to talk about language.

The Hanen Programme, often called, Learning Language and Loving It, provides enriched language learning environments for pre-school children. An interactive training approach encourages adults to adapt their language and interaction style to meet the needs of individual children (Coulter 2001). Language interaction programmes such as this should be fully recognised for their value to the education system as a whole and implemented in education policy so that every child has the benefit of language development as a firm basis before they commence formal programmes of work.

The Enriched Curriculum recognises the central role of oral language in early learning. Establishing a sound basis in oral work for all children is one of the primary goals of the programme.

3.4 Picture book reading

The importance of picture book reading by parents to their children is well established (Bus, Ijzeendorn & Pellegrini 1995). Reading picture books to children is termed 'dialogic reading' where the child adopts the role of storyteller under the guidance of an adult (Whitehurst et al, 1994). Whitehurst's research on this activity displayed its benefits for all children and especially for enhancing language and pre-literacy skills in low-income preschoolers. They came to the conclusion that training mothers to effectively engage in this task with their children is provided an excellent medium for teaching language skills. This method of interaction is considered useful for early years as it can occur with individuals or with small groups, with parents including low income parents or with day care assistants - it does not solely rely on highly educated adults for its effective implementation.

In a meta-analysis study of quantitative research, Bus et al (1995) provided further confirmation that joint book reading by parents and their children was significantly related to language growth, emergent literacy and reading attainment.

Joint picture book therefore provides a good tool for developing a strong language and early literacy basis before children commence formal reading programmes, and it is one where parents can have an effective role in supporting the work of the school.

The Enriched Curriculum includes joint picture book reading as an important means of preparing children for literacy and of involving parents with this preparation.

3.5 Language analysis and reading

Terminology – phonetics, phonology, phonological skills and phonics
In discussions about language and reading, it is not uncommon to find terminology misused. So it is important to define terms clearly.

Phonetics is the study of the speech sounds that occur in all the languages of the world.

Phonology is the study of the systems and patterns of sounds that occur in a particular language.

Phonological skills are those skills involved in achieving conscious awareness of the sound structure of a language, in the analysis of the speech sounds of that language and in the manipulation of these speech sounds. These skills are sometimes referred to as **metalinguistic skills**.

Phonics is the study of the relationship between individual, written letters or combination of written letters and the speech sounds denoted by these letters.

Whereas phonetics, phonology and phonological skills are all concerned with oral language only, phonics is concerned with the relationship between written and oral language.

Phonology and phonics are relevant to the study of reading, because the translation of written symbols into meaningful language is mediated by the speech system.

The importance of phonological skills in reading is now widely accepted. It is backed up by an enormous amount of empirical evidence, drawn from a wide variety of research design, through various researchers in different countries and built up over many years. Bryant & Bradley (1983) carried out one of the earliest and most influential studies in this area. They followed up a group of 368 children over a number of years and showed that the children's sensitivity to rhyme was a significant predictor of later reading success. There is a consensus from the research that children's phonological development is significantly connected with their later reading success, establishing highly specific links between children's oral language and their subsequent literacy. It is also widely agreed that children's phonological development follows a clear pattern from being aware of syllables, to being aware of onsets and rhymes within syllables, to being aware of phonemes (Treiman & Zukowski, 1996).

Following from these research studies, early phonological skills are now often taught first through nursery rhymes so as to encourage 'an ear' for the sound of words. Comparing and contrasting words through rhyme and alliteration are usually taught next, followed by blending and syllable splitting, then word segmentation tasks and finally segmentation and manipulation of individual sounds (phonemes). These tasks are best taught slowly over an extended period and lend themselves to a variety of types of instruction using game-based methods. Again, they are taught prior to beginning a formal reading programme because the success of the reading programme depends crucially on the children having these phonological skills prior to the onset of the programme. Nevertheless it seems that the effect of teaching phonological skills is relatively small if these skills are taught in isolation (but see below).

Early language and literacy

The role of letter knowledge in early reading has been the source of some debate. It is clear that letter knowledge is a predictor of early reading success, but it is equally clear that the teaching of letters by themselves does not determine reading success. It seems that letter knowledge just acts as a proxy for wider literacy experiences in those studies which have found a predictive relationship between letter knowledge and reading success. Nevertheless the successful teaching of reading cannot take place without letter knowledge. This means not only that children should learn to recognise letters but also they should be capable of recognising them confidently, instantly and automatically. There is an important link here between the teaching of phonological skills and the teaching of letters.

The effect of teaching phonological skills in isolation is recognised to be effective but small (Castle, Riach & Nicholson, 1994). It is only when the teaching of phonological skills is combined with the teaching of letters and letter patterns that there is a substantial effect. Snowling (1996) reports a study which states that it is the practice of making explicit links between phonology and orthography (spelling patterns) that is responsible for the greatest gains in literacy development. This is a good example of the total being greater than the sum of the parts, and it means that the teaching of phonics should be effectively combined with the teaching of phonological skills.

One effective means of phonics instruction involves identifying phonemes in oral language and then teaching children to understand how these are represented by letters and by letter combinations (3). This point is frequently reiterated throughout the literature (Bond & Dykstra, 1967: Foorman, Rancis, Nory & Librema, 1991). This approach improves upon some more traditional methods of phonics instruction which taught phonics skills in isolation and were divorced from real language. This approach to reading instruction rests on the pivotal basis of the systematic relationship between letters and sounds. However, the role of semantics and syntactics is also to be considered. The old debate as to whether children should be taught by code-based means (ie phonics) or by means of context and comprehension (ie through meaning) is now considered sterile. It is recognised that children need both a code and a purpose. Without a code the child will not be able to decipher the text and without a purpose the child will not want to.

In the first instance the Enriched Curriculum seeks to make children enthusiastic about books and stories and later to carry this forward into enthusiasm about reading. Thus the programme attends to the need for children to have a purpose in reading. The Enriched Curriculum also concentrates on phonological skills before progressing to phonics.

3.6 Semantics and Syntactics

Though reading programmes and instruction using phonics have generally reported better outcomes than approaches based upon syntactics and semantics (Iversen & Tunmer, 1993; Foorman, Fletcher, Francis, Schatschneider & Mehta, 1998), the benefits of phonics only programmes are generally very small and do not normally extend to reading comprehension. The use of real books in classrooms are now well-established and their role in motivating children towards reading are widely recognised by teachers. Also the importance of children acquiring a reading habit is an idea fundamental to the real books approach, and there is strong evidence that increasing the amount of children's reading lots improves their reading skill (Cunningham & Stanovich 1990).

It is also accepted that contextual information can be used to facilitate word identification, especially in readers with poor phonological awareness. For all these reasons, semantic and syntactic approaches to reading should be used from the earliest stages of reading, and combined with phonological and phonic approaches to form a comprehensive and balanced literacy programme.

Using 'Big Books' the Enriched Curriculum promotes extensive class discussion of stories specifically related to their pictorial context. Through question and answer sessions children are encouraged to understand the story.

