Observation Lessons

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Observation lessons seem to be a curiously local phenomenon. They were used by Caleb Gattegno in London in the 1950's as a teacher training technique, and when he founded the Association for Teaching Aids in Mathematics (later the Association of Teachers of Mathematics, or ATM) it was a technique adopted by members running sessions at branch meetings or annual conferences Since then it has remained almost exclusively a prerogative of ATM members.

The first observation lesson I ever saw was in fact given by Gattegno. That was at the Institute of Education in London in December, 1959, so I can be forgiven for not remembering much more than a piece of string and a stick of chalk, an oft-repeated question ("What is it?") which never seemed to educe an answer that satisfied the teacher, and a general air of bewilderment among the audience, me included. And if I am to be forgiven, then it is not so much because time has erased things from my memory, but perhaps because in 1959 I was much younger and less experienced and I failed to see more that was worth remembering

I began to accustom myself to observation lessons in the early 1960's, when the ATM Research and Development Group, which comprised about twenty people, had regular weekend meetings, with a lesson traditionally given by one of us on the Saturday morning. I took some time to get used to both the lesson itself and the discussion afterwards. In the lesson I tried hard to see what the *teacher* was getting at, and found myself mentally taking his or her place and wanting to do it differently Yet the discussion always centred on the *children*, and what they were doing, and I became frustrated because others could see things that I could not, and talked about things that I did not understand.

Generally, lessons given at ATM meetings were easier to cope with. They were called "demonstration" lessons, and I could see that they were set up to do just that, to demonstrate a method of teaching a particular topic, perhaps They were easier to replicate back in one's own classroom, so they were more "relevant" and "useful" Some conference members found this out shortly after the 1961 conference, when their children came home from school and related an unusual lesson they had had from their normally traditional mathematics teacher, which turned out to be one of two given by Georges Papy at the conference!

Papy it was who first demonstrated for me one important teaching principle. He had set up one of his arrow diagrams (known thereafter as "Papygraphs") representing the class of girls he was teaching, where an arrow meant "has the same initial for her surname as I have for my first name", and after several arrows had been inserted by the pupils, he asked if any girl could point to herself When after a pause none had replied, the class teacher sitting nearby indicated who could do so. Papy gave her a withering look of reproach and disappointment which no one from that conference has ever forgotten

I shall return to the principle But quite by the way a subsidiary rule presented itself for observation lessons, one of two I always give to the observers The first, *Do not talk during the lesson*, is obviously justifiable. The second is never so obvious in its reasoning, until perhaps the lesson begins: *Please don't interfere*! And yet, on the few occasions I have forgotten to issue this second rule, someone has always interfered!

On one occasion some 6-year-olds were playing for the moment with some logiblocs. I then asked them to "tidy up", and as they were doing so I realised that I had forgotten to remove one of the blocks as a prelude to the next activity However, during the play one had fallen on the floor, so that saved me the trouble. They tidied up, after a fashion, and I asked, "Are they all there?" "No," said one of the watching teachers, "there's one on the floor." I felt like Papy must have done, but refrained from the withering look.

Another occasion turned out to be a more extreme case of interference. The children with whom I was working were seated at two tables. For some time I became involved with those at one table. When I turned round to the other table one of the teachers was working with them as though she were a fellow tutor I seemed to have no option but to let her continue!

Apart from the issuing of the two rules, I have often felt the need to explain something about the nature of observation lessons to those about to watch one. Some teachers are used to the situation, but there are always some who are not, and I remember clearly my own struggles to get to grips with what such lessons are about, and exactly what it is one is supposed to be observing.

But what is it? And what exactly is the purpose of observation lessons?

