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Improving Learning in Schools — An In-Service Problem

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A central function of in-service education is to improve educational standards within schools. There are, however, few case studies which show how particular forms of in-service support have influenced improvements in classroom practice. The case study below describes how the in-service support from Bath University Science Centre influenced improvements in learning for 11-14 year olds in mixed ability science groups.

The Form of In-Service Support

In February 1974 the following form of in-service support was offered to science teachers from Bath University Science Centre. "If four or more members of a department wish to move towards enquiry learning a tutor will attend weekly or fortnightly meetings at a school to plan syllabuses and particpate in the production of resources. For schools with one or two members of staff interested in specific curriculum changes we will organise meetings with teachers from three or four schools. We also hope to develop an evaluation service with you. This will entail video taping, interviews, and practical problem solving situations with each other and the pupils".

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This form of in-service education was based upon the following assumptions

1) Teachers could isolate the problems they experienced when they were not living their intentions in practice.
2) Within the science teachers' intentions was a view of scientific thinking which accepted that asking questions was a necessary component of this type of thinking.
3) Teachers needed easy access to resources which would help solve their problems.
4) Teachers could evaluate the contradictions between intentions and practice when presented with objective evidence. Evaluate, that is, in terms of the relations involved in the transformation of intentions into practice.

1. Isolating the Problems

In February 1974, a group of 6 science teachers from 3 comprehensive schools discussed their problems with a lecturer from the Bath Science Centre and committed themselves to work together to design, produce, organise and evaluate enquiry learning situations for 11-14 year olds in mixed ability groups.

The lecturer taped conversations with the teachers in which they explored their intentions, what they were doing in practice and what they could do about the differences, with the following results.

A) The Teachers' Intentions

The teachers intended to establish a learning situation in which the pupils gained an understanding of science, as a body of knowledge, a way of solving problems and a creative activity in which knowledge was generated. In relation to science as a creative activity they intended to create an atmosphere in which the pupils experienced freedom, trust and security to express and pursue personally and socially valued scientific enquiries.

B) The Teachers Classroom Practice

In practice, the teachers found themselves attempting to convey the same scientific body of knowledge to pupils of different abilities at the same time. They were aware of addressing the middle ability group and "missing" the more and less able. They were conscious that the relations or resources which would give the pupils the opportunity to pursue their own scientific enquiries did not exist.

C) What could be done?

At a meeting in March 1974 the teachers agreed that the most urgent problem was the design and production of independent learning resources. These resources would allow the pupils to work at different rates with some degree of freedom, choice and independence. The account which follows, describes how a network of in-service support has evolved, between educational institutions, in response to the teachers'

problems. This network involves giving the teachers access to the resources of:

1) The Schools Council, Wiltshire LEA and Bath University.
2) The Association for Science Education and Independent Learning in Science.
3) The Avon Resources for Learning Unit.
4) The Department of Education and Science.

This account is followed by examples of how a particular process of evaluation influenced improvements in teachers' and pupils' practice.

II Access to Resources

(1) The Schools Council, Wiltshire LEA and Bath University.

By the end of April 1974 it was obvious to the group that the increasing need for paper, duplicating equipment, secretarial, teacher and lecturers' time could not be met within informal procedures. As the Schools Council had expressed its commitment to support local curriculum development projects, £6000 was requested for teacher secondment, resources and reprographic assistance.

The initial draft proposal was drawn up by the lecturer and submitted to the teachers and LEA advisors for criticism and amendment. The final proposal was submitted by the lecturer to the Council with a letter of support from the C.E.O. of Wiltshire LEA. The Head of the School of Education at Bath University agreed with LEA officials that the lecturer should direct the project on a one day a week secondment.

The process of formalising the in-service procedures nearly resulted in the abandonment of the project. When the procedures were informal, and improvements resulted from personal commitment rather than institutional role expectations, the teachers worked co-operatively, yet critically, in secure and trusting relations.