3.7 Early Intervention

Why is the early implementation of these strategies important for later literacy development? A theme, which seems to be emerging from the literature, is that if the child is unsuccessful in learning to read when this skill is being taught, subsequent attempts to teach the child to read require increasingly intensive efforts and as time advances achieve fewer successes. Again there is the finding that the best predictor of achievement at the end of a school year is the achievement at the beginning (Carter, 1984). The reception year, before commencement of the formal schooling, is regarded as vital in establishing a solid foundation. As the pupil progresses through school his/her level of performance becomes progressively more related to the previous level of performance (Carter, 1984). (This relates to the findings in Section 2 of this report regarding the age at which formal schooling commences.)

3.8 Time and structured teaching

With the introduction of the literacy hour focus has now been directed to the amount of time spent on specific subject areas such as literacy, either within or outside of the classroom. However the importance of time spent in reading activities has been recognised in research findings for a long time. In 1966, Harris & Serwer in a very large Grade 1 study (the Craft project) of phonics versus look say methods of teaching found that the most significant relationship with improvement in reading was 'the average time per day devoted to reading activities as computed from the Teacher Logs'. Stanovich (1993) found a correlation of 0.39 between amount of time spent reading books in the classroom and a child's level of vocabulary. He also found that print exposure was a significant predictor of verbal growth even after general cognitive abilities had been taken into account (Stanovich, 1993). 'Interestingly this applied even to children with limited reading skills and low general ability. They built vocabulary and cognitive structures through immersion in literacy activities just as his or her high achieving counterpart did' (Stanovich, 1993).

Investigating the time spent on literacy events outside the classroom appears equally supportive. In a well-controlled experimental study Whitehurst, Arnold, Epstein, Angell, Smith & Fischel (1994) found that children who regularly engaged with a parent in dialogic picture book reading over a six week period made substantial improvements in their performance on language tests.

In a meta-analysis of school effectiveness studies from across the world, Jaap Scheerens (1992) identified 'effective learning time' as one of the major factors which stood out as

having 'multiple empirical research foundations'. Apart from curricular emphasis in the distribution of learner time, this included an emphasis on whole class teaching rather than individualised teaching because in the latter the teacher has to 'divide attention in such a way that the net result per pupil is lower'. He also included the need to 'inspire, challenge and praise' so as to motivate and thereby increase net effective learning time.

The other major factor which Scheerens (1992) identified as having 'multiple empirical research foundations' was 'structured teaching' which included making clear what has to be learnt, dividing material into manageable units, teaching in a well considered sequence, the use of suitable materials, immediate feedback and regular assessment of progress.

3.9 Class size

The variable of class size is thought to be a significant contributing factor in an effective and enriching early years environment. The benefits of small class sizes were demonstrated in a large-scale study in Texas (Project Star 1999). Smaller classes were found to improve the environmental quality of the classroom, to contain fewer distractions, to have increased space per student, increased use of instructional materials, more direct interaction between teachers and students, more individual attention, more opportunity for students to participate and a decrease in the number of students retained in their grade.

In terms of academic achievement, smaller class sizes are beneficial in producing a significant advantage for Kindergarteners in small classes (STAR). First grade students in small classes outperformed other students in reading and maths (Achilles, 1996) and the benefits accrued from small classes in elementary schools appear to have residual effects on student achievement in later years.

However, adding another adult to a large classroom as a teacher aide does not seem to increase student achievement in the same way (Nye, Zaharias, Fulton, Cain, Achilles & Tollett 1995).

3.10 Idea of self as learner

In 1985 Michael Rutter reviewed the literature on the effects of education on children's development and concluded that: 'the long tenn educational benefits stem not from what children are specifically taught but from effects on children's attitudes to learning, on their self-esteem and on their task orientation'. In another research review near a decade later, Sylva & Wiltshire (1993) came to a broadly similar conclusion; that 'the most important impact of early education appears to be children's aspirations, motivations and school commitment'. Sylva & Wiltshire (1993) went on to conclude that these dispositions were moulded through classroom experiences during the period before a formal reading programme commenced. The importance of successful, early classroom experiences is thereby reinforced. Similarly the argument for a curriculum, which is developmentally appropriate and which does not introduce formal education too early to cause failure, is enhanced.

It is a stated primary goal of the Enriched Curriculum to remove the early sense of failure from children's early learning experiences.

4. Early numeracy and mathematics learning

4.1 Overview

There are two very distinct strands in research into the learning and teaching of mathematics, the psychological perspective and the education/pedagogy-based perspective. It is often apparent in the literature that each group is relatively uninformed of the work of the other. In accordance with Whitehead's 'rhythm of education' model, which stresses the greater importance of child-centred learning in the early years (See Section I), it is appropriate to concentrate on the psychological perspective in this section. This emphasis arises because the education/pedagogy-based studies tend to concentrate on topics like teaching schemes, international comparisons and classroom practice and processes. These are aspects of learning which are more pertinent to the social realism model of pedagogy. Some of them were examined in the section on international comparisons.

Early mathematics learning is generally centred on numeracy. Other areas emphasised are simple shapes in two and three dimensions, recognition of pattern, ordering and basic ideas of position. There is very little psychological research is these areas which would impact directly on the curriculum or on classroom practice in early years mathematics. Rather, this research impacts on more general thinking skills in the early years.

In recent years, awareness of the importance of development of appropriate language has been increasingly recognised as an important foundation stone for mathematics learning but research into general language learning covers this adequately.

This section goes on to discuss the relationship between algorithmic or procedural learning, conceptual learning and rote learning. In this context, the difficulties of the introduction of symbolic recorded mathematics are then examined.

Finally, the characteristics of mathematics deficit in older children of normal intelligence are discussed.

4.2 Developmental aspects of early Numeracy

There is ample evidence that the propensity to acquire a number sense is, like the ability to acquire language, biologically determined and hard-wired into the brain (see Deheane, 1997, for a review of the evidence). Deheane argues that this number sense is stored as a number line in analogue form in the inferior parietal lobe of the brain. This number line is 'organised by numerical proximity and with increasing fuzziness for larger and larger numbers'. The number line enables the individual to count, to perform simple addition and subtraction using mental counting on the number line, to compare the relative size of two numbers and later, to estimate (for example that 3 + 9 cannot equal 124).

The evidence for an innate number sense comes from a variety of sources.

1. Infants have been shown to discriminate number from as young as four months (Wynn, 1992).

Early mathematics

2. Street children from a number of cultures have been shown to acquire informal mathematics, that is, the ability to count and reckon money, even in the absence of any academic education (eg. Ginsburg, Posner & Russell, 1981).

3. Dyscalculia, the inability to perform basic computations, may be acquired as the result of a brain lesion (Gerstman, 1940) or may be due to congenital pathology (Benson & Geschwind, 1970). When damage occurs early, lifelong difficulties with arithmetic may follow, demonstrating that the disorder is unlike language in that the number sense is not easily transferred to undamaged brain areas and is not amenable to education. Neuroscience has demonstrated through brain imaging techniques that single-digit calculation takes place in the same area which is damaged in dyscalculia (Roland & Frieberg, 1985).