Some things are easy to say (almost too easy!): "Such an occasion is a unique opportunity to watch children working at some mathematics, unhampered by the responsibility for the lesson, or the normal classroom distractions of behaviour problems, other groups in the class, accidents, interruptions "

Well, I have never had any accidents, and in the circumstances in which one gives observation lessons interruptions are rare. So are behaviour problems, but I have occasionally had these and find them very difficult to deal with, not so much because I have forgotten what to do in normal classroom procedures or because I am usually dealing with a strange group of children, but because the ethos of an observation lesson is usually so different from what it sometimes can be in one's own classroom and one is shy of destroying the harmonious and purposeful atmosphere in order to make an issue out of an incident. The saving grace is always that

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the observers find it extremely amusing that the so-called "expert" has trouble getting a 6-year-old to do what he is told, and is forgiven if there are sufficient positive things in the lesson to compensate!

The question of responsibility is not necessarily so easy Being relieved of it sounds like an advantage if the purpose of the exercise is to observe But it also implies a lack of control, and this can prove unsettling for the teacher who is, by the nature of things, accustomed to being the person in control of the lesson. So it does not help one to be an observer if one's reaction is: "Why did he do that? If only he would do this " This may partially account for some of the *anger* I have occasionally met from observers.

The anger also relates to the question of who one is watching. It is all very well asking observers to watch the children, but it is inevitable that they also watch the teacher, and indeed if I am honest they *should* be doing that too, because the lesson is the result of continual interaction between teacher and children, and this interaction is also something that it is important to discuss. I shall return to this later.

It is often necessary to point out the so-called artificiality of the situation. I say "so-called" because the normal classroom, in which up to about 30 children are constrained within unnatural confines of space and time to carry out the whims of one teacher, is also artificial, but it has become a "natural" institution merely because both teachers and children have become used to it However, whether teachers consider their classroom lessons to be natural or not, the observation lesson can have all the extra artificialities of a teacher conducting a one-off session, with a usually smaller group of children than normal, that he has not met before, and probably will not see again

(Geoff Sillitto years ago dealt deftly with the inevitable question that arises after a lesson, usually just when the discussion is beginning to dry up: "What would you do next?" "Oh," said Geoff, "I hadn't planned to do anything next; I knew I was only going to see the children for one session!" That remark, in the early 'sixties, was another significant one for me.)

Two further artificialities are that this already artificial lesson is surrounded by a group of observers, and that they are expecting something *extraordinary* — or why would we all be there together doing this? Indeed, one may ask why we, the in-service providers or whatever we are, put on observation lessons The old-style demonstration lessons were in a sense easier to justify One was saying: here is a way of teaching something that you can use yourself. The only possible objection might have been that it was quicker merely to tell teachers what to do, but that in itself carries with it the logical consequence that the purpose of in-service education *is* to tell teachers what to do.

A further reason for observation lessons emerged incidentally from a day course in the early days of government-funded advisory teachers put on jointly by ATM and the Abbey Wood Mathematics Centre. This was the idea of a "shared experience", something that everyone on a particular course had been through together and could therefore discuss and develop between them. This could be some mathematics they had worked on, a teaching problem they had discussed, a video they had watched, or indeed an observation lesson.

So, one of the things about an observation lesson is that this shared experience provides a stimulus to discussion and development of further ideas.

That means, naturally, that the lesson should provide something worth discussing. And it is here that, for me, the essential "artificiality" of the situation occurs in two different ways.

First, one cannot always treat an observation lesson like a classroom lesson, where perhaps a large part of the time the children may be working quietly on their own or in pairs or groups, because then there is nothing for the observers to observe. Well, one *can* provide something if at the same time the observers can walk round and observe the writings of individuals or the conversations of small groups, or are attached permanently to groups. I have tried this on occasions, and it does have some advantages, but it rather destroys the idea of the "shared experience", and precludes a lot of the things that, as we shall see, can come out of everyone discussing the same activity

This means, then, that a lesson has to be conducted so that there is always something happening that can be observed.

The second, and more positive, aspect of artificiality is that one has the option of *manipulating* the situation, in a way one would perhaps not do in one's own classroom, in order to demonstrate certain things for the observers. Further examples of this will occur in other contexts, but I can give an immediate one.