As the procedures began to be formalised, LEA advisors came to watch rather than participate and the teachers became so uneasy that productive activity nearly stopped between June '74 and January '75. In January 1975, however, the Schools Council formalised its support and other teachers began to attend meetings and share their resources. A second group of teachers formed in Salisbury in April 1975 in the same way that the Swindon group formed in February '74. This process of growth has continued.

(2) The Association for Science Education and Independent Learning in Science (ILIS)

Between September-December 1973 the members of Independent Learning in Science contributed copies of their resources to the Science Centre at Bath. These resources were extremely valuable in stimulating the teachers' imagination to see ways of improving standards in their mixed ability science groups. This resource collection has been used extensively by science teachers in the area and the decision of the Association for Science Education to form a joint ASE/ILIS collection of Resources for mixed ability teaching, has made the resource collection at Bath University the most comprehensive in the Country.

(3) The Avon Resources for Learning Development Unit (RFLDU)

This Unit is a teachers' co-operative, planned, managed and operated by teachers for teachers. The aim is to produce an organisation to promote independent resource based learning in secondary schools, by making available a wider selection of resources than teachers could hope to produce individually for themselves. The Science Editor of the Unit has, from September 1975, played an active part in the Swindon and Salisbury groups, helping with design problems and producing workbooks of very high graphic design and reprographic quality.

(4) The Department of Education and Science.

Financial support from the Schools Council finishes in August '76. In order for the work to continue the local inspectors of the DES have accepted in principle that they will finance a one year in-service course of some 80 hours duration entitled "Improving learning for 11-14 year olds in mixed ability science groups". This course is based on the formation of working

groups of teachers in a similar process to that described above. Of crucial importance to the form of in-service support offered, to teachers, from Bath University, was the creation of the process of evaluation described below.

III The Process of Evaluation

The process of evaluation was based on the third assumption above that teachers could evaluate the contradictions between their intentions and practice when presented with objective evidence. When the first drafts of the workbooks were produced by individual teachers they were criticised and modified at fortnightly intervals. The modified materials were typed onto Gestetner Skins in the Science Centre and class sets were reproduced in each school for trial. The lecturer visited schools once a fortnight to observe the classrooms video tape and interview the pupils and teachers. The video tapes were viewed either immediately after the lessons or at the next meeting of the working group. Transcripts of the interviews on the teachers' intentions and pupils' interpretations were given back to the teachers within a fortnight.

The following example illustrates how the process of evaluation provided a basis for improvement for Roger Barrow, a science teacher in Wootton Bassett School.

A) Roger Barrow
STATEMENT OF INTENTIONS

i) Roger: Well, I was concerned with the fact that most of my teaching was being pitched in the middle of the ability range and I wasn't really catering for individuals. I also had the problem of designing courses for teachers who are not specialists in particular fields. In the first instance I feel we must produce good work schemes which increase the teachers and pupils confidence. When we have built up our understanding of this situation we can then move on to the second phase of responding to the learners questions.

Jack: You see the vital thing is getting the kids to ask questions?

Roger: I'm not sure everybody agrees. I feel that so much of what has happened in Science Teaching has been a dull simulation, jumping through hoops at the appropriate moment at the command of the teacher or the examiner. I've come to realise over a period of time that we were chaining any creativeness and inventiveness in science. I know someone has to work through all the permutations and combinations but I think we have got to open out the possibilities for originality. I think so much of what we do in science is forced on us by exam syllabuses and kills all expression of opinion or development of ideas.

Jack: I can see what you are getting at but I'm curious how you came to these ideas and how you are going to create the situation to make it possible for your pupils.

Roger: I came from a very rigid grammar school where I was very dissatisfied with what was happening. I went into the comprehensive system with the hope that I would find greater freedom and a greater concentration on the needs of the individual. The first step is creating the learning situation I believe in was to move over to this more individual approach because then you can respond to the kids and if they ask a question you can say, "go on and try it".

Jack: Have I understood, when you are face to face with your pupils you are struggling in your relationship with them to help them be creative in the sense that they can ask questions and you must try and show them resources which can help in their enquiries.