4. The properties of the analogical number line can be demonstrated (Dehaene, 1996). These include size and distance effects: Discrimination efficiency between two quantities requires a greater numerical distance between them for larger numbers: It is faster to decide that 9 is larger than 5 than that 9 is larger than 8. This suggests that, in order to make the comparison, the brain first converts Arabic numerals or number words to analogical format. Further, use of the number line is implicated in single digit addition. Even in well-trained adults and calculating prodigies, response times for deciding the truth of the result of single-digit addition are longer for larger numbers (Pesenti, Seron, Samson & Duroux, 1999). Rote memorisation of number facts cannot remove this effect. This implies that whilst rote learning is a necessary adjunct for facility in addition and subtraction, it can be no substitute for acquisition of the innate number sense.

These factors taken together suggest that the origin of the number sense may be traced deep into evolutionary history, certainly many times further than the written word (Gallistel, 1990). In contrast to specific reading difficulties, which are phylogenetically young enough not to have been minimised within the population through natural selection, we would therefore expect to encounter relatively few children with a developmental disorder specifically affecting these early number skills. Russell & Ginsburg (1984) have confirmed that relatively few mathematics deficient children 'are seriously affected in key informal mathematics concepts and skills' at the age of 11 years.

This large body of evidence also suggests that, apart from a very small number of children with brain damage, children can acquire the ability to count, to compare number size and to do simple mental addition and subtraction with relatively little teaching input. This is not to say that they will not acquire these skills more quickly and accurately with appropriate teaching. Rather, it suggests that we may draw extensively on an analogy with the learning of language. Language learning is also largely developmentally driven but is known to be more efficient and fuller within a suitable learning environment (see Section 3 of this report). We may therefore expect that extensive exposure to enumeration of concrete objects and frequent opportunities for mental addition and subtraction will encourage early development of these basic skills.

Early mathematics

At present, there appear to be no instruments capable of addressing assessment of the child's number sense. Although some aspects of its assessment are obviously covered in traditional attainment tests, the EYECEP team know of no test which examines the analogical nature of the mental number line. The analogical aspects are crucial to the child's development of estimation skills. There is a need for development of such an instrument, based on a sound understanding of the properties of the human number sense.

4.3 Important foundation thinking skills for mathematical learning

Within early mathematics curricula world-wide, a number of activities such as ordering, recognising patterns and matching are normally included. Although these activities are crucial to a child's understanding of mathematics, most of them are not limited to that domain. Rather, they are key thinking skills underlying many facets of human learning. For example, categorisation is a fundamental component of human cognition which is just as vital in understanding subjects such as biology or human behaviour as it is in understanding mathematics (See Rosch, 1978 for a full discussion of categorisation). This is beginning to be recognised in school curricula at every level. Several thinking skills interventions highlight the importance of explicit teaching of thinking skills such as classification and categorisation [e.g. ACTS at Key Stage 2 (current CCEA-funded project at Queen's University Belfast), CASE at post-primary level (Adey,1992) and 'Let's Think' for 5/6 year-olds (Adey, Robertson & Grenville, Available from Nfer-Nelson)].

4.4 Algorithmic and conceptual learning in mathematics

The ability to 'do' arithmetic depends on more than the analogical number line (Deheane & Cohen, 1997). Deheane & Cohen have developed a triple-code model of number processing which has three elements: the mental number line, the mental representation of numbers in verbal format (strings of words) and their mental representation as a string of Arabic numerical symbols. This model serves as an introduction to the various processes involved in learning mathematics. Whilst a procedure such as number comparison takes place on the analogical number line, knowledge such as multiplication tables is memorised as relations between the number words in the verbal code. Deheane (1997) believes this explains why multiplication tables are open to frequent errors (typically 10% in adults) as they involve the same number names 'in slightly different orders with misleading rhymes and partial overlap'. In the multiplication tables, we have an instance of learning which depends on attention and rehearsal skills and is best explained by information processing models of learning.

The triple-code model is an indication that mathematics learning is extremely complex. Some aspects of mathematics learning, such as the number sense, are developmentally driven. Some, such as multiplication tables, are rote-learned. These two strands are well understood and relatively straightforward. In addition, there are two other major facets of mathematics learning, procedural learning and conceptual learning.

The learning of algorithms, such as addition of multiple-digit numbers, may bear more resemblance to the learning of motor sequences. Davis defines a procedure as a series of unit steps with a well-defined goal which is stored in passive memory (where a unit step is a procedure which has previously been automatised: Davis 1984, p. 29). A hierarchy of sub and

super-procedures is the result of extended learning. A specific type of algorithm is the visually moderated sequence (VMS). In a VMS, the student looks at a line in the sequence, ponders what to do next, and cued by the content of the current line, writes the next step (Davis, 1984 p.34). In the early stages of learning, the child does not usually understand the reason for each step. Each step is a concentrated effort which does not leave the child with many resources for conceptual understanding. Instead, as in a motor sequence, each step begins to be cued by the previous one. At this stage, once the algorithm is instantiated it is difficult for the child to interrupt it (Davis, 1984), indicating a lack of conscious control over the process. Eventually, with practice, the entire procedure becomes automatised and welded together (chunked), at which stage the child may come to understand what he or she is doing in the conceptual sense. This final mental leap has been termed retrospective constructivism (Greer, 1998) and is entirely consistent with Piagetian ideas of action before understanding. However, the precise nature of conceptual understanding and exactly how and when it is achieved during the learning process remain topics of hot debate in the mathematics education literature (Vergnaud, 1982, 1990; Pirie & Kieren, 1988,1989,1994; Davis, 1984).

Gray & Tall (1994) have recently proposed that one method of encouraging development is to study the conceptual and procedural aspects of a topic separately. Whilst able students may be able to absorb algorithmic and conceptual elements simultaneously, less able students will suffer from trying to divide their attention between the two elements. Gray and Tall propose that when it is appropriate, students should practice procedures and address conceptual learning separately and explicitly. This would often require a more child-centred teaching approach. It should be stressed that Gray and Tall, like all respected mathematics educators, accept the sterility of rote-learning in isolation. A vast body of research has shown that children cannot successfully apply and transfer to novel situations algorithms which have only been rote learned (See Schoenfeld, 1992 for an extended discussion). Successful application depends on conceptual development which is best addressed by the use of mathematical knowledge for problem-solving within a meaningful context for the student.

4.5 Acquisition of symbolic mathematics

The ability to acquire basic number skills does not imply the ability to acquire symbolic mathematics. Clearly, any child who has a difficulty with symbolic representation in general will also have a difficulty in this area but what is the nature of the task for the majority? In the earliest number work, symbolic representation is limited to learning the one-to-one correspondence between a given number, its name and the appropriate Arabic digit. Only with the introduction of recorded arithmetic does the task become cognitively more difficult. A simple addition may be represented in several ways, incorporating a variety of signs and implied structure:

$2 + 3 = 5;$ $\quad 2 + 3 \rightarrow 5;$ $\quad \begin{array}{r} 2 \\ +\,3 \\ \hline 5 \end{array}$

The child must learn the operation associated with each sign, its correspondence to. English words and phrases (‘+’ may correspond to ‘plus’, ‘add’ or ‘and’) and the significance of the order of placement within the representation (See Kieran, 1989 for a discussion of the appreciation of structure in symbolic mathematics).