I was working with a whole class of 7-year-olds in Belfast and they were making triangles on 9-pin nailboards and discussing them. This was going well as a demonstration of what ideas the children had about classifying triangles, and the properties that they were noticing Then in the course of conversation it transpired that one of the triangles, in a particular orientation, was, in the opinion of the class, *not* a triangle. We discussed the number of sides, and they agreed that a triangle had three sides, and even that three-sided shapes were called triangles; but this did not make the triangle in question a triangle

It occurred to me to try to demonstrate to the observing teachers something about the impossibility of giving definitions to 7-year-olds.

> "Look," I said, "*Any* shape which has three sides is always called a triangle Whatever it looks like. So if a shape has three sides, what do we call it?"
> "A triangle "
> "Is *this* a triangle?"
> "No."
> "How many sides has it?"
> "Three "
> "What do we call a shape with three sides?"
> "A triangle."
> "So is this three-sided shape a triangle?"
> "No!"

The children luckily responded in a way that was helpful to the point I wanted to make, but it is not always so easy, and in an observation lesson one is always at the mercy of the children. Most of the time the children have risen to the occasion, but I have had many lessons where it was not all plain sailing.

After one lesson in my early days one teacher began the subsequent discussion by saying, "You didn't teach them anything." Maybe with Geoff Sillitto's example in mind, that had made me very conscious that the purposes of an observation lesson were quite different from those of an ordinary classroom lesson, I managed to reply, "Maybe not. But this is a course for teachers, not for children; did *you* learn anything?" And luckily she admitted that she did!

My most salutary experience was at the 1965 ATM conference. I had by then watched many lessons, and every time I noticed firstly that rarely were the children older than about 11, and secondly that the teacher had never met them before. The conference that year was in West Wickham in south London, so I offered to teach some 14-year-olds from my own school, who could easily be ferried by private car. This was programmed, as was customary in those days, in front of the whole conference of 250 people.

The lesson I planned was typical of most of this class's lessons. I presented them with a new situation, and invited them to work with it.

Nothing happened!

Well, some things did, but very slowly and, to me, painfully. The only question from the observers afterwards was how I managed to leave some chalk lines on the blackboard when I erased the others!

Eric MacDonald took half the children back home, and when he asked them about the lesson, they confessed to trying to think of all the mathematics they had been doing lately to see what it was I wanted!! So perhaps even the children recognised the artificialities in the situation.

(Years later Harold Fletcher made me feel a little better about that lesson. He said he had admired the way I asked questions and then *patiently waited* for answers. If only he had said something about it at the time I might have felt that some of the 250 got something out of the experience other than how to fix chalk lines on a blackboard!)

Just as difficult as the class that says too little can be the one child who says too much. This happened to me at the Second International Congress on Mathematical Education at Exeter in 1972, when one boy (the son of an ATM colleague!) hogged the whole lesson to the exclusion eventually of the rest. The lesson was for the benefit of a working group on in-service education, so the discussion fortunately could be centred on how one deals with observation lessons that go wrong!

But the biggest difficulty about the talkative child is that what he or she says can be so interesting. This happened again some years later at an ATM conference when, with continuing rashness, I agreed to teach a class of 17-year-olds. The one boy who seemed to make sense out of the situation I presented was all too interesting and, in the artificiality of that particular occasion, it seemed worthwhile pursuing his ideas and never mind the others. But I had a hard time justifying this to the observing group, some of whom wanted to preserve at least that "natural" element of normal classroom practice that required that the teacher made sure that *all* children participated.

This is always difficult, and it is made worse by not knowing the children, because I then find it difficult to keep track of who is not participating. This is always something that teachers seem nowadays to pick up on first, and with awareness raised about sex differences they are almost waiting in advance to see if boys take more part than girls.

The degree of participation has sometimes become an interesting point of discussion, when we find that we cannot actually agree about who has participated and who has not. "That girl took no part at all," says one observer. "Ah," says another, "but I was sitting opposite her and I could see that she was doing a lot." Where you are sitting seems to be crucial.