Roger: Yes, that's right. The individual teacher is a vital part of the process. Recently we had four teachers on the same scheme. I suppose because I had a large hand in writing the scheme I somehow got a better relationship with my class. I don't know what it is but it's a different relationship to some of the others who were struggling with the materials.

B) Pupils Rresponses

(i) One of Roger's pupils was interviewed by Jack Whitehead:

Jack: What kind of things did you do yourself?

Paul: Well, we got all the apparatus and put it up ourselves and poured in the mixtures ourselves and we did, Mr Barrow just helped us a little bit, if we were stuck.

Jack: Really, yes. Did you ask any questions about the way you were doing this?

Paul: No.

Jack: You didn't. You just did it?

Paul: Yes.

Jack: But where did you get your ideas from then, if it didn't come from you?

Paul: Well, Mr. Barrow had a little talk with us in the beginning and then he got all our stuff out for us and we put it up and we went to go and get it and then we did our experiments.

Jack: I see. As you were doing the experiments did you have any ideas of your own that you wanted to test?

Paul: No.

Jack: I see. And if you've got questions of your own, like when I put that in front of you, you said, you know, I've tried to separate it, is that because when you're given substances like this, you were told how to separate it or not?

Paul: Mr. Barrow helped us a little bit.

Jack: Yes.

Paul: And he told us if we were doing things wrong. If we did we started again.

Jack: Yes. The thing I want to try to find out is do you have any ideas of your own that you'd really like to think about and test out.

Paul: No, not really.

Jack: You don't?

Paul: No.

Jack: What do you think scientists do? Do you think all their problems are always given to them or do you think that some scientists really try to think out ideas of their own.

Paul: Yes.

Jack: Which one do you think?

Paul: That they try to think it out themselves. Trying to make things that can help people, medicines or something.

(II) Roger interviewed his own pupils.

Roger: You remember that, and you had to try to save water yourself didn't you? Yes?

Tracey: Yes.

Roger: Well, what did you do to stop it evaporating away?

Tracey: We put a dish on the top of a beaker with water in it and put ice in it.

Roger: Oh, yes. Why did you get that idea?

Tracey: I'm not quite sure.

Roger: You're not quite sure. Did you see other people doing that?

Tracey: No.

Roger: Or did you work it out for yourself?

Tracey: No.

Roger: How did you get it then? You just don't remember.

Tracey: You told me.

Roger: I told you! Deary me. That's the second person who's said I told them, been splitting obviously. What was the ice doing then?

This process of evaluation has highlighted to Roger Barrow the gap between his intentions and his actual classroom practice. Roger modifies his approach with the following result.

Roger: Now what I want to do is just ask you one or two questions about what we've been doing in science this term. First of all what did you do, what were you expecting when you discovered that you'd got science on your timetable? Did you have any idea

what you would do?

Boy: No, not much. Well, some that we did in our other school was very different.

Roger: I see, what was different about it?

Boy: Well, it was more set, you know, they did more for you instead of now you have to do more for yourself.

Roger: You feel you've had to do more for yourself?

Boy: Yes.

Roger: Have you enjoyed doing more for yourself?

Boy: Yes. It's the independence of it . . .

Roger: The independence of it you enjoy?

Boy: Yes. Discovering the actual thing with nobody telling you what's going to happen.

Roger: You really enjoyed that did you?

Boy: Yes, that's what I liked about it.

Roger: You really liked that? Oh, splendid.

Finally, Roger Barrow attempts, in dialogue, to make sense of his experiences.

Jack: How far do you think that the basic ideas that we are working with are feasible?

Roger: Well, I think the questions pupils ask fall into three categories, there are those who are asking a shallow, trivial question for the sake of asking a question, or because sir said they were to think about some questions on the topic; there are those who ask a question quite seriously but are totally lacking in the ability to follow through their question with any sort of mature thought about it because the questions they've asked require some kind of thought and therefore they need guidance. This is where they need a resource, something you can put into their hand, at least to start them. This is the biggest problem with any project, getting them going. Once you've started the lesson off, or particularly the project overall off, then one can spend time in individual groups, one can then help them. Now the third group asks serious questions and are capable of following them through, like Ian and Gary with that plastic stuff. They were capable of a very mature level of thinking and the way they faced up to the problems they met en route was exceedingly encouraging.

