

A GENEROUS EDUCATION IN MATHEMATICS

By Alice Horrocks

Michael Farris, in his letter to his sons in law, gives math education first place in his list of things that the next generation of homeschoolers must improve.

http://www.worldmag.com/world/issue/04-28-01/cover_6.asp

In the year or so since first reading his article, I have often wished I could ask him what he had in mind. Was he just looking at statistics, and seeing that homeschoolers are not excelling in math as much as in other areas? Or was he thinking of specific problems that we as homeschoolers should address?

I have a particular interest in math education. While teaching at the highschool level, and then, after returning to university to earn a Ph.D. in math, teaching at the university level, I have seen a lot of people struggling with their math studies. But, if I perhaps may consider myself an expert in the area of math, I am a novice in the area of homeschooling, since this is only my third year teaching our children. As we all know, homeschooling is a whole new ball-game in many ways. So, what am I doing writing this article about homeschool math?

During the past three years, I have been eagerly learning a lot about how to provide my children with a living education. I am trying hard to instill in them a love of learning -- any subject. There are many wonderful books that have taught me a great deal about these things and more. I love the CM (Charlotte Mason) approach, and am a little influenced by classical and other methods. But in all my reading (books and online) one area has been disappointing. I have been looking out for those math experts who might give great advice to homeschoolers on how to approach math, but this seems to be lacking. I have even been disappointed in looking for serious discussion about approaches to the teaching of math among homeschoolers. I have the impression that many homeschoolers, perhaps themselves a little math phobic, are just buying a curriculum and hoping that this will somehow take care of their children's math needs.

So, maybe I could, with this article, do my bit to get the readers to think about math education, not only on the level of coping with daily lessons, but also on a more philosophical level. Let us consider together what it is we are trying to accomplish in homeschooling our children in the area of math. So often math gets bad press. "Math is hard. Math is irrelevant in everyday life. People who love math are geeks." You know what I mean. I think it's all quite unfair. I'd like you to examine your opinions about math by inserting the name of some other subject, maybe your favourite, instead of the word math. "Reading is hard." "History is irrelevant in everyday life." "People who love music are geeks." It just doesn't sound the same, does it? Math is really like anything else. Some people are stronger in this area than others -- true. You can get away with a minimum of math education -- true. But if we want our children to be truly educated people, we should examine how we are providing and encouraging them in the math aspect of their education.

What should we, I mean the homeschool community as a whole, be aiming for in math education? How can we know if we are succeeding in the sense that Michael Farris is suggesting?

If we are doing well in the area of math education, then there should be a reasonable number of mathematicians coming out of the homeschool community. Not every one of our children needs to grow up to be a mathematician (!), but our approach has to be adequate to detect and encourage and prepare those children whose strengths lie in that direction. A talented child who is taught poorly will easily turn to other interests and not pursue math as a serious interest and career.

As for the rest, in teaching those who will be scientists and accountants, artists and historians, educators and plumbers or even homeschooling mothers, we should be aiming not for a basic minimum of math, but for a generous math education. (I looked it up -- one of the meanings of magnanimous is 'generous'.) We would never consider a person well-educated if he could read only well enough to make out his parking tickets or an instruction manual. We expect a person to read well enough to read for information of any kind, as well as for enjoyment. So also with math we should try to go well beyond what is necessary or practical, and aim for a broad education.

I would suggest this means two things.

1. Competence -- A well educated person should be able to use whatever math he might need. He should be able to do basic calculations, of course, but as well he should be able to solve any problem of a mathematical nature he might come across in his life or work. Or he should know where to go for the solution. His logic and reasoning skills should be adequate to meet any challenge.

2. Comfort -- Every well educated person should be comfortable in dealing with math concepts. Just as we should all appreciate history or reading or music, we should all enjoy the challenge of working on a math problem that comes up in our life or work, rather than be intimidated by it. It is completely unnecessary, especially in a homeschool setting, that anyone should have a math phobia any more than that anyone should fear or hate _____ (insert your favourite subject). I am convinced that a fear of math indicates a lack, not first of all in the person, nor in the subject, but in the way he or she has been taught math.