Early mathematics

There is evidence that some children never acquire sophisticated understanding of many symbols. For example, the '=' sign implies equivalence, but for many children, it retains elements of a unidirectional nature (Behr, Erlwanger & Nichols, 1976; Cortes, Vergnaud & Kafavian, 1990; Hersovics & Kieran, 1980; Kieran, 1981); they show vestiges of the limited meaning 'gives (the answer)' for the sign 'equals'. Indeed, we are all familiar with statements of the type 'Four plus two gives six'. Such statements serve to reinforce the child's limited understanding. The child is then less likely to realise that 'Six gives four plus two' is also implied by the equation. This difficulty demonstrates the difference between a child who uses the sign appropriately in many algorithms but who lacks true conceptual understanding. This particular problem is recognised within the National Numeracy Strategy (1999) for England and Wales, in which teachers are encouraged to employ the equations written in both directions.

It is clear that deep conceptual understanding of appropriate mathematical language related to the symbols is one of the pillars of symbolic mathematics and its importance has been recognised in many studies. It is explicitly given much attention in the National Numeracy Strategy (1999) as one of the bases for mathematics development which should be studied from the first year of primary school. The suggested (and ambitious) vocabulary list for the first year covers three pages and relates to number, measurement, time, pattern, shape, symmetry, position and direction, problem-solving and mathematical instructions. Primary 1 children are unable to undertake recorded mathematics connected with many of these topics. The only way in which they can begin to understand these words is through classroom discussion of suitable activities related to these topics. The National Numeracy Strategy makes it clear that learning of vocabulary is very sensitive to use in context; definitions are particularly inappropriate in the early years.

Later, children must acquire understanding of the Arabic system of place value. It is known that this task leads to difficulties for many children (Resnick, 1983, pp 109 – 151). This topic is not normally covered in Primary 1 but it is clear that incomplete understanding of the fundamental symbols discussed above would be a serious barrier to understanding of the place value system. Indeed many aspects of mathematics are strongly hierarchical in this way, implying that moving children onto a higher level-topic is doomed to failure without firm foundations.

4.6 Factors in poor mathematics achievement

In the past, it was suggested that inner-city children or certain racial groups gained poor results in mathematics. A study in the United States by Ginsburg, Herbert & Russell (1981) on social class and racial influences in 4-5 year-olds found that middle-class children performed significantly better than inner-city children on certain tasks. Inner city children performed less well on perception of more items in a set, addition operations and addition calculation. There were no significant differences on counting words, enumeration or cardinality tasks. However, inspection of the data on the perception-of more task found that several children had scores of zero, eight in the inner-city group and one in the middle-class group. Such a score indicates a very severe problem, possibly a dyscalculia. When these children were removed from the data, cultural differences were no longer significant but a trend remained for superiority of the middle-class group. There are two possible explanations

for the performance deficits of inner-city children. This group may contain members who suffer from a pathological dyscalculia which might be found more often in inner-city. Alternatively, inner-city children may be more likely to suffer from environmental deprivation, resulting in extreme delay of the development of basic number skills. Inspection of the patterns of response of the nonzero-scoring groups showed that both groups found the same items difficult and most inner-city children showed a basic competence. This argues for the developmental delay hypothesis in inner-city children. In a second series of experiments using seventeen tasks, which addressed some methodological criticisms of the first series, the researchers found four significant main effects of social class: conservation of number, equivalence of sets, cardinality and which number is greatest. In conservation, the difference was relatively large: in equivalence, it was moderate. In the other two tasks, the differences disappeared by the following year of school. With respect to race, significant differences were found on only two tasks: seriation and making two sets equivalent by adding or removing one element. The mean differences on these tasks were very small. Ginsburg et al. concluded that most of the effects were amenable to a developmental delay explanation with roots in poverty of environmental stimulation.

In a further study by Russell & Ginsburg (1984), the nature of children's mathematics difficulties was investigated in American fourth-graders. The mathematics difficulty (MD) children were of normal intelligence and were compared with a group of their peers and a group of third-graders. The findings are summarised as follows:

- MD children were not deficient in informal mathematics (number sense).
- MD children have difficulties with the more subtle aspects of the base ten representation system but display superficial competency.
- MD children display 'bugs' in algorithms found in normal children, but more often. . MD children display severe difficulty in recalling common addition facts and performed well below even the third-grade group in this respect.
- MD children had more difficulty in monitoring errors.
- In problem-solving, MD children are capable of insightful solutions.
- There was an interaction between many of the difficulties of MD children.

This is a complex picture. The most striking finding concerns the poor knowledge of number facts in children who had no apparently difficulty in rote learning in other areas. Russell and Ginsburg admit that 'the explanation is by no means obvious'. They imply that they do not believe that these children would necessarily respond to extra practice.

The study provides further reason to believe that true dyscalculia is uncommon, since MD children display competence with basic numeracy.

The work confirms the previous research on base ten notation and underlies its importance in mathematics development generally.

4.7 Conclusions

Children are predisposed to develop a basic sense of number. Until this stage is properly completed, further meaningful developments in numeracy will be virtually impossible.

This finding is in accordance with the principles of the Enriched Curriculum since the learning of recorded mathematics is postponed to give time for the basic sense of number to become established.

For less able children, it may sometimes be useful to separate algorithmic learning from conceptual learning.

This is in accordance with the principles of the Enriched Curriculum in that children are taught, for example, the meaning of three before they begin any algorithmic learning.

The teaching of mathematical vocabulary cannot begin too soon. It must be undertaken within a context meaningful to the child.

General thinking skills, such as categorisation, are vital for mathematical development and crucial in other areas of learning also. There is a trend towards teaching these skills explicitly but this is best done by embedding them within the general curriculum rather that teaching them in isolation.

The understanding of symbolic representations and structure is cognitively difficult for many children. As this is a strongly hierarchical aspect of mathematics, it is very important to assimilate the basics before moving on to higher levels.

The findings on older children with mathematics difficulties present a complex picture. Many of the problems can be traced back to incomplete understanding of lower-level concepts. An exception is the poor memory for number facts displayed by these children.

5. Emotional and social development in the early years

5.1 The role of emotional and social skills

The development of emotional and social skills are of prime importance in a child's early years to ensure not only academic success, but also social and behavioural competence in later years. A number of these skills underpin the child's ability to participate in formal learning situations and without these skills, failure rather than success is more likely.

5.2 Important early skills for school

The development of emotional regulation for instance involves children in learning to control their emotions so that they can react appropriately in various situations. Failure of emotional regulation can involve temper tantrums in response to minor frustration or outbursts of anger involving physical aggression. This type of behaviour is perhaps most often seen in the 'terrible twos' but it is not that uncommon when children start primary schools particularly if children are from socially disadvantaged backgrounds.

The development of other social skills involving sharing, waiting for a turn, waiting in line, not grabbing or shouting out, are all related to emotional regulation and all can be problematic at the beginning of primary school for a significant number of children.

The development of listening and attention skills is a fundamental preliminary to formal work with children because it requires them to listen to the teacher, to take in what she says and then attend long enough to carry out some task to completion in response to the instructions given.