This example shows how the evaluation process has helped a teacher to appreciate the varying reactions of children to learning situations, and therefore to a modification of his behaviour in a direction which is most likely to lead to the practical realisation of his intentions.

The above form of in-service support for teachers has been described in terms of the teachers problems, access to the resources of different institutions and a process of self-evaluation. The claim that this form of in-service support has influenced improvements in practice is based on the following evidence. This evidence clearly demonstrates how learning has actually taken place within a classroom where the children were working on a series of experiments highly structured by worksheets. The majority of the class could continue their activities with a minimum of supervision from the teacher. This allowed the teacher the opportunity of fulfilling the role of "consultant, advisor or tutor".

It allowed the process of self-evaluation to occur in dialogue between a teacher and small groups of learners.

Four second year girls were measuring the acidity or alkalinity of lead monoxide (a fine orange powder) by adding drops of indicator (a green liquid) into a mixture of the powder and water. One pair obtained an orangy-red liquid indicating an acid and the other pair obtained a blue liquid indicating an alkali. They went to the teacher, formulated their problem, "We got different colours" and received permission to continue work to solve their problem.

By the end of a double lesson they succeeded, after three failures involving highly creative work, to obtain the same blue colour indicating that lead monoxide is alkaline.

Teacher: What was important about what you were doing?

Tracey: It's just that, well, when we got different answers, we couldn't see why we got different answers and so we wanted to get them so that they were the same.

Judith: We were excited . . . It would have been better if we'd had longer.

Teacher: I mean, why was what you did so valuable? What was its value to you?

Judith: I suppose it was our own little discovery.

Denise: We achieved something . . . we don't normally get so interested in lessons, but this time we just got interested because we wanted to find out the answer to it.

Teacher: Was it the answer, the so-called answer that was important or was it something else?

Tracey: Well, we was very pleased when we got the right answer, but I don't know . . . well, every other experiment that I do is normally a complete flop and, well, this one seemed to be going quite well and so I got really interested in it.

Teacher: But for someone coming into the room, your experiment would have seemed *more* of a flop than the normal. Do you understand that? They would have seen one of you with a blue colour and one of you with an orange colour and said 'Well something has gone wrong . . . do it again . . . it's not right'. In fact it would have seemed a complete flop.

Tracey: Well, it came out of a . . . well, it wasn't exactly a flop, but it was more or less, but the reason was . . . it started off with a flop and we got it to a good experiment. Well, I thought it was.

Teacher: What do you feel you created in this room?

Sandra: Noise!!!

Judith: I suppose, you know, the atmosphere was, we were just getting more excited after it didn't work twice, so, you know, we just kinda, well when the teacher come into the room and saw it was a flop, I don't think I could have seen it as a flop, because it was, you know, just a discovery which you wanted to take further. So if they saw it as a flop then I can't see why.

And subsequently:—

Judith: Well, I suppose really it was that we were doing an experiment off our own bats, and it was working was the most important thing because it was our achievement and not prompted by the teacher and it wasn't what everybody else was doing, so it was different and so we enjoyed it more than we would have before.

Teacher: Are there any questions that you want to ask me?

Judith: Well, in the next lesson, can we carry on?

Sandra: Yes, 'cos we didn't find out why. All we did was we finished the experiment, you know, just got the result the same, but we didn't find out why!!!

Teacher: Right! Yes. That's what you want to do. That would be good, you know, to find out what it was that made the lead monoxide go, on the one hand blue and on the other hand red.

The dialogue shows how the evaluation process has encouraged the formulation of a new question; A sudden realization that another problem has arisen to which they were personally committed.

This personal commitment to the solution of a question which they had formulated produces a huge leap in their understanding of the scientific process, in their motivation and in the understanding of the concepts of acids and bases.