Perhaps more than in most subjects, a classroom is a poor arena for the study of math. We are all products of our education to some extent, so it is difficult to get beyond what we have learned and experienced ourselves, but we can certainly look at this area, and try to improve.

So I would encourage you to provide a generous math education for your children. Don't limit yourself or your children. Don't limit yourself by the attitudes you have or those you instill in your children. Don't limit yourself in your understanding of what math is. And finally don't limit yourself to using only a curriculum. The study of math should be broader than what can be confined to formal lessons.

ATTITUDES AND GOALS

Math phobia is a widespread (inter)-national problem according to Marilyn Burns in Math: Facing an American Phobia. Some sources say that as much as 85% of (North) Americans have a fear of mathematics. Some of the reasons math is a much feared subject in our society are directly connected to problems inherent in the classroom schooling setting.

** Math is a subject which must build up, one concept upon the last, and 'missing' a concept causes learning to break down. People miss a concept when they change schools, and the new school does things differently, or they miss some school time because they are sick, or because they learn at a slower pace than that of the average student -- toward which the classroom teaching is geared.

** Classroom teachers especially at the elementary level, are often not comfortable with math themselves and find it difficult or impossible to teach it well (assuming that each teacher does his best?).

** It is difficult in a classroom setting to use learning styles to suit every student.

** In a classroom setting, math is taught in isolation from the world. It is difficult to see math in the world around us when we experience it only in a classroom. This leads to the common question: "When will I ever use this?", and no one can give a satisfactory answer.

In a homeschool context, it is possible to avoid all these pitfalls. But since we ourselves are products of our past experiences, we will not be able to do so without deliberate effort and some rethinking of the subject.

My suggestion to those homeschooling parents who suffer from math phobia is to make a serious effort to get over this, because it is a complaint which is easily transmitted to one's children, even unintentionally. Do you really want your children to feel about math as you do? A good place to start is to read the book by Marilyn Burns mentioned above, or the book by Patricia Clarke Kenschaft entitled ***Math Power: How to Help Your Children Love Math, Even if You Don't***.

This latter is my favourite book about learning math, and I truly think every parent should read it. There are lots of things to ponder in this book. I'd just like to give several short quotes from it:

" Learning math well is more like learning to ride a bike than increasing skill at running." No matter how much runners practice, they will never attain the speed of children who have tolerated frustration enough to learn to ride a bike, even though at first they moved not at all. A child who learns that repeated failed attempts often end in success has learned one of life's greatest lessons."

Parents and teachers who want children to continue to tolerate frustration and failure beyond (third grade) must provide appropriate challenges-not so dangerous or difficult that they will damage the child, but hard enough so the child gets a real sense of achievement by meeting the challenge. Confidence comes by experiencing success after failure."

"Six necessary qualities (for persistence in solving a problem) are hope, patience, productive skepticism, the ability to start over, concentration, and tolerance of frustration."

A key principle in Charlotte Mason's Method of education is stated in the maxim: "Education is an Atmosphere, a Discipline, a Life." This is also true with math, or perhaps especially true with math. If math is nothing but a school subject that must be studied divorced from everyday life, it loses much of its relevance and appeal. We are ready to accept discipline as a part of the study of math, but creating an atmosphere and life with math as an integral part is something which takes more effort and imagination.

Charlotte Mason also stressed building a relationship with the subject studied. For example, biology for the young student should consist of a lot of time spent outside experiencing nature first hand. Study history by 'getting to know' some of the people well through biographies or historical novels. It may be more subtle in math, but I am convinced that also in math we must try to establish a relationship between the learner and the subject.

We can use manipulatives to see mathematical connections. We can set our children real-life problems to make the math involved truly relevant to them. I don't mean that we should all start a family business, and allow the

math involved in that to be our math curriculum. There math is the tool, and running a successful business is the objective. I'm thinking more of searching for real problems that will illustrate and use the mathematical concepts we would like our children to learn. See the difference? Here the problem is the tool, and the math lesson is the objective.

WHAT IS MATH?

Formal math for young children seems to consist of learning to add, subtract, multiply and divide. Maybe this is why we sometimes equate math with arithmetic. But math is so much broader, even at the early stages. Let us now consider together what math really is.