Compliance involves children doing what is asked of them by a caring adult, doing this consistently, automatically and without undue delay. Lack of this skill is a major barrier to formal education, yet a substantial number of children entering primary school have little experience of compliance. It is estimated that for a substantial minority of children entering school, their normal response to parental request is opposition and defiance. Again this is more common in children from socially disadvantaged areas but not exclusively so.

5.3 Behaviour problems

The growth in behaviour problems in very young children is very well established and has been related to demographic changes over the last thirty or forty years including changes in family patterns and other social trends (Rutter, Giller & Hagell, 1998).

Given that a substantial and increasing number of children enter primary school with inadequate skills in emotional, social and behavioural development, these children are not ready to participate in a formal programme of education, and if required to do so are likely to fail. They are also likely to disrupt the education of other children and make it much more difficult for the teacher to deliver the formal programme. These types of behaviour problems are quite stable over time; Richman, Stevenson & Graham (1982) found that 67% of children with aggressive behaviours at age 3 years continued to have aggressive behaviours at age

eight years. These types of behaviour problems, if not dealt with in the pre-school or early school period will often escalate into later aggressive outbursts and antisocial behaviour in adolescence leading to delinquent activity. Webster-Stratton & Herbert (1995) determine an early age of onset in the pre-school years as a significant contributing factor. It is for this reason that intervention and prevention should be at an early stage and that teachers have a significant role in addressing these problems. Causes of behavioural and emotional problems are due to a complex combination of factors, the child, the family and the school. The child's temperament or an academic deficit, a parent's depression or marital conflict or school difficulties in teacher-child interactions or a lack of encouraging behaviour are just a few of the variables mentioned by Webster-Stratton & Herbert (1995).

5.4 Intervention and prevention in behaviour problems

Intervention for children with emotional and behavioural difficulties should span across multi-contexts to be wholly effective. Porter (1982) reports the important effects of family environment variables on both cognitive and social development at school entry. There is obviously therefore an important role for parental support and the development of parenting skills as a means of helping prepare children for school (Taylor & Biglian 1998). However it should be recognised that suitable parenting programmes are not widely available and that their uptake will continue to be low unless they are provided as part of a community wide initiative (Webster-Stratton, 1998). Meanwhile many children with problems in emotional and social development commence primary school. If they are exposed to a formal programme of education without having the necessary emotional and social skills to benefit from such a programme, then they are at risk of educational failure.

The Enriched Curriculum in providing a 'breathing space' at the beginning of primary school creates an opportunity to teach those emotional and social skills which will provide a sound foundation for more formal teaching.

Particular characteristics of the EYECP make it therefore a strategic tool to be used by teachers in the prevention and intervention of emotional and behavioural difficulties in young children. When adults work together with a small group of pre-school children, they can provide stability and consistency in a classroom, which may be absent at home, and a supportive, encouraging environment. Webster-Stratton (1999) recommends games and activities which promote the use of the language of feeling and promote understanding of the feelings of others. The EYECP can encourage children to recognise and identify their own feelings, positive and negative. Behaviours involving self-control, persistence with difficult tasks and appropriate expression of feelings can be taught as part of the curriculum and practised within the classroom situation. (Webster-Stratton, 1999).

6. The Role of Play in the Early Years

6.1 Overview

In this section of the report we look at play from the perspective of research, schools and pupils. Until recently play was a taken for granted part of the balanced early years curriculum. Nowadays, although the curriculum generally acknowledges the importance of play, other curriculum demands are thought to have had a detrimental impact on the time available for play in the reception class.

Play is basic to the Enriched Curriculum, which aims to involve children in a wide range of activities with well planned structured playas a vehicle for learning. Teachers are expected to use play to allow children to exercise autonomy, decision making and problem solving skills in the classroom. Funding of large soft play equipment or outdoor play areas is seen to encourage gross motor skills.

Although there is considerable debate about how young children learn, the research suggests that it is difficult to disentangle the relative impact of play in early education. The effectiveness of any single element of early education must take account of factors such as the characteristic of the child and his or her background, school resources, teacher characteristics and training, class size and the curriculum. This review provides a brief account of major themes in the psychological research and theory on play. The later sections highlight the views of teachers and children on the role of play in the school classroom and playground.

6.2 Forms and functions of play

Although play does not seem to serve any immediate purpose at first sight, it is regarded as an essential part of a child's development (Pellegrini & Smith, 1998). It enables the development of physical, language and social skills. Young children learn through play and first-hand experience. They increase their social play and sustain attention longer as they age. By the time a child is five, they are usually able to sustain co-operative play although they may choose to play alone with a toy. Boys frequently, interact through rough-and-tumble play, which involves fighting, chasing and wrestling when no dispute is occurring. Children as young as two and three years of age engage in pretend play and they can employ fantasy by putting themselves into stories or pretending to be television favourites.

Pellegrini & Smith (1998) suggest that a cost-benefit analysis of play reveals surprisingly few costs but on the other hand the research in this area is limited and the long term benefits of play are not clearly understood. They do point out that if play is developmentally important, depriving children of play should lead to a 'rebound effect' involving higher levels and longer duration of play activity when these children are provided with the opportunity to play again. Their review of a number of studies in which children were deprived of locomotor play, are consistent in showing that increased deprivation does lead to increased levels of play afterwards.

The role of play

The immediate and longer term impact of play on three aspects of development are generally highlighted in the literature:

Physical benefits are the most obvious. Through locomotor play children exercise muscles, improve eye-hand co-ordination and refine skills.

Social and interpersonal skills are developed as children use fantasy to cope with problems, master situations and explore the world around them. Teachers' ratings of social competence are positively related to the frequency children engage in social pretend play and for boys social competence is also related to rough and tumble play. It is argued that playing with peers is important for development as children's relationships with their friends is qualitatively different to the relationships they have with adults. Unlike adult-child relationships, peer relationships are characterised by equality, co-operation, reciprocity and mutuality. In these circumstances children learn rules, negotiation skills and how to resolve conflicts.

The cognitive benefits of play have been of particular interest to theorists such as Piaget, Vygotsky and Bruner (See Section 1 of this report). Play has been shown to improve planning and problem-solving abilities, It enables children to integrate new ideas and practice new skills. It promotes language use, creativity and flexibility of thought.

