

This New Year edition of the magazine focusses on mathematics and explains why mothers and fathers, no matter what their background, always make the best teachers of the subject.

Mathematics

When parents consider teaching their children at home, the subject which causes them the greatest anxiety tends to be mathematics. It has acquired a reputation for being difficult, and, in consequence, most people believe that it can only be taught properly in schools or with the aid of materials that have been produced for the school curriculum.

The aim of this article is to demonstrate that nothing could be further from the truth. Mathematics is, in fact, the subject that lends itself least well to being taught in schools, and least suited to school-inspired workbooks.

Both parents who home educate their children and those who send them to school, would find it well worth their while to take a step back from day-to-day pressures and to consider what they would like them to achieve in the field of mathematics in the long term.

Recent History of Mathematics Teaching

It may seem sensible to assume that the objective should be for every child to have a good understanding of the school mathematics curriculum – but the experiences of the past fifty years have shown that there is something flawed in this approach.

Current problems with mathematics date back to the introduction of compulsory secondary education after the second world war and have been compounded by the changes in society brought about by technological innovation. Until then, the primary school curriculum, at least, was fairly

clear-cut: children were made to learn their tables, to do mental arithmetic, work out problems involving money and weights and measures, fractions and decimals, etc. Arithmetical skills remained fairly high and schools took the credit, even though their contribution even then was probably negative.

Around thirty years ago, devices such as calculators and electronic cash registers became widely available and people were no longer obliged to work out the answers to sums for themselves. This had a profound effect in primary schools, where teachers found that they were no longer able to teach children to do simple arithmetic – large numbers of children simply would not or could not learn.

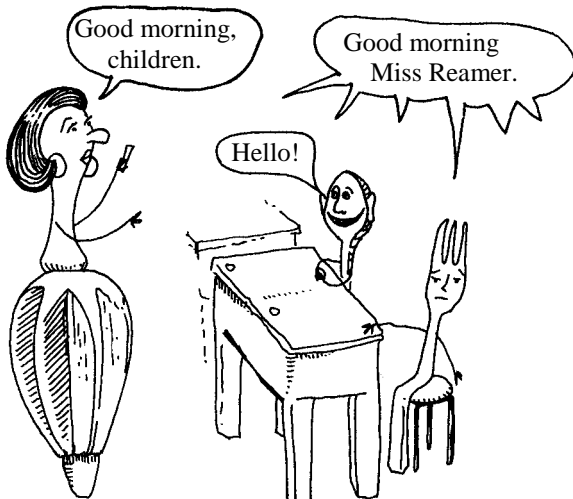
"Something that must be avoided at all costs is to put a child in a situation in which they may be confused, frightened, distressed, or over-pressurised by the mathematics that they are being asked to do."

Primary schools compensated for not being able to make children do endless amounts of repetitive calculations by introducing more complex mathematical concepts into the lessons – such things as decimal places, fractions, geometrical shapes, etc. For very many children this has provoked an aversion to mathematics which has stayed with them throughout their education and beyond.

Similar problems have beset secondary school mathematics. Prior to the twentieth century, the syllabus was clear cut and consisted broadly of geometry, algebra, trigonometry and calculus, but when secondary education became compulsory, this traditional curriculum was considered to be too difficult for the population as a whole. At the same time, it became apparent that some other areas of the subject – such as set theory, matrices, number bases, and networks – were going to be significant in the new, emerging, computer technologies and that it might be useful for school pupils to know something about them. This gave rise to a hybrid syllabus which contained some algebra and geometry, but not enough

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for it really to make sense to the students, and some 'new' mathematics which also did not make sense because children in schools did not have the underlying knowledge of the subject that would enable them to understand the significance of the new ideas. The inevitable result was that even people who passed their exams were confused, and it was obvious to everyone that mathematical skills (as well as the arithmetical skills already mentioned) were going into a sharp decline.

In an attempt to remedy this situation, school mathematics is regularly overhauled, usually by replacing 'new' elements in the curriculum with more traditional aspects such as algebra or geometry. As a result, children never follow the same mathematics curriculum as that followed by their parents and, because even children who go to school fundamentally look to their parents for help in this area as in others, confusion multiplies upon confusion.