Teachers also begin to recognise that children can participate in different ways. A verbal contribution is not the only possibility: children communicate by gestures, or by actions on the materials they are using. Judgement about participation thus becomes a matter of what is fact and what is conjecture. There are definite phenomena of participation, like speaking and demonstrating or gesticulating. There are other phenomena that enable one only to make conjectures, like facial expressions, smiles, nods, frowns.

One can, as the teacher being observed, choose to make an issue of some of these things during the lesson, by trying to draw out the reticent child, or contain the talkative one, or encourage the child communicating with gestures to verbalise. (This is another example of the "manipulation" of the situation that I mentioned earlier.)

On one occasion, after eight children had come in and distributed themselves, by choice, four girls at one table and four boys at the other, I was soon aware that little response was coming from the girls. I stood in front of them, looking at them and ignoring the boys at the other table, asking questions; the girls remained silent, and the boys replied from the other table!

(We have also experimented with different combinations of children, asking the school to provide girls only, or a mixture of dominant girls and shy boys!)

Maybe what is important is for observers to learn something about the business of observing, and the limitations put on it by such factors as the geography of the room, or whether you have responsibility for the lesson, because it invariably transpires that I as the teacher know less about what goes on than any of the observers. All this can be salutary in getting teachers to consider how much they really know about what goes on in their *own* lessons.

These points about participation often arise early in the subsequent discussion. Even if nothing unbalanced occurs someone will comment, "The girls took part just as much as the boys." (Sometimes I feel that teachers would rather talk about these things than about the mathematics!) It then becomes a problem for me to steer the discussion towards what the children actually said or did by way of mathematical activity.

This is never so easy. There can be as much disagreement about what happened in this respect as there is about the level of participation. That is, there can be differences of opinion *about* what was said or done. Memory can play tricks, of course, and often some teachers will support their claims by reading out the notes they made during the lesson. One advantage of a lesson on video, incidentally, is that it can be played back in order to verify what happened, and that is sometimes a salutary experience for the careful notetaker, because the second time round the perception can be quite different. And sometimes there is conflict between the records of different observers. The whole process of ascertaining what happened is thus shown to be somewhat precarious, as a result of the simultaneous observing of people with different (physical) viewpoints, different expectations, or different preconceptions about children. This is again an unnerving challenge to the cosy feeling that in one's own classroom one knows more about what is happening, because there is no one there to contradict; and the advantage over the giver of observation lessons, that of knowing the children, can be lost in the preconceptions that arise from that very knowledge.

Teachers can thus begin to appreciate that there may be different accounts of what actually took place in a lesson, and that the facts themselves, in terms of what children say or do, can be difficult to ascertain and must be handled with care. They can more readily accept that there will be different opinions about what conclusions can be drawn from the observed facts

One of the never-ending problems, however, is to get people to realise what is *fact* and what is *conjecture* "How do you know that happened?" I often ask "Because I saw it happen," is a different answer from "Because I saw something else happen and so I *assumed* that happened." Once we have managed to sort out the difference between fact and conjecture we can then see that participation, for instance, is very often a matter for conjecture.

The conjectures, in spite of their greater scope for error, are the most important aspects of observation, because on them rely all forms of evaluation, assessment, testing and diagnosis We can only know what ideas children have by forming conjectures as a result of what they say or do. Most people go for the "obvious" explanation. Gattegno had an endearing habit of contradicting the obvious with a justification for the opposite point of view. This is a useful tactic in providing alternative possibilities in particular cases, and generally in dissuading teachers from jumping too easily to conclusions.

Often the "obvious" is a platitudinous and glib attempt at explanation I observed a session recently in which teachers were watching a video of the BBC2 programme [1] called "Twice five plus the wings of a bird" One sequence shows a young boy adding five and three, by adding four and four; when explaining this to the interviewer he demonstrates clearly with his fingers, but has trouble finding the right words. The comment of one of the teachers was, "The language gets in the way of the mathematics."