6.3 Play in the classroom

Until the 1990s there was general consensus in the UK that play contributed to the objectives of early childhood education to foster the social, intellectual, physical and creative development of each child (Smith, 1990). The reception years were not included in the national curriculum reforms in the nineties, but many authors have articulated concerns about the early focus on academic skill development in the downward extension of the primary curriculum (e.g Hayes, 2000; Marcon, 1999; Keating et al, 2000). In America, Caldwell (1989) suggested that the argument about whether the emphasis in the early years should be academic or social/emotional was spurious. She coined the term 'educare' to describe the approach in the early years that offered a 'developmentally appropriate mixture of education and care, of stimulation and nurture, of work and play' (Caldwell, 1989, p266). Walsh & Gardner (2001) found that in Northern Ireland, Year 1 educators were mixed in their views on the importance of 'academic' learning and play whereas teachers in Denmark saw play in their educare system as 'the paramount consideration for young children'

Keating et al (2000) report the findings of a major study that focused on play in the reception classroom. The research provides a unique in -depth view of the beliefs and attitudes of headteachers, class teachers, classroom assistants, parents and children on the role of play in the English reception class. Overall, the interviews showed that the adults generally saw playas a foundation for future learning. However, there was also evidence of considerable tension felt by teachers between the demands of the curriculum and their belief in playas a learning medium. As one noted,

> 'It can seem easier to get through most of the curriculum if you do a very formal lesson and you get children to copy things or fill in answers '
> (Keating et al, 2000, p441)

The role of play

Among the many insights gained from the research team's sensitive probing was that teachers and children made a distinction between play and work. They provide many examples of how children distinguish between reading and writing and 'play' activities. As one teacher noted she had a child who had done PE, music and used sand and then complained,

> 'Well I've not done any work today. I don't know why I came to school' (Keating et al, 2000, p 443)

Pupils and parents generally expected schools to provide basic experiences in reading writing and sums. They considered that work involved compulsory activity carried out while sitting at a desk. Every thing else tended to be labelled as play. The research team found that there was a tendency in many classrooms to see playas a reward for finishing work or a method of keeping children occupied as they engaged with individuals. Given this approach to play and teacher's commitment to hearing reading, there was little evidence that staff were involved in play sessions. In the words of one child who was asked if her teacher plays with her' she doesn't play, she's busy doing' However, most teachers planned the children's play activities, organised access to resources such as sand, home corner etc and used play as part of their assessment process. In general teachers' approach to play suggested that play was seen as an inferior form of learning, a secondary activity that did not justify their direct involvement in helping children to initiate or sustain activities.

Some teachers interviewed by Keating et al had redefined structured play activities as 'work' or used terms such as 'choose', 'explore' and 'discover' in order to underline the importance of these activities. Moyles (1989) recognised the problems associated with play when he noted,

> 'many people would agree that there is an urgent need for a different terminology -play has all too often been used to infer something rather trivial and non-serious, the polar extreme to work rather than, as in the child context, the essence of serious concentrated thinking ... and one purposeful means to learning. Thinking about free and directed play could possibly provide a solution' (Moyles, 1989, p 16)

6.4 Play in breaktime

The threat to children's break, playtimes or recess in schools in the UK and America has led to considerable research on the nature and benefits of play outside the classroom. Blatchford (1998) notes that a negative view of break time has developed over recent years based on a number of concerns, including:

- an appreciation of the extent of bullying in the playground
- high levels of violent incidents
- general concern about misbehaviour
- a view that children are not so constructive in their play
- more demanding national curriculum.

The role of play

In the light of his own research and a review of the available studies on play at breaktime, Blatchford finds that this negative response to breaktime is not justified. Indeed, there is a very strong case for suggesting that playtime experience can have a very positive impact on many aspects of development and it an important part of the young child's school day. His programme of research at the University of London, Institute of Education found that peer interaction in the playground can have positive as well as negative effects. He stress that' there are few signs of appreciation in schools that breaktime may be the context for fundamental social processes that have value in social development' (Blatchford, 1998, p65).

Pellegrini (1991) highlighted the importance of breaktime or recess for both social development and their subsequent classroom activities when he wrote,

> 'Children need recess because they are temporarily bored with their immediate classroom environment. When they go outdoors for recess they seek novelty by interacting with different peers in different situations. But, when the novelty of the recess environment begins to wane, they again need to change. At this point, the classroom becomes a novelty and children actually pay closer attention (Pelligrini, 1991, p40)

The importance of breaktime for pupils' experience of school must also be taken into account. Blatchford (1998) considers a balance should be struck between the deliberate management of breaktime activities and the maintenance of independent activity through a non-interventionist approach. The balance between control and independence has been helped by improvement in the school playgrounds, schemes that involved improved training for supervisory staff and the development of dialogue between lunchtime and teaching staff. He has developed a number of principles that may help in ensuring that breaktime is a valuable and enjoyable experience for most children. These are:

1 'better descriptive information on, and better understanding of, the meaning and value of pupils' breaktime experiences;

2 a more active role in facilitating in a sensitive way breaktime play and activities; and

3 working toward a moral context for breaktime activities and social relations' (Blatchford, 1998, p65)

6.5 Conclusions

The evidence on the importance of play in the early years is overwhelming. There is consensus in the research that it is not possible to isolate a one-to-one simple connection between curriculum content and children's development. At the same time, there is acknowledgement that effective early-years provision depends on the involvement of well-qualified teachers. The early years teacher who has knowledge of children's development and the skills to employ resources in planning appropriate experiences are critical for presentation of a curriculum that involves appropriate structured play. (TACTYC, 2000). However, as Keating et al (2000) demonstrate teachers' commitment to play has to be supported by policies that affirm the importance of play in school at breaktime for the social, personal and emotional development of the young child.

7. The contribution of neuroscience to research in early learning

7.1 Overview

As Blakemore & Frith (2000) make clear in a recent authoritative review of the literature, we are at such an early stage of research into neuroscience that 'brain research has not yet found an application in theory or practice in education.' Whilst neuroscience has been making contributions to our understanding of the mechanisms of learning for many years, it is not until recently that we have possessed the tools to investigate many of them in detail. Unfortunately for the progress of our understanding, learning operates at several levels within the brain; the cellular level, the 'module' level and the system level. Further, their interaction is extremely complex. Since we have only begun to scratch the surface of a description of learning from a biological perspective, we must be careful not to over interpret the research findings. Blakemore & Frith (2000) and Bruer (1998) have suggested that this has already happened. Bruer (1999) has gone so far as to write a book detailing the ways in which government in the United States, the press and practitioners have misinterpreted 'brain science'.

In the first part of this section, we shall discuss the neuroscience and related psychology of learning. In the second part, we shall look at specific research on neurological deficits which may be influential in the Enriched Curriculum. Finally, we shall draw together the implications for teaching.

7.2 Neuroscience and the psychology of learning

So what are the key findings of brain research? We know that knowledge is not stored within a nerve cell but at synapses, the junctions between nerve cells. Nor is it stored at a single location, but rather within a network of synapses which may be distributed widely over many parts of the brain. These widespread interconnected groups of neurons are known as neural networks. We also know that there are three major basic processes which underlie learning:

- Changes in the strength and number of connections between neurons (nerve cells) (synaptogenesis and synaptic pruning).
- Changes in the 'insulation' between signals travelling in neighbouring nerve cells and the speed of conduction in nerve cells (myelination).
- The specialisation of various parts of the brain for different functions and the degree to which that specialisation may be modified by maturation, experience or injury (modularity and plasticity respectively).

Our increasing knowledge of each of these and other subsidiary processes is likely to have an increasing influence on aspects of psychological theories of learning.