It is a measure of the degree to which mathematics teaching has failed over the past fifty years that parents *should* feel unable to teach the subject to their children. Virtually all of today's parents have endured at least ten to twelve years of compulsory mathematics tuition: this represents an enormous number of mathematics lessons; if they had been in the least effective everyone would now know everything there was to know about the subject and would be able to teach it to their children with no problem at all.

A Passion for Mathematics

The truth is that, left to their own devices, everyone has an innate and unquenchable interest in numbers and everything connected to mathematics. This is most noticeable in young children who seem to have a natural desire to start counting things even before they can speak, but it is also noticeable in many adults, from all walks of life, who develop interests in every branch of the subject from calculus to betting odds, reading mathematical research papers to dealing in stocks and shares.

Like many other people, my own interest in mathematics only really took off several years after I left school. It began when I found myself teaching the subject; the more I tried to explain it to other people, the more I realised that I didn't understand it myself. This led me to start reading mathematics books in my spare time, and I soon developed a passion for the subject that has continued unabated to this day. Since starting to write and talk about maths, I have been

surprised by the number of people who have had a similar experience – that is to say, only discovering the beauty of mathematics long after they have left school.

The challenge facing today's parent is to help their child to maintain and develop their natural interest in mathematics throughout the time that education is 'compulsory' and to prevent them having a twenty year gap in their lives where this most enjoyable of pursuits becomes something to be feared and dreaded. Fortunately this is not as difficult as it might seem.

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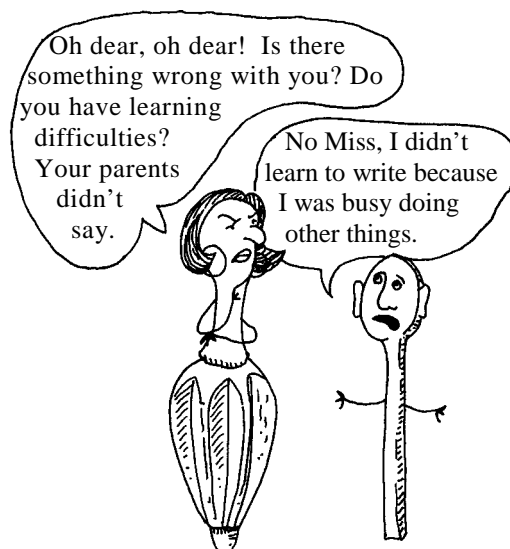
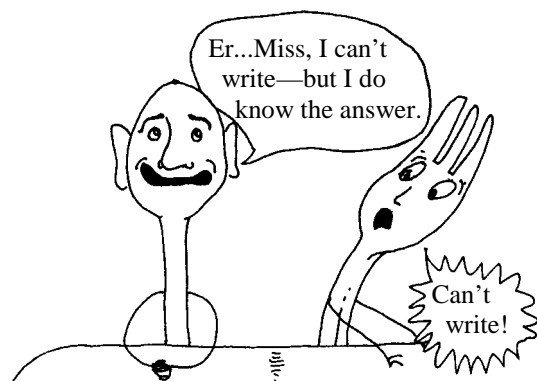
A Simple Approach

It has always been recognised that there are two distinct sides to mathematics – the pure and the applied: pure mathematics deals with the theory, and applied mathematics with its practical applications. The two are related but are also quite distinct from each other – for example, in applied mathematics $1 + 1$ is definitely 2, but in theoretical mathematics the answer is not so clear cut; the answer might be two, or it might not be, it depends on the parameters set for the discussion... and so on.

When working with children, adults should restrict themselves to applied mathematics – it is fine for children to be allowed to speculate about the nature of infinity, or whatever else they want to think about, but difficulties arise if adult concepts of theoretical mathematics are forced upon them before they are able to evaluate them for themselves.

Applied mathematics involves using numbers in practical situations; it covers the simplest situation, such as counting or using weights to measure out quantities in a shop, to the most complex, such as in the design of computers or the construction of aircraft. It differs from pure mathematics only in that it relates mathematical ideas to things that can be seen and felt in the real world.