I queried this, and asked if it was not rather that *the mathematics got in the way of the language*

Maybe that was not quite right either, but it seemed nearer the truth However, the important thing was that it prompted a deeper discussion about what got in the way of what, what skills the child in question did or did not have, and how the business of communicating one's ideas is to do with far more than spoken language. The interviewer, and the viewers, understood what the child meant, so communication had been effected, even though the verbalisation was difficult. In a similar way, *we* understood what the *teacher* meant, so she had communicated with us; and it was only when I focused attention on what she actually said that they realised that it was not correct So my intervention prompted a discussion about the nature of communication, as well as attempting to sharpen up the clarity of the conversation.

What I try to do is to get teachers to behave more mathematically, more analytically, in their conjecturing And often what is necessary is to say that as a result of what we perceive, then various consequences are *possible*. We may wish to attach probabilities to these possibilities, but that is more subjective. It is all to a certain extent subjective anyway, but I am trying to minimise the subjectivity by tightening up the process of deduction. Gattegno would, I hope, have called this being more scientific. If there is to be a "science of education" [2], then it must be based on scientific principles

This process of deduction is something that I also expect from the children A result of this expectation is that a first teaching principle is never to tell the children anything that they can deduce for themselves

Teachers sometimes react strangely to this. "You never tell them anything," is a common comment. (Sometimes this is transferred into: "You never tell *us* anything!" In fact on one occasion during a coffee break a teacher asked me a question, and before I could say anything another interrupted with: "It's no good asking *him*, he never tells you anything." I let the first teacher continue talking until she had answered her own question, and then she suddenly realised this and said, "Oh, I see why you don't answer questions.") The manifestation of the reaction sometimes works in reverse, when a teacher who is used to watching me teach accuses me of telling the children something! This happened once when a group of ten-year-olds who had cut out some rhombuses from folded sheets of paper insisted on calling them "diamonds". I told them, after a little discussion, that the correct word was "rhombus". In a way this counter-example enabled the subsequent discussion to clarify the principle more easily. There was no way in which the children could *deduce* the word rhombus: it was something they had to be told

A consequence of this first principle, that one does not tell children what they can deduce for themselves, is that one does not correct mistakes

Alas, the videotape is now lost of the lesson years ago with a class in my own school, when, in the course of an investigation about transformations on a grid of equilateral triangles, someone suggested that two of the angles (of 60 degrees) made a right angle, and this was accepted without question by the rest of the class I did not interfere. The discussion continued. Some 20 minutes later a contradiction arose; the class traced back their arguments, and realised they had made a wrong assumption about the right angle.

The video, as far as I know, was never used. But, at the time it was made, the head of the modern languages department at the school was watching on a monitor, and she commented on her amazement, not just that I did not correct the error, but that I could let it go for so long. Mathematics teachers, those who are unused to such principles, are amazed in a different way! And this is when anger becomes apparent.

In Ontario in 1980 teachers were obviously not ready for such heresies. At a summer course someone had assembled for me a group of about thirty children of various ages in front of the same number of elementary teachers. I began by saying, "The answer is 10; what is the question?" This is a favourite opening, because after the initial shock (someone usually answers "Five plus five", and then they wait for the next question!) it always produces a wealth of ideas from the children. As usual, I wrote everything they suggested on the chalkboard. And as usual, after some time someone suggested something that was incorrect.

In my customary way, I wrote this down in the same way as I had everything else. This produced a ripple of obvious discontent among the children, and an even bigger one among the teachers! Ignoring the latter, I asked the children if there was something wrong; that is, if there was something wrong with *them*, not something wrong with the mathematics. But they politely declined to admit anything. So we continued with further suggestions, and as two further incorrect ones were handled by me in exactly the same way further ripples went through children and teachers, but each time my queries to the children brought the same polite denials.

Eventually one boy looked so discomforted that I managed to persuade him to tell me what was troubling him, and with the same politeness that had inhibited the whole group he tentatively asked if there was not something wrong with some of the statements I had written.