Synaptogenesis and synaptic pruning

Children's brains undergo massive amounts of change in the first few years of life. Synaptogenesis is the proliferation in the number of network connections between the nerve cells in the brain to form additional communication junctions between them. These junctions

are called synapses and are formed on both the input and output sides of the nerve cell. Synaptic pruning is a mechanism used later in the process, in which frequently used connections are strengthened to produce more efficient communication between the two nerve cells involved and infrequently used connections are eliminated. Huttenlocher (1990) reports that in the human visual cortex, there is a rapid increase in the number of synaptic connections at two or three months. This peaks at ten months and thereafter, synaptic pruning produces a steady decline until at ten years old, the level remains stable. This cycle of synaptogenesis and synaptic pruning suggests that although we are born able to interpret visual information to some degree, we learn to see in the adult sense of sophisticated interpretation of the visual world. For higher thinking functions, which are located in the frontal lobes of the brain, this cycle occurs later and lasts longer (finishing around 18 years). This gives support to the Piagetian idea that pre-adolescent brains have not fully matured and does not contradict the theory that before a certain age, children are unable to learn to think in a fully mature fashion. Piaget linked this immaturity to the incapacity for abstract thought in the young child. Neuroscience has therefore begun to describe mechanisms which may underlie the maturational changes in children's thinking which had been documented by psychologists. Modem constructivist research over many domains confirms that the younger the child, the more constrained to learn by manipulation of concrete objects rather than being able to deal with abstract representations.

The Enriched Curriculum has fully accepted that younger children find abstract thought difficult and learn best by manipulation of concrete objects.

So far, it may seem that early learning is dominated by processes which are maturational in character and thus biologically determined. In a classic experiment, Wiesel & Hubel (1965) demonstrated the degree to which maturation could be influenced by environmental factors. Wiesel & Hubel demonstrated that covering one eye of newborn kittens for a period led to a deterioration of neuronal connections and virtual blindness in the eye. Such studies of visual deprivation led to usage of the term, 'critical periods' to describe windows in time during which the brain requires a certain kind of stimulation for normal development. This has often been cited as evidence for the importance of early childhood education. In later studies however, it was demonstrated that recovery of the eye was possible (e.g. Mitchell, 1989).

Other types of synapse, known as experience-dependent synapses, can be strengthened or weakened throughout adult life (Greenough & Juraska, 1986). This is necessary to enable learning to continue throughout the lifespan.

Myelination

Myelination is the process by which a substance called myelin is gradually deposited on the long fibre or axon of a nerve cell. Myelin serves to act as an insulator, shielding the electrical impulses transmitted down the axon from accidental interference from those in adjacent cells. It also increases the speed of conduction of impulses in nerve cells and makes the cell more sensitive to input signals. Like the cycle of proliferation and pruning of synapses, myelination is not complete until puberty and perhaps beyond Kanner (1991).

Neuroscience and early learning

As with the cycle of synaptic changes, myelination does not happen at the same rate in all parts of the brain. Konner (1991) has suggested several parallels between myelination in particular parts of the brain and the development of related functions, including myelination of hearing centres with language learning. Konner also observes that in cortical areas associated with complex thinking behaviours, such as the learning of associations, myelination does not begin until between four and eight years of age. This highlights another important facet of these processes, namely individual differences. One child may be ready to begin complex thinking at the age of four but another may not be ready until the age of eight. In addition, this difference in maturation rates does not determine adult intelligence, just as individual differences in growth patterns are not the sole predictors of final height. Within the Enriched Curriculum, this difference is accommodated as the child who develops slowly in this area is given more opportunity to mature before moving on to more advanced types of study. Conversely, the child who develops quickly is given the opportunity to move on when he or she demonstrates readiness and is also able to increase knowledge in depth, for example by the acquisition of a larger verbal vocabulary.

The reticular formation, a part of the brain implicated in lengthy concentration, is one of the last areas to myelinate (Tanner, 1990). This may explain why young children are unable to concentrate for long periods. This helps to validate the use of shorter lessons which is a strong feature of the Enriched Curriculum.

Plasticity

Plasticity is the ability of the brain to adapt to new circumstances because of the presence of immature neurons which have not yet become specialised. It ranges from the synaptic changes which are the normal result of exposure of the adult brain to new types of stimulation to the ability to recover from injury. In the latter situation, it is intimately linked with the specialisation of areas of the brain for different functions, known as *modularity*. It is very well known that the brain contains areas specialised for different purposes, including areas for language, vision and motor skills. The specific effects of damage to these are most often observed in stroke patients. What is less well known is that after injury, there is a tendency for undamaged immature cells to adapt their functions to take the place of those that have been lost. This even extends to neurons in the opposite hemisphere of the brain, that is within a different module of the brain, taking over damaged functions. The younger the person at the time of injury, the more dramatic the possible recovery. For example, young children who lose the language centre in the left hemisphere before a certain age[1] will make a virtually full recovery of language skills, although they will probably have subtle deficits (See for example, Muller, Chugani, Muzik & Mangner, 1998). This and similar studies confirm that the young brain is extremely flexible and plastic. Huttenlocher (1984) believes this is a result of the larger reserve capacity of immature nerve cells in the child's brain: We continually lose neurons throughout life through cell death. This is further evidence that we need not become too discouraged by deficits in the child's early learning environment because correction is possible (although it requires much effort and resources). On the other hand, intervention in some areas, for example, oral language skills, would undoubtedly be even easier if undertaken earlier than Primary 1 level.

[1] There is no sudden cut-off and there would be individual differences, but five years is probably a good rule of thumb.

The Enriched Curriculum attempts to provide the child with a rich oral language environment and this is especially important for those children who may not have received appropriate stimulation at home in the pre school years.

7.3 Specific research into neurological deficits

A large number of groups are currently engaged in exploring specific connections between learning difficulties and neurological deficits. Several approaches are having an impact in Northern Ireland; Brain Gym activities, the work of Sally Goddard and her colleagues and the work of Martin McPhillips and his colleagues.

'Brain Gym' is a trademarked programme of 26 targeted physical activities based on the concept of Education Kinesiology, available from 'The Educational Kinesiology Foundation', a commercial organisation (A number of other organisations refer to 'Brain Gym' but are not trademarked). It was founded by P. Dennison, whose work does not appear to have been published in any peer reviewed journals but has been published in a book (Dennison & Dennison, 1986). Dennison claims that 'Whole brain learning [takes place] through movement repatterning and Brain Gym activities enable students to access those parts of the brain previously unavailable to them. ' On his website he also says that 'learning disabilities occur when information does not flow freely among [functional centres] within the brain. The [Educational Kinesiology] movements stimulate this flow of information within the brain, restoring our innate ability to learn and function at top efficiency.' The functional centres in the brain must be 'integrated' laterally (across the two hemispheres, related to reading, writing and communication), from 'higher to lower' (supposedly related to emotion, relaxation, grounding and organisation) and from 'front to back' (supposedly related to participation and comprehension). Of these three elements, only the relationship of the lateral flow of information to language and communication skills has a sound basis in neuroscience (laccino, 1993). In support of the programme, Shifft & Calsa (1991) found a significant positive effect on simple and choice response times following the programme. Further, Camissa (1994) found a significant improvement in perceptual motor skills after following the programme but no significant change in academic skills. However, these are both small studies and it is important to keep them in perspective.