When viewed in this light, it becomes obvious why schools are so bad at teaching mathematics: they create an artificial environment in which children are isolated from



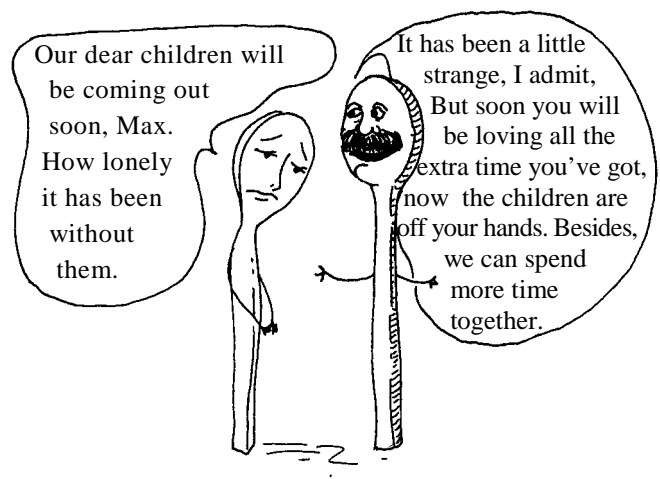
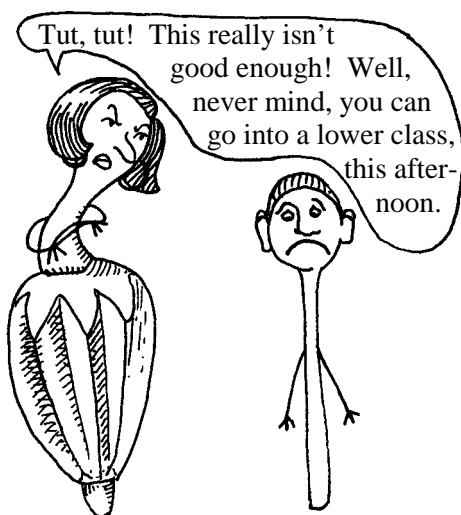
the wider community and are prevented from engaging in useful, practical activities. Mathematics is typically presented to them from the pages of a book, while they are sitting at a desk – which makes it just about as far removed from real life as it is possible to imagine. Even when dealing with practical applications of mathematics, the material is presented in such a way as to make it appear purely theoretical and completely disconnected from the child's personal experience.

The solution is for a parent to ensure that, in the home, a child is involved in as wide a range of practical activities as possible.

- **Counting:** As already mentioned, babies appear to begin their study of mathematics by counting, which is the simplest application of mathematics that there is.
- **Being Outside:** Simply being outdoors, especially in the countryside or in a place where there is a wild, natural landscape, is a rich educational experience which impresses the rich diversity of mathematical relationships that exist in nature upon a child's senses and imagination. Modern teaching methods fail to take account of the importance of simple observation. The more years that children are allowed to spend simply observing and experiencing nature, the better equipped they will be to understand and evaluate explanations and theories when they are older.
- **Gardening:** Gardening takes being outdoors a stage further. Instead of simply observing nature, the gardener has to work with nature to create something of beauty. This involves using a myriad of mathematical ideas ranging from counting out seeds and measuring the distance between plants and laying out beds, to following the increase and decrease in the length of the days, using a calendar, being aware of the cycles of the moon, and undertaking construction projects. Gardening is applied mathematics at its most advanced; it involves working with the most complex machine that there is – nature itself – and yet it could not intimidate even the most fearful student of mathematics.
- **Playing Games:** Board games, card games, dice games, and puzzles of every sort (including jigsaw puzzles) are all ideal ways of developing an understanding of mathematics through practical experience. It is not necessary, or desirable, for children to be taught about the laws of probability, statistics, or logic – the important thing is

