Interview by Michael Worboys

MW. Professor Matthews, at different stages in your career, you have been involved in the mathematical education of children of a wide variety of ages. To begin with the secondary school, you are well-known for your involvement in the St. Dunstan’s Project (Contemporary School Mathematics Series). Would you briefly describe this project, your part in it, and how it fitted in with the secondary reforms that were beginning at that time?

GM. Well, it was perhaps the first secondary reform that started at that time. Certainly I gave the first lesson in the United Kingdom on matrices, and this was the birth of the St. Dunstan’s venture. I used to have old boys who came back to see us in time for the coffee break at school. One group came from a university I had better not mention, and told me that they had an appalling lecturer on a subject called matrices. They suggested that if I could give some of the future 6th formers an idea of what a matrix was, then the St. Dunstan’s boys would be one up on everybody else at the university. That is how it all started. I had just finished my doctorate on infinite matrices. I didn’t know much about finite ones, but I thought I had better find out. It seemed to me that the most interesting thing was that AB did not always equal BA. I devised the now notorious Yogi Bear routine, which I have since been trying to live down. This was a coding introduction to matrices, and I tried it out on the current 6th form, who were amused. I left it on the blackboard; the 5th form came in, and after a few days, it had got down to the 1st form, where it stayed. It was about 1958, and I started thinking about finding out what was going on in the mathematics curriculum. There was restlessness among the whole staff about the old “O” level. Various words came to my attention, e.g., set, computer, statistics; and I set members of my staff the task of finding out about particular topics. Eventually we started teaching them to the 3rd and 4th forms.

I gave a lecture to the Mathematical Association in about 1960 called “Matrices for the Million” which became well-known. A very enterprising man named John Morgan, who was managing director of Edward Arnold came to lunch and announced that he would like us to write some booklets. The whole thing was managed after lunch. We decided to write little booklets to supplement the old Durell and other standard texts. Afterwards, people said that it was not clear what should be left out of the older books, so my successors at St. Dunstan’s wrote course books to go with the booklets.

I think that historically we were the first in the field. In fact, SMP and ourselves asked for special “O”-level papers within about a fortnight of each other.

MW. Is the St. Dunstan’s Project still running?

GM. It had rather a happy outcome. The MEI (Mathematics in Education and Industry) project in the North London schools was very interested in “A” level. They produced a new “A” level based on their excursions into industry, and they were looking round for an “O” level. I had left St. Dunstan’s at the point where we had done an “O” level but not an “A” level so that it was a very natural take-over bid. Our “O” level survives to this day as MEI (St. Dunstan’s).

MW. How do you feel now about the introduction of these newer topics into the secondary school curriculum? There seems to be a reaction against them in some quarters.

GM. I think that we all made a tremendous number of mistakes in the beginning. I am totally unrepentant, because the time had come to do something, and if you are going to do anything, you will make a mistake. What I like particularly about SMP is the way that they are keeping going. Some of their first efforts were pretty disastrous, but they are keeping on rewriting. MEI are looking at the St. Dunstan’s “O” level again at the moment. I think that this is the way that we will stop the need for the awful revolution of the early 1960s, by having a continuous creation of curriculum rather than letting it fossilise.

MW. At present, part of your work relates to the CSMS (Concepts in Secondary Mathematics and Science) project. Is this a development of your earlier work at St. Dunstan’s?

GM. Only loosely. St. Dunstan’s was comparatively a slapdash effort. This is not meant derogatively, because SMP and all the others were slapdash as well! They were slapdash in the sense that nobody knew the order in which children learn things or the stages at which children are capable of learning things. This led to quite a lot of unpleasantness in classrooms through teachers trying to teach children things which were totally unsuitable and probably too difficult. In some cases perhaps they were too easy. It was in the back of my mind during the St. Dunstan’s days, that one day somebody ought to do something a little more scientific
in finding out what mathematics was relevant, and what the children were capable of understanding.

In the Nuffield Project, we were able to identify a partially-ordered map of what children were capable of learning. It’s a very complicated tree with numerical and spatial sides. It was being able to pinpoint so much better at primary level the “tree of knowledge” which made me think that we should have a go at this at secondary level. This is much more difficult. People really know very little about formal operational thinking. I light-heartedly put in for an enormous grant from the Social Science Research Council, which to my amazement came through. So now CSMS is trying to get the Nuffield concept map into the secondary level, in science also. Already, we are beginning to get results, which are well-proven, showing what children are really capable of doing. I am sure that this will have a much bigger effect than anything else that I have touched in helping mathematics education to be a sensible and pleasant subject.

MW. There seems to be a great divide between research in education and what goes on in the classroom. What, if any, of the current research should the teacher in the classroom be aware of, and influenced by? Can you see any big gaps to be filled?

GM. I like to think that CSMS is filling a gap. I would agree that many people have been researching into the most abstruse topics, which seem to have very little relevance to the classroom. CSMS is thoroughly classroom based, and our aim is to help the teacher. Another interesting piece of research was Neville Bennett’s up at Lancaster. To my mind the message was that it didn’t matter very much whether you called yourself formal or informal. The important thing was to have a framework. My wife’s infant school is a marvelous place. A classroom may look completely chaotic, but scratch under the surface and you will see that the teacher has a flow diagram, and a very definite knowledge of exactly where each child is. Those children, for at least part of the day, are being pushed at their threshold. It doesn’t matter much to me whether everyone is silent or noisy; progressive or ancient, provided that the framework exists.