They continue their investigation:

Teacher: Denise, can you tell me about the experiment you are doing today?

Denise: Well, I get two test tubes, but I *don't* fill them up with the same amount

of water and I measure up the *same* amount of lead monoxide, one spatula, and 7 drops of indicator. Tracey uses dirty test tubes, Sandra uses exactly the same amount of water but different amounts of indicator but the same amount of water and lead monoxide.

They say that the results might have been wrong the first week, for one of four reasons:

1. They used different amounts of water.
2. They used different amounts of lead monoxide.
3. They used different amounts of indicator.
4. They used dirty tubes.

The experiments they devise use a sophisticated technique called "a controlled experiment" where one variable (i.e. amount of water) is altered while all other factors are kept constant. This concept is notoriously difficult for a major proportion of children at this age when taught in the more conventional ways.

They obtained their results.

Teacher: Now you've said "It's nothing to do with the amount of water, it's nothing to do with the amount of lead monoxide, or with dirty tubes, or the amount of indicator. In fact it doesn't seem to be to do with anything that you've tested.

Sandra: No.

Teacher: Now what do you think was different about the experiment that you did last week which makes it different to the experiment you did this week?

Tracey: Well I suppose what we could try, sir, is that we could have say, different amounts of water in the test tubes *and* different amounts of lead monoxide and dirty test tubes and see whether it was all four of them.

They are saying "It wasn't one factor on its own that made the difference but it could have been caused by all these factors acting together!

Teacher: Yes, that is certainly true. It could have been. What about this idea. The lead monoxide should turn indicator a blue colour, but last week you had one tube that went red. Could it have been a dirty test tube which had had acid in it?

Tracey: Wouldn't it go neutral, because a certain amount of acid and a certain amount of alkali in there . . . shouldn't it turn neutral, but we didn't. We got a very strong acid and one got a very strong alkali.

Teacher: You think about that.

Sandra: I don't get what you mean.

Tracey: I thought about it before I asked you!

Teacher: Well, think about it again. Sandra, you don't understand what we are driving at, do you?

Sandra: No.

Teacher: The mistake might have occurred last week because you had a dirty test tube and it had acid in it already. Now what would happen if you did all this in a test tube which was dirty to begin with, with a bit of acid. What might happen?

Sandra: What . . . what, you mean if we did an ordinary experiment and it turned acid and then we tipped it out without washing it, do you mean?

Teacher: Mm.

Judith: Well then it would turn acid wouldn't it.

Tracey: Well no, it wouldn't. If you have got lead monoxide and that's, well we found out it was a very strong alkali. A strong alkali and a strong acid is going to make neutral isn't it?

Teacher: Well it depends . . .

Sandra: You've got to have virtually the same haven't you.

Teacher: Yes it's a balance isn't it.

Sandra: Tracey said if you had a strong acid and a strong alkali — would make a neutral, but how is Tracey going to know how much

acid is in there to add the same amount of alkali?

Teacher: Good point.

Judith: If we use a syringe, then we could put exactly the same in, so we know that it's balancing, or we know if it's stronger or weaker.

Sandra: But we don't know how much acid is in there.

A minute ago Sandra didn't understand the problem the other girls were raising. She has now grasped the idea of 'acids cancelling out alkalis' and of her own accord is appreciating the idea of balancing out different quantities of acids and alkalis whose "strength" is unknown. A giant leap.

Conclusion

The form of in-service support offered to teachers from Bath University Science Centre has influenced improvements in educational standards in 11-14 year old mixed ability science groups. This form of support has emerged from an exploration of the 4 assumptions above. These assumptions are related to enquiry learning, teachers isolating their own problems and evaluating their own practice and an easy access to resources. The resources included the objective evidence on which the teachers evaluate the contradictions between their intentions and classroom practice.

The above form of in-service education is not offered as a blueprint for improvements in classroom practice. The improvements occur through the creative power of individual teachers to transform their own situation. The above form of support is one attempt to respond helpfully to the problems of those teachers who are involved in their own local curriculum development.