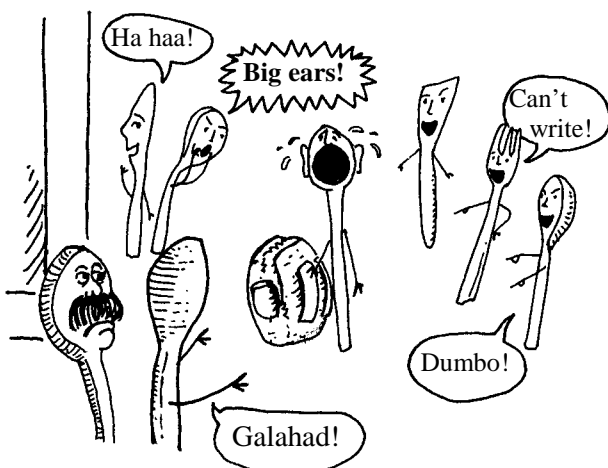
for them to have a chance to experience these laws in operation, for themselves, without any explanations being placed upon them.

- **Crafts:** Crafts of all sorts provide the perfect introduction to the use of mathematics in engineering and science. Simple crafts such as sewing or paper folding require quite complex mathematical skills, but in a non-intimidating way: they do not lead a child into the peculiar situation of being given a problem to solve and then told whether it is right or wrong, but involve a child in a real situation in which they can tell for themselves whether they have measured things correctly, scaled things up and down correctly, etc. If they have got their sums wrong they will probably retrace their steps, find the mistake, and then do the job properly – an ideal preparation for how mathematics should be tackled. The more complex the craft – woodwork, metal work, dress-making, design, electronics, etc. – the more complex the mathematics, but there is no reason why a keen student should not be able to take the most difficult ideas in their stride providing they have a clear goal in mind.
- **Cooking:** Children who cook learn about measuring, ratios, volume, fractions and decimals, different systems of measurement, temperature, and much more. For many people this is the simplest and most natural way of becoming acquainted with a wide range of mathematical ideas. It also has a close connection with household management and economics.
- **Money:** Money provides the perfect link between the maths of the real world (counting out coins and bank notes, is not so different from counting out beans or pieces of gold) and theoretical mathematics; bank statements with negative balances, money moved around by electronic transfer, fluctuating currency rates, inflation, credit cards, etc., are all ideas derived directly from pure mathematics. It is surprising how quickly children can learn to understand the intricacies of money when they are given a chance to do so.
- **The Family Finances:** There is no reason why children, as they get older, should not be involved in helping to manage the family finances. If they do choose to do so, they will have an opportunity to come to terms with mathematical ideas far in advance of what is generally expected at school – every family now finds themselves having to deal with tax, insurance, banking arrange-



ments, savings accounts, pensions, etc., and many are involved to a greater or lesser extent in business activities. Children who are allowed to help in the management of these affairs acquire mathematical skills that are bound to be useful to them for the rest of their lives.

- **Computers:** In some ways, computers represent the most pressing challenge to the current educational system: they are at the cutting edge of technology, but the best way for a child (or anyone) to learn how to use a computer is not at school, but in their own home. Providing that a young person is given enough time and they have something that they want to do on it, they will eventually push their computer to its limits and, in the process, will come to understand something about computer programming and the underlying mathematics upon which computer technology is based.
- **Mental Arithmetic and Written Sums:** Working out the answers to sums is essentially enjoyable. Parents and children can have a lot of amusement simply asking each other the answers to sums – adding-up, taking-away, multiplication, division, fractions, decimals, etc. Mental arithmetic has the advantage that if you ask a question that is too difficult, you can simply move on to something else. It is often when children are presented with written sums, that difficulties with mathematics begin; this is not because children do not like sums, it is because the teacher or parent is setting sums that are too difficult. Sums are a way of practising a skill, rather than a means of acquiring one, and should therefore be set at a level that allows a child to get all the answers right.
- **Art:** Mathematics involves both the study of numbers, through arithmetic, and the study of space, through geometry. The best way for a child to get a feeling for geometry is for them to do as much drawing and painting as possible. No attempt has to be made to explain drawing in geometrical terms - straight lines, curves, circles, triangles, etc. - it is simply sufficient that they should spend time learning how to draw for themselves.
- **Music:** Music is perhaps the subject most aligned to pure mathematics. Musical notes and musical arrangements are similar to numbers and mathematical formulae. Just as a musician strives for perfection in their music, so a good mathematician strives for simplicity and elegance in their reasoning. Playing a musical instrument is an activity quite closely aligned to the study of mathematics.
- **Talking:** Everyone, especially children, needs to have an opportunity to talk about mathematics; they need to be able to discuss the relationship between numbers, how



Mathematics Homework

Many children who can cope with, and even enjoy, mathematics lessons at school find mathematics homework an insupportable burden.