The children later retired, and I faced the barrage of angry comments from the teachers. It was among *their* principles that mistakes should be corrected immediately, before children assimilated them as correct, and that on no account should incorrect statements be written down, because that was how children would remember them.

I seem to remember that I commented on the strange unwillingness of the children to correct each other, and the reticence to query what I had written down, which obviously followed from the tradition of the teacher having control of right and wrong. But there was little I could do on this one-off occasion to mollify the anger.

The argument about the infallibility of the written word has been raised on many occasions. It cropped up in the early days of the Certificate of Secondary Education [3] during discussions of multiple choice questions, with members of examination panels finding it hard even in that setting to reconcile themselves to a betrayal of their principle. It was useless, both then and on the occasion in Ontario, to compare the education of children in English lessons where they were perhaps taught not to believe everything they read in the newspapers!

In a way it is good that the anger shows, because whatever one decides to do about it, or is *able* to do about it, one is at least aware of it. This was not so on one occasion when I worked for another education authority, and the observation lesson went in a similar way to the one in Ontario. Judy Morgan, the mathematics adviser who had invited me, told me later of the anger which erupted after I left. But in a way it was an easier situation, because the anger could be released without any inhibitions, and because Judy could explore the reasons for it with the teachers in a more detached way. It is more difficult to discuss one's anger rationally with the person with whom one is angry, or even with him present.

The principle of not correcting errors is not *solely* due to general ideas about who has control of learning, though this is obviously important; it also has considerations peculiar to mathematics. It relates to the principle of children being able to deduce things for themselves, because, as the example of the right angle showed, it is possible to deduce errors from subsequent contradictions that arise; and this, I believe, is a skill that children should be allowed to develop, from when they first start to learn mathematics.

It is also desirable that children develop a critical approach to other people's mathematics. So it was a natural part of my teaching always to invite ideas from the class, and then to ask for judgements about the ideas offered, with criticism and justification, argument and counter-argument. *They* had to decide what was correct or not, and my role, after presentation of the initial problem or situation, became more that of chairperson than even that of arbiter.

This ability to be critical paid off in an unexpected way when three boys in the sixth form wanted to take SMP Further Mathematics at Advanced Level [4]. No-one else in the school's mathematics department felt able to take on the syllabus, and I had already moved next door into the Mathematics Centre. So I agreed to see them about once a week for a tutorial, but admitted that there was a lot of mathematics with which I was not familiar so they would have to do it largely on their own. This seemed sensible, since *I* was not taking the examination, *they* were, and it was more important that they knew the mathematics than that I did!

At the time the only texts available were in draft form, and they were full of mistakes! This meant that the three had to read more carefully than they otherwise might have done, and it was essential now not to believe everything they read. Their ability to teach themselves showed first in the "tutorials", when most of the time I merely had to answer questions like "I don't see how they get this line from that" (usually an error that I could put right, even if I was not familiar with the context!), and second in the examination, which they passed well.

In the normal classroom setting it was probably difficult for me initially to avoid making judgements on the responses of the children. I had to develop techniques for being non-committal. One has only to read John Holt [5] to see how easy it is unwittingly to betray one's opinions with body language or voice inflection, by being selective or by biassing one's reactions. So early on I worked on the necessary techniques until I thought they had become second nature. But I had a small shock one day from my sixth form, most of whom I had been teaching for six years. I had asked a question, and I had written someone's answer on the blackboard, and as usual I was waiting for them to decide whether it was correct or not. Suddenly Bill said to Graham, just loudly enough for me to hear, "It must be right, because he's got the chalk in his right hand and the blackboard rubber in his left!" For some reason or other I just laughed and never followed it up, and I like to think that Bill was pulling my leg; but sometimes I have wondered whether all my efforts at disguise were in vain, or could be undermined by the habits of the class's other teachers, or even whether Bill had been reading John Holt!

The principle of non-correction of errors leaves only one worry: what happens if the children do not notice one?