Let's compare our pursuit of a generous math education to the pursuit of an education in music. To be educated in music, surely one should be able to read music; to play an instrument -- or two or three; to know something about music theory; to recognize many pieces of music and know something about their composers; to appreciate various styles of music and know where they fit into music history. If I go on, I'll just prove that I am not very well educated in music. Ah, but I do appreciate it, and I hope that my children's musical education will surpass mine.

Now, analogies are never perfect, so please just try to see the point I am trying to make about math, and ignore the weaknesses of the analogy.

The first comparison I would like to make is that thinking math is drilling the basic facts of addition and multiplication (and their inverses, subtraction and division) is like thinking that music is nothing more than practicing scales for your piano lesson. Let me say it again in a different way. You should no more restrict your child's experience of math to learning the basics of arithmetic, even at the elementary level, than you would consider practicing scales for piano lessons to be the whole of a child's musical experience.

I'm sure that the practice of scales is important to prepare those little fingers for a nimble performance of the music he will play as he becomes an accomplished musician. But surely that is the least interesting part of his lesson. The real pieces he will play are more fun. Nana will ask him to play a song for her, but not scales. Nor is his piano study the whole of music. He will also wish to sing and know of other instruments, or hear music from other sources. So memorizing the times tables is like those scales. *Let us continue the analogy.*

Music is piano lessons; **math** is arithmetic.

Music is the violin, the tuba, and all the other instruments of the orchestra.

Math is counting, measurement, sets and solving equations.

Music is jazz, classical, rock, Gregorian chants, waltzes, chamber music, and brass bands.

Math is shapes and geometry, statistics, calculus, computer science, analytic geometry and combinatorics.

Music is theory and composition. **Math** is logic, reasoning, proofs and problem solving.

We all know at least a little about Bach, Beethoven and Mozart, Louis Armstrong and Leonard Cohen. How many people know that Galois was killed in a politically motivated duel, and spent the whole night before his death writing up his mathematical discoveries so they would not be lost to the world on the morrow? Or that Gauss was a bright little boy, and when his teacher, to keep him busy, gave him the task of adding all the numbers from 1 to 100, he came back minutes later with the solution? He had paired the number 1 with 100, 2 with 99, 3 with 98 and so on, giving 50 pairs, each summing to 101. The total is $50 \times 101 = 5050$.

More of us may have heard of Fermat's Last Theorem. Some three hundred years ago, after Fermat's death, a note was found in the margin of one of his books, to the effect that he had a wonderful proof of this theorem but that he could not write it down because the margin was too small. This theorem has fascinated and eluded mathematicians ever since, until in 1993, it was finally proved by Andrew Wiles. (The proof was checked over very carefully by the mathematics community!) The news made the front page of the New York Times! ***And there are other stories about Fibonacci and Descartes, Pascal and Newton. Wouldn't it make math more interesting to a youngster if it were put into the context of its stories?*** Would that not help build a relationship between student and subject?

You can learn about a period in history by studying the music (or art or literature) that came out of it. In much the same way, the topics mathematicians are interested in reflect the society of their time. Not surprisingly, much of math research today has a computer connection. (For a very readable novel about math history, see Denis Guedj's book *The Parrot's Theorem*.)

Neither list is complete, but you get the picture. So what can we say that math is -- in its totality?

Math is a description of the order God has put into His creation. That can be seen in the consistency with which two plus two equal four regardless of what kind of objects you are summing. We find patterns in numbers and discover that they describe the patterns we can find in creation (consider the Fibonacci numbers). The orbits of the planets can be described by equations, as can the shape of the shell of a snail. Mathematicians extend mathematical concepts, thinking they are just following the imaginations of their minds and find that once again they have just given a description of some other aspect of God's creation (as with imaginary numbers).

HOW DO WE TEACH MATH TO OUR CHILDREN?

Oh, but enough lofty philosophizing. We have to get junior to do his lesson every day. What do we actually do in the math portion of our homeschool day? How do we plan? What curriculum do we choose?