Homework makes a child use their free time to work out answers to questions without support from their teacher, and as such it is unreasonable and cruel. It also makes it more difficult for a child to have an independent life outside of school.

Parents have to do everything in their power to protect their children from unreasonable homework – they can do the homework themselves, talk to the teacher, get the answers from a book, or whatever it takes to ensure that their child is not subjected to unnecessary stress.

they are able to remember the answers to some sums and not to others, ideas about infinity, what they understand about fractions, etc., etc. Mathematics is not a one-way street in which the teacher talks and the pupil listens; if anything, it is the pupil who should do the talking and the adult merely provide support.

It should be obvious from the above list that *any* parent who is providing their child with a full life in the modern world will be giving them a firm grounding in the foundations of mathematics: there is absolutely no requirement for a parent to be a mathematician, a qualified teacher or to have purchased an expensive mathematics course. Any child who is gardening, cooking, making things, drawing, painting, talking, thinking, working on a computer, helping in the home, etc. - or any combination of similar activities - will be learning about whole numbers, fractions, decimals, ratios, percentages, weights, measures, using a calculator, logic, statistics, finance, computer languages, etc.

If a child's interest leads them into design or electronics or any similar area, they are able to learn about algebra, or trigonometry, or anything else relevant to the work that they are doing, in the same way that they have acquired more basic skills.

When viewed in this light, it can be seen that the school curriculum is both too ambitious and, at the same time, too ready to accept failure. On the one hand teachers attempt to teach children a range of abstract ideas relating to algebra, trigonometry, geometry, etc. which they will never be able to make use of in their lives, while on the other hand it has be-



come commonplace to accept that a child can spend years in school and at the end of it not be able to add up a column of figures or multiply two numbers together. Instead of working with, and respecting, a child's natural development, schools all too often try to impose their own agenda upon the child and, whereas children ought to be allowed to explore how mathematics fits into the world around them, for themselves, they are instead subjected to ideas that they are not in a position to fully comprehend.

Pure Mathematics

It is possible to teach some young children algebra, or calculus, or any other mathematical technique, but you cannot teach them to understand it, or to be able to make an individual assessment of its merit. By teaching them very complicated ideas, they are effectively being treated in the same way as performing monkeys, that is, they learn to repeat tricks that have no meaning for them. Many children are simply unable to comply with this treatment; such children are regarded as being 'bad at mathematics', even though they may well be the ones who have the most interest in the subject.

There is, in fact, no justification for teaching pure mathematics to children; it is one of those subjects that becomes interesting when one is older, after one has gained a good grounding in the use of mathematics in practical situations, and when one starts to wonder why it is that mathematics *is* useful in real life, and why it is that this most abstract of subjects should have proved to be so integral to every aspect of the technological revolution that has taken place over the past few hundred years.

If educators really believed in the principle of life-long learning, they would realise that all that they had to do was inspire their pupils with an interest in mathematics and then let nature take its course: it is an area in which everyone really can continue to learn throughout their whole lives.

Something that must be avoided at all costs is to put a child in a situation in which they may be confused, frightened, distressed, or over-pressurised by the mathematics

Mathematics Exams

It is hard to think of anything more bizarre than a mathematics exam: people working in the real world have to get all their sums correct and a mathematics exam that has a pass mark of less than 100% therefore has no relevance to the world of work. In the realm of pure mathematics, on the other hand, there are no right or wrong answers and if the aim is to make students into free-thinking mathematicians, then making them repeat things parrot-fashion in an examination could not be more misguided.

For these reasons the older children are before they take their first mathematics exam, the better, and in all probability it would not do any harm if they never sat a mathematics exam in their entire life.