In the classroom one can decide to leave it to the next lesson, or, in a secondary school, set an appropriate homework! But an observation lesson has no follow-up, so that very often a decision has to be made about letting a strange group of children leave without something being corrected, a decision that not only considers them but also considers the teachers watching.

Luckily the situation rarely arises, because usually the children discover errors before the lesson finishes Often I feel this is due to subtleties of teaching that are difficult to analyse: the more pointed question, the gesture that changes the focus of attention, a steering onto a different track that will lead back to the error, a fresh example that will lead to a contradiction, or even a blatant query about whether something is correct! And on many occasions when time is flexible the finish can be delayed until the error has been detected!!

Teachers have sometimes asked, "What would you have done if the children hadn't spotted that mistake?" I have had to answer that I did not really know, that in my experience children always found the mistake before the end of the lesson, and perhaps they, the teachers, could think about what it was I did that assisted the children in the discovery

Only once did I consciously decide to leave an error uncorrected. It was another session with the beginning, "The answer is 10", and towards the end the group of eight-year-olds embarked on a series of subtractions which culminated in "a million and ten minus a million". I asked how I should write a million, and they told me, "a one with four noughts", so after a similar interchange about how to write a million and ten I wrote:

$$10{,}010 - 10{,}000 = 10$$

And at that stage, when the children did have to leave on time, I reckoned that it would be ambitious to go into the notation for a million, and perhaps inappropriate for eight-year-olds anyway, so I left it, thinking that no harm was done.

The members of the London Branch of ATM thought otherwise, and I was severely taken to task for leaving those children with the everlasting impression that a million was 10,000. Would that children could always remember such knowledge on such short acquaintance! Well, I think I admitted at the time that it would have been easy enough to put the children right. They could not have deduced the information for themselves, so I could have done so without going against any principles

What also tends to upset teachers, though, is the way an observation lesson can sometimes be left hanging in mid-air, so-to-speak I first realised it at a Schools Mathematics Project conference in 1963. We watched a film of a delightful lesson given by David Page who was then with the Madison Project in the United States One prominent remark made in the subsequent discussion was, "I would have felt better if at the end he had *rounded things off* by summing up for the children what they had learnt."

This remark raises all sorts of questions about how we tell what children have learnt, and whether everyone in a class has learnt the same thing, as well as whether a film designed for in-service education should preempt discussion about these very things. To be fair to the SMP commentator, he was thinking not of the conference audience but of the children And yet, some of the same questions are still pertinent if we consider lessons in general, and whether it is appropriate for the teacher to "sum up" at the end of a lesson.

In yet another observation lesson which began with "The answer is 10, what is the question?" a group of ten-year-olds were eventually working on all possible ways of adding *two* numbers to obtain ten, and had justified their conclusions, when one boy said, "What about seven-and-a-half and two-and-a-half?" "Two-and-a-half is not one number, it's two numbers," said another; "two, and a half." "No, it's three numbers," said a third, indicating the whole number, the numerator and the denominator. The argument continued I concluded the lesson as I usually did merely by thanking them for coming, but they were still arguing fiercely as they walked out of the room!

I pointed out to the observing teachers what a nice way it was to end a lesson, and they agreed.

Not so a group of primary inspectors, who as part of their own in-service day on mathematics watched me work with a group of ten-year-olds with calculators. We worked on a series of problems, and it was clear to me that the last one was going to be a little difficult for them, so I more or less said so to them, and suggested that as it was time for their lunch they go off and think about it later if they wanted to

This raised the anger of some of the inspectors, who seemed mainly to be concerned about the worry it would give the children because they had gone away without solving that last problem. I found it very difficult to persuade them that in the first place it was unlikely that they would remember anything about the problem once they got out of the door, but on the other hand that it might be nice if they went away sufficiently interested in it to want to carry on working on it.

But again I felt that the real worry on the part of the inspectors was the feeling that things had been left in mid-air, and that an apparent concern for the children disguised their own discomfort which was caused by the lack of resolution.