MW. Where can we find the results of the research done by CSMS?

GM. That’s a particularly happy question because the answer is in Mathematics in School, where can be found some of the first fruits of this work. Some of the individual tests of ability in separate topics are being published by the National Foundation for Educational Research. More important is to find out whether there are common mathematical concepts which hold children up at a certain level across the board. We are still working on that one, but I promise you that Mathematics in School shall have the results as soon as anyone does.

MW. I believe that you have had connections with the work of Jean Piaget. In what way do you think that his theories should influence the teacher?

GM. I think that Piaget is the best educational psychologist that we have. His influence has been enormous. Sometimes his writings have been obscure. It’s rather like the Bible, in that you can prove anything by reading Piaget, and this has led to a lot of misconceptions about him. He has personally denied to me many of the things which he is said to have said. He got really angry when I mentioned the word “test” one day. He said “Jamais! I have nothing to do with tests”. One of the troubles with Piaget is that he himself was not particularly interested in teaching, but in the theory of knowledge. It was really only through the Nuffield Project, to the amazement of his colleagues, that he suddenly realised that it might be a good idea to be of some use to teachers. I am sure that his ideas at primary level are sound, and the Nuffield concept map is largely based on his work. When it comes to secondary level, Piaget has said remarkably little about mathematics.

MW. Going back to the Nuffield Project, one of the aims stated in Mathematics Begins1 is “... the children must be set free to make their own discoveries and think for themselves, and so achieve understanding, instead of learning off mysterious drills”. Do you continue to stand by this statement?

GM. Yes. Perhaps it wants qualifying to the extent that you can’t discover everything on your own. I would stick by the fact that if you give children the chance of discovering certain key things, then they will take for granted that other things could have been discovered if there had been time. Without this, you are back in the days of brainwashing, algorithms and rote, and an absolutely established fear and hatred of mathematics, as you can see by asking almost anybody in the street. It was this absence of the joy of discovery which I am sure is directly responsible for this hatred. One needs to balance everything; the old and the new, the discovery and the rote.

MW. How do you see the impact in the primary school of Harold Fletcher’s series Mathematics for Schools?

GM. Harold Fletcher was a most valued member of the Nuffield team. I’m not going into how right or wrong he was to write the series Mathematics for Schools, but I am quite sure that a lot of people have abused it. The philosophy behind it was pure Nuffield, and I’m sure that Fletcher would not have wanted children to simply go down the lines in his linear booklets. You completely lose the whole effect of the child’s environment. I’m not sure that they should have been published at all, but they certainly have been misused by teachers, probably under pressure of time and the fact that the thing looks like a package.

MW. Would you say something about the project Early Mathematical Experiences2 which you are presently involved in? The most important early school experience that a child has must surely be to learn to read. How do you see mathematics fitting in at this stage?

GM. If I could only teach a child one thing before he had left infant school, it would be to read. Having said which, I am sure that one can do the two together. An extension of the Nuffield Project is now in the process of producing pupil material. One of the things that they are producing is a series of about 20 booklets, which look like readers but in fact are mathematically involved with concept phrases like “taller than” and this is a tremendous contribution to getting across the barrier between mathematics and reading.

Concerning the Early Mathematical Experiences project, I took on the job of co-director with my wife with amazement when I was asked to do it, because I knew very little about young children. Luckily my wife knew more. It was quite sure that the Schools Council Working Paper 41 was on the wrong track, when it suggested as a possibility for the nursery, “simple addition and subtraction sums”. We had to ask the nursery teachers and others concerned with children from 3 years upwards; what they thought early mathematical experiences were. To my delight, it came out to be the top row of my Nuffield concept map — words like sorting, ordering and matching. Of course, for children of that very young age, the concepts are essential before the skills.
Ratio is a topic long recognised as difficult by both Mathematics and Science teachers but agreed by both to be very important. Previous research has emphasised the difficulty of the topic. Piaget declares the true understanding of Ratio to be a task requiring formal level reasoning (The Growth of Logical Thinking). Children performing the Piagetian tasks on enlargement will assume any enlargement is sufficient or decide on a fixed degree of enlargement (one unit or two units) no matter what the question demands (Epistemologie et Psychologie de la Fonction, 1968), Karplus (Proportional Reasoning and Control of Variables in 7 Countries, 1975) further demonstrated a marked lack of achievement on a question involving an enlargement in the ratio 3:2 and also found a large incidence of the "Addition" strategy. This incorrect strategy for dealing with a Ratio problem involves the child concentrating on the difference a-b rather than a:b. The Ratio test given by CSMS, to some extent shows for us all telling the same story. We are such anarchists in this country. There are so many different approaches that, although none of us would accept a laid down syllabus from the Ministry, a little more thought towards what we are doing, and whether we shouldn’t all be doing more or less the same thing, is only to the good. I am afraid that this will annoy some progressive people, but things are a little out of control with all the private armies pulling in different directions.

Another thing which has come out of the great debate is the setting up of links with industry. One of my smaller ventures has been a project concerned with London Transport and the problem of the craft apprentices. We shall shortly be issuing what I think is a very interesting report showing that the thing is not black and white. The more we can get together with industry, the better.

References
2. Early Mathematical Experiences. (To be published by Addison-Wesley in January 1978.)
3. Nuffield Mathematics 5-11 Project (To be published by Longman in 1979.)