If a young person does reach a point in their life, however, where they decide that they need a mathematics qualification they will have no difficulty in passing the relevant exam, provided that they already have a good grasp of the basics of the subject: they will be able to analyse the requirements of the syllabus, work out what the examiner wants them to do, and then to do it in the most efficient and expeditious manner possible. In effect, they ought to be able to treat the exam itself as a real-life mathematical problem.

that they are being asked to do; any unpleasant experience of mathematics can arrest a child's development in the subject for many years, perhaps for life.

In conclusion, the objectives that an enlightened parent might set themselves for their child's mathematics education are firstly that they will always retain the same enthusiasm for the subject which they have as a small child; secondly that they will learn how to use mathematics in all the practical situations that they encounter in their daily lives; thirdly that they will have the confidence to acquire any new mathematical skills that are required by any activity or profession that they wish to pursue in later life; and fourthly that they may perhaps one day wish to take up the challenge of pure mathematics and discover for themselves the beauty hidden within the heart of this most enigmatic of academic subjects.

Gareth Lewis

Books by Gareth Lewis:

One-to-One, A Practical Guide to Learning at Home, Age 0-11

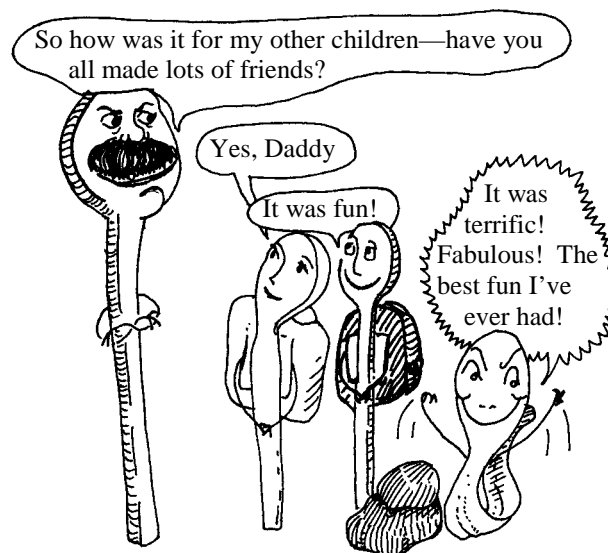
Unqualified Education, A Practical Guide to Learning at Home, Age 11-18

A Set of Sum's Books: 500 Adding-Up Sums, 500 Taking-Away Sums, 500 Multiplication Sums, 500 Division Sums
www.nezertbooks.net

The freedom in education newsletter is edited by Gareth Lewis.

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Follow the further adventures of the Spoon family in next month's newsletter.

Letters

Valuing Children on Exam Results

I had a sad reminder of this when I bumped into an old friend yesterday. She was bubbling over to tell me about her son's G.C.S.E results and his expectations for A-levels (or hers). She was with her very un-academic daughter, one of two, whose face fell as her mother talked. We visited them a year ago and saw her daughter getting angrier and more hostile as heaps of praise were showered on her son. She has a tendency to judge on other "status" symbols too and acid remarks about our still being in our little terraced house are a regular thing - I certainly know how it is to be judged by the area you live in and not just by the authorities.

Then the usual questions about which exams Holly will take and blank looks at my answer that she won't be taking any unless she chooses to...and at this time she doesn't. It wasn't exactly a cheery Christmas encounter. I know Holly was really hurting for Emily (who is her age) because they have discussed how she feels a failure in her mother's eyes.

Angela Cox

Readiness and Interest

Your magazine seems to fall on my mat on the days I particularly need to read similar ideas about education...the days when I am doubting our decision to home educate. The main articles always seem so relevant, too. So, thank you for your honest words and sharing your views, which help me to remain true to my beliefs about education.

December's article 'Preparing for the Real World' reflects my thoughts on this issue...those that I've realised through experience, despite once trying to teach the National Curriculum, and which form the basis of why we decided to learn at home.

My children are under 5, so we have yet to experience the questions from well meaning relatives to any further degree than, "Does W go to nursery school?" I am hoping for a smoother ride than I imagine it to be...(any comments or tips about this from other readers would be very welcome).