The other worry about that session was the perpetual one of matching the problems one sets to an unknown group of children. Sometimes one has to struggle a little to find the right level, a generally crucial issue if one believes that if problems are too easy then this can be as off-putting as when they are too difficult, because problems must have enough of a challenge to be interesting and worth solving. This necessitates a certain amount of flexibility, and a willingness to change course if the situation demands it

A change of plan may be necessary because of the general level of difficulty, or because an essential piece of mathematics is missing. An observation lesson in a local school began easily enough with an exploration of the effect of pressing "times, equals" on a calculator with an automatic constant on multiplication (it squares the number previously entered). We squared various numbers this way, and I began to ask what we could square to obtain numbers like 49 or 121 Then I asked what we could square to get 10 The class decided that 3 was too small, and 4 was too big, so it had to be between 3 and 4, but "there wasn't a number between 3 and 4"! What does one do? One can abandon the idea and go back to larger perfect squares. Or one can try, as I did on this occasion, to pursue the matter (with a patience that was later commented on!), meeting insecurity about fractions and an almost complete lack of knowledge about decimals from the class of ten-year-olds.

We began to develop ideas about decimals anyway, as one can with a calculator in this sort of situation. In fact this possibility is often a surprise in itself to teachers who have never considered it. But it does rely on something from the children.

Very occasionally the children surprise one in delightful ways. One Saturday morning in Cornwall the only children available for a teachers' course were a group ranging in age from six to ten. I began by finding out what they knew about decimals, and it seemed that only the ten-year-olds had met them, but even *their* knowledge was shaky. However, we embarked on a similar series of calculator problems that developed from whole number solutions to fractions, with the ten-year-olds leading the way. Then in the middle of everything it was the *six-year-old* who suggested, "Try two-point-five."

It is wonderful to be able occasionally to share such delights with other teachers. But in order to do so one must be prepared to take risks. One risks "failure", the possibility that nothing will happen, or that the "wrong" things will happen. One risks anger and alienation. But one can never be *safe* with children, and in mounting observation lessons one is exposing oneself in order that everyone may learn something.

Indeed, one must do more. I was engaged in helping with a course at another mathematics centre, and after one of my days, which included a lesson with children, I sat down with the course tutors to discuss it. One of them suggested I had "threatened" the teachers, and we discussed why. The reasons seemed to have something to do with the way I taught, not telling, not saying whether things were correct, not praising.

We discussed the difference between being "threatening" and "challenging", and the idea that which of the two it was depended perhaps on the confidence of the person on the receiving end. But when I asked what the purpose of in-service education was, the tutor answered that it was to *change* teachers. I would not have put it quite like that myself, but I did suggest that if this were the aim then one could not achieve change without implying in some way that what the teachers were already doing needed to be changed, and hence the need at least to challenge.

The way I *would* put it, and indeed have put it to teachers, is that the purpose of my standing up in front of them and teaching children is not that they go away and teach like me, but that they use what they see in order to think about what they do themselves.

That is, of course, admitting that they inevitably are going to observe the teacher. But I still want them to concentrate on what the children do.

When, in 1961, the Research and Development Panel of ATM first got together, we were discussing what books we should read in order to learn more about children learning mathematics. Caleb Gattegno happened to be present. He reprimanded us severely, and told us that we were all teachers of children, and if we wanted to learn about them we only had to observe them. Maybe it was then that the true observation lesson was born.

Notes

[1] Twice five plus the wings of a bird, Horizon, BBC2, April 1986.

[2] See C Gattegno: A prelude to the science of education, *Mathematics Teaching* No. 59, 1972

[3] The Certificate of Secondary Education was an examination for 16-year-olds instituted in 1965, for which local panels of teachers set questions

[4] The School Mathematics Project (SMP) instituted examinations in "modern" mathematics in the 1960's. Advanced level of the General Certificate of Education is an examination taken by 18-year-old students, and Further Mathematics is normally taken a year later

[5] J Holt: *How children fail*. Pitman, 1964