Well, let's start with the last of these. But I definitely will not leave it there. There are a lot of curricula out there, and after only three years of homeschooling I am not an expert on these. The best I can do is suggest you consider carefully the following:

1. What is your child's learning style? *The Way they Learn* by Cynthia Tobias is one good source of information for this.
2. Does the curriculum teach and encourage the child to think, to understand the concepts? Or does it just give pages of arithmetic worksheets?
3. Does the curriculum have manipulatives for the visual or tactile learner?
4. Is it something that you, the parent can work with? You may have to put in some significant effort if your child is to succeed. (That is one of my pet peeves --a parent complaining that a math curriculum cannot be done independently by the child. Would that parent expect the child to learn to read independently just by using a phonics program? Math does take parental involvement, especially in the early years.)

Now, once you've got the curriculum, you've got the backbone of your math taken care of. Ah, but you have to implement it. How many parents have assigned a math lesson that should take 20 minutes, and 2 hours later it is still not done? You can lead a horse to water ...

Again, CM to the rescue. CM advocates short lessons, and I believe this is very applicable to the study of math. My personal approach is to assign a certain length of time for math, not a certain amount of work. While three pages may seem to the child to be an insurmountable obstacle, 10 minutes isn't. Adapt the time depending on age. A young child may not be able to concentrate for more than 10 minutes. If I may judge from my highschool teaching experience, even an older child can't concentrate for more than 45 minutes or so. Surely 20 minutes of concentrated work is better than 2 hours of dawdling. Often I set the timer (!) for 10-12 minutes, give a 5 minute break, and then another 10 minutes. During the work time I expect concentrated work.

Now, the above applies to the math time spent actually sitting down with books or paper and pencil. This is the backbone of the math program, and keeps you on track. I strongly believe that to have a 'generous' education in math, the child has to have a much wider experience with it.

At a homeschool workshop I attended recently, the speaker was an expert in the theory of learning. One thing he said really struck me. **He said that we learn by comparing new information with previous knowledge.** It is obvious when you think about it, isn't it? He described the learning mind as being a velcro ball, the velcro being all the things you know at present. New information comes along, and sticks to the velcro. So to learn something totally new is much harder than to learn something about which you have some previous knowledge.

As usual my mind was taking this 'new information' and applying it to the study of math. It was one of these 'aha!' experiences. I think this is something I've known for a long time, but never heard expressed in those words. It explains why it is so beneficial to do activities and games which use mathematical concepts and reasoning. Such activities prepare the brain, by giving it the 'previous knowledge' it needs for the formal math lessons to 'stick'.

I believe that most of a young child's understanding of the basic concepts of math could and should come, not from his math curriculum, but from other experiences and reading. There are a lot of books, games, online activities, etc. that one can take advantage of. I will just point out several resources I have found useful.

1. Games such as Monopoly, Snakes and Ladders, Set, Rummy-O, Battleships, and many more develop skills that are useful for the understanding and formal study of mathematics. Some involve the practice of arithmetic. Others ask a child to find patterns in numbers or shapes. Your family probably has some favourites and might enjoy trying new games.

2. Find some books of games or activities that are mathematical in nature. Marilyn Burns has written several that should be available in most public libraries. *_Math For the Very Young: A Handbook of Activities for Parents and Teachers_* by Lydia Polonsky et al has lots of wonderful ideas. Peggy Kaye's *_Games for Math_* is an excellent source of games for practice of specific skills or concepts.

3. Your local public library will also have many other children's books dealing with mathematical subjects. If you have access to an online catalogue, look for books by Loreen Leedy, Pat Hutchins, Marilyn Burns, Amy Axelrod, Mitsumasa Anno and others. Search by subject to find books on counting, shapes or numbers for the little ones, addition or subtraction and other operations for the elementary student, geometry, statistics or any other mathematical sounding word you can think of for the older student. There are series of books such as 'Young math books', 'Math Start', 'Hello Math Reader' and others. For the older child there are 'Exploring Mathematics' and 'World of Science'. It takes little effort to find such books, and reading them is enjoyable even for the child who finds math a challenge.

With these practical suggestions, I will conclude. I hope that this article has given every reader something to think about and ideas which inspire you in your homeschooling task. Mathematics is not only a necessary school subject and an important part of what our children will need in their adult lives. It is a way to examine and understand the world in which we live --to see the order in the creation around us. If we approach it as an exciting challenge, and encourage our children to see the math all around them, we will be giving them a generous education in mathematics.

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