I notice that next month will be about Maths at home... another area which led me down this road in the beginning...

When my son was beginning to show us how much he was learning by himself, and beginning to speak, I noticed he was using numbers as well as words. I'm sure he knew what 2 of something looked like very early on, perhaps "one in each hand...that's 2!" at first finger food stage was the beginning? I'd always used songs a lot in my teaching in school, and so with my own children we sang at breakfast time right through to bath time and always whatever came to us naturally. We found ourselves developing routines such as counting on each swing to finally 'plop' him into the bath on 5, or something like that...but we did these things consistently but naturally and it was fun. He's 3 and likes counting but it's not as important as Lego or cars or his best friend Ben. His sister, not yet 2, spontaneously counts how many apple rings in her bowl to check they have the same and that mummy is being fair! Maths was the beginning of this journey for me (us), because I could see how little I knew (know) about how children learn, what they learn and when they learn it, despite my training (although it wasn't all for nothing) and I very much wanted to have the privilege of learning with my two children and for them to have the freedom to choose when they are ready to learn and what they are interested in. Without those two elements, readiness and interest, for me there is no point in trying to teach.

It's not the easiest thing I've done in my life, I might even say it's the most challenging. Such days as I mentioned at the start of this letter are the worst, when one wonders how on earth to find out and cater for two people's interests at the same time and be in two places at once with two very demanding toddlers (who probably don't want to do anything that day anyway, so I must stop trying so hard to justify me being here). Those days are very few thank goodness...the rest are busy with growing mushrooms, sand, cars, boxes, masking tape, pretend play changing baby's nappy or shopping trolley "bye bye, go shopping", puzzles, snacks, drinks, walks, planting bulbs....and that's just a couple of hours in one afternoon juggling probably 4 of those things at once. (More on one-to-one education for two - or three or four would be interesting).

We look forward to next month's article.

Regards,

Amanda Bond

News

UK: Reading Less Enjoyable

A poll of 5,000 children aged 9 to 11 showed that the percentage of the older children enjoying stories had fallen from 77 to 65. Among nine-year-olds it dropped from 78 to 71 per cent. Researchers from the National Foundation for Educational Research said the fall might be linked to the rigidity of the national literacy strategy which prescribes an hour's reading lesson every day in every primary school.

UK: Bribery and Intimidation

A study, by the BBC's *Six O'Clock News*, showed parents were applying increasing pressure on more than half of the head teachers of England's 100 'leading' primary schools. About 32 per cent of head teachers admitted to being offered cash, other inducements or threatened with violence; and 70 per cent of those questioned said parents lied on applications, commonly using a false address to qualify for the school's catchment area. One family even listed an empty field as its home.

US: Florida Education Vouchers

The state of Florida is in the middle of a radical attempt to reform education through the use of vouchers. Parents whose children attend 'failing schools' and parents of 'disabled' children and parents on low incomes can claim vouchers which they can use to purchase the education of their choice for their children.

Voucher schemes were adopted with surprisingly little opposition in 2001 but opposition is now starting to mount as it

becomes apparent that children educated with the help of the vouchers do not have to sit standardized tests and do not have to attend accredited schools.

US: Virtual Charter School for Texas?

Eagle Academies which runs 14 charter schools in Texas, wants to take its curriculum to home-schooled students.

The company is seeking approval to operate a statewide virtual school that could reach as many as 3,000 students at a potential cost of \$15 million.

Eagle is proposing to provide a computer, printer and Internet connection to households where children study at home.

If successful, Eagle would receive \$4,500 to \$5,000 state funding for each student, annually. The application was opposed by 80 schools and has been turned down pending resolution of issues relating to bilingual pupils - but it is widely regarded as being only a matter of time before such schemes become commonplace.

UK: School A Waste of Time

A report released by the National Commission on Education says that almost 39 per cent of young people in Britain leave full-time education without a worthwhile qualification.

US: Pennsylvania Online Charter Schools

The state Supreme Court has refused to hear an appeal in a Pennsylvania School Boards Association lawsuit over whether online charter schools are legal.

School districts have argued that cyber charter schools essentially amount to an unregulated form of home-schooling.