Goddard, Blythe & Hyland (1998) are amongst a group of researchers who argue that some children's' borderline learning difficulties have their origin in subtle neurological dysfunction. Primitive reflexes are reflexes present at birth which disappear during normal development during the first few months of life. At this stage, postural reflexes, which control equilibrium and balance should emerge and remain throughout adult life. Neuro-developmental delay (NDD) is defined as the continued presence of a cluster of primitive reflexes above the age of one year, and the absence or underdevelopment of postural reflexes above the age of three and a half years.

There is a wide medical literature to attest to the developmental delay associated with gross persistence of primitive reflexes; this syndrome is an accepted indicator of neurological pathology. As an example of the effects of one of these reflexes, Goddard (1996) describes how the palmar reflex, if present in a child beyond six months of age can have a detrimental

effect on a child's educational achievements. The palmar reflex is the infant grasp reflex in which the thumb closes across the palm and the fingers curl in. It may represent a remnant of our evolutionary history during which its function was to enable young primates to grasp securely on to the mother. In normal children, this reflex transforms gradually via the coarse ulnar (clawlike) grasp to the pincer grasp between the thumb and index finer, which is under conscious control and allows both sensitive tactile exploration and fine movement. It is self-evident that a child who cannot use the pincer grasp at all is at a disadvantage, but Goddard goes further. She maintains that incomplete persistence of the palmar grasp will interfere with the child's conscious control of the pincer grip. If this persists, it 'will affect the pencil grip when writing [and give rise to] poor manual dexterity and even speech difficulties'. Goddard's (1996) further contribution is to claim that an individually tailored exercise regime will 'give the brain a second chance to pass through the developmental stages'. This 'Developmental Exercise Programme' is fully revealed only to accredited trainees of Goddard & Blythe's 'Institute of Neuro-Physiological Psychology', a commercial organisation based in Chester. However, the exercise programme appears to be a combination of patterning of the reflex movement slowly but in an attentively conscious manner and of practice of adult patterns of control of normal movements. In a recent presentation at the Northern Ireland Council for Curriculum, Examinations and Assessment (CCEA), a presentation of Goddard's work appeared to strike many chords with some of the early years educators present. For example, many of us will have seen children unable to grasp a pencil properly and having concomitant difficulties with control, and such instances make Goddard's ideas intuitively appealing. This research on primitive reflexes is a young area of research and remains somewhat controversial. Goddard herself has not yet conducted full, double-blinded control studies of the outcomes of the exercise intervention regime.

McPhillips, Hepper & Mulhern (2000) investigated the effect of a different primitive reflex remedial exercise programme on children with reading difficulties. In a fully randomised, double-blind control study, children on the specially designed exercise programme showed a significant greater decrease in manifestation of primitive reflexes compared with no significant improvement in groups given non-specific exercises and no exercises. However, this preliminary study did not measure improvements in reading difficulties. In another fully randomised study using the same exercise programme, Mullany (2001) found no significant correlation between persistence of the Asymmetrical Tonic Neck Reflex and reading scores. However, she did find a small highly significant negative correlation between persistence of the Asymmetrical Tonic Neck Reflex and mathematics scores ($r = -.22$, $P = .002$).

The main significance of this research to the Enriched Curriculum appears to lie in its inclusion of the Brain Gym system of exercises into the curriculum. Independent of the outcome of further research, it is clear that many teachers are convinced of the value of the exercises in promoting co-ordination and muscle control, the training of attention skills and the use of language (particularly in the naming of body parts and in the use of prepositions such as 'across'). Provided teachers are not asked to encourage exercises beyond the scope of their training, the system is unlikely to cause harm and it has intrinsic value in many areas of learning.

7.4 Lessons for education

Appropriate goals for early learning

There is increasing evidence from neuroscience that early learning is biologically influenced to take place in a particular order. This order is governed by the order of the beginning of maturation of different parts of the brain. To date, this evidence suggests that visual areas are the earliest parts of the brain to begin to mature, then motor areas which overlap with development of hearing and language production areas (For an extended discussion, see Konner 1991). We have, as yet, less information about other domains, particularly those related to social and emotional development. We do have enough evidence from neuroscience to suggest that considerable acquisition of visual, motor and language skills in early life is intended to be part of the natural order of things. In the light of this evidence, the idea that it is ill-conceived to distract young children by attempting to teach other skills for which the brain is inadequately prepared must be considered. As yet, we have insufficient research from neuroscience to fully confirm this idea, but Blakemore & Frith (2000) conclude that 'there is no biological necessity to rush and put the start of teaching earlier and earlier. Rather, late starts might be reconsidered as perfectly in tune with findings from (present) brain research.' This is also in accord with evidence detailed in other parts of this report from research in education and psychology.

The role of sensitive periods

Just as recovery of the visual system has been demonstrated in kittens, recovery from wide-ranging deprivation of stimulation has now been demonstrated in humans. Studies of Romanian babies reared in severely deprived conditions show they are more likely to have delayed development of skills and impaired social, emotional and cognitive development (0' Connor, Bredenkamp & Rutter, 1999). However, the studies also showed good recovery and resilience in these children when they received remedial treatment. From this and studies in other domains of neuroscience and psychology, the idea of the 'critical window' for learning has lost ground to be replaced by the notion of 'sensitive periods'. Sensitive periods are defined as 'a time during which the brain regions responsible for an ability are maximally modifiable' . This definition is less rigid and more flexible in terms of the optimum times when learning can occur.

The best understood example of a sensitive window is certain aspects of native language learning, particularly basic syntax learning (de Villiers & de Villiers, 1978). This is further discussed in the section on oral language.

Within the Enriched Curriculum children who have not had an opportunity to learn good language skills at the height of the sensitive window are helped to recover the lost ground through the provision of a rich oral language environment.

Bruer (1998) emphasises strongly that sensitive windows are not an appropriate framework in which to consider the timing of teaching culturally and socially transmitted knowledge, such as music, reading, or mathematics (with the exception of the number sense in mathematics): Topics which are not old in evolutionary terms have not had time to become 'hard-wired' into the brain and people can benefit from instruction in these at any age (Greenough, 1997).

Neuroscience and early learning

Questions not yet answered by neuroscience

Blakemore & Frith (2000) detail several research questions not yet answered by. neuroscience and some of these are particularly pertinent. They are briefly summarised here because they are worth keeping in mind. We do not yet know if we can speed up neurological development in certain areas and more importantly, we do not know whether such a process would have a positive effect on whole-brain development. To a certain extent, the corollary of this is the question of whether the brain takes advantage of its plasticity to rewire to accommodate certain taught abilities and whether this might be to the detriment of other abilities, such as social and emotional development. Finally, we do not know to what extent sensitive periods might be extended by teaching.

The Enriched Curriculum and current neuroscience knowledge

We have demonstrated the consensus that neuroscience research is, to a large extent, in its infancy as regards direct application to education.

We have established that the Enriched Curriculum is doing nothing which is contraindicated by current knowledge. We have further demonstrated that as regards the goals of early learning, the Enriched Curriculum is in accord with current neuroscience research. The Enriched Curriculum also accommodates individual differences by reason of its child centred approach, and this is supported by research which demonstrates individual differences in neurological development. Finally, the shorter lesson times are in accord with the known immaturity in young children of centres in the brain responsible for sustained attention.

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