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ABSTRACT

This study investigates the ideas and beliefs of a small group of high school science teachers about student observations in the science classroom. Student views on science classroom observations have been previously reported on, but teachers and their students' ideas about observation is a very little researched area in science education. There are a significant number of students that do not consider observation relevant in the science learning process. The data for this study was collected from teachers and students in three 10th grade science classes. (Contains 13 references.) (YDS)

THE INFLUENCE OF TEACHERS ON STUDENT OBSERVATION IN SCIENCE CLASSES

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INTRODUCTION

The essential purpose of this investigation was to explore in detail the ideas and beliefs of a small number of high school science teachers about observation and the processes of observation in their teaching of science, and to then consider these ideas and beliefs in terms of both the teaching approaches used in their science classes and the ideas and beliefs about observation held by the students in their science classes. The detail of the views of these students about observing in science classes has been reported previously (Haslam & Gunstone, 1996).

In that earlier paper we argued the significance of the study in terms of the ways science curriculum documents and science teaching practices overwhelmingly assert the importance of observing. An examination of almost any school science curriculum document will reveal that student observation is held to be central to the learning of science. A systematic inspection of such documents from the U.K., Australia and New Zealand that was undertaken at the beginning of this study provides many examples of this. We give just one here, taken from the school science curriculum document from that part of Australia in which the study was conducted.

> Observation and direct experience are crucial in concept development and in challenging existing beliefs and understandings. (Malcolm, 1987, p.72)

However there is little known about how teachers (and their students) construe the nature and value of observation in their science teaching/learning. As an illustration of this assertion consider the recent handbook of research in science education (Gabel, 1994). The index for that volume contains no entry under "observation", nor any entry about observation under "Teaching" (although there is an entry for "beliefs, about nature of science"), "Learning", "Science Laboratory" or "Student". The need for some understanding of how teachers and students see the nature and value of observing to their teaching/learning is well illustrated by considering the nature of a science classroom where a significant number of students do not see observing as relevant to their science learning - clearly such a classroom will be substantially believe that observing is central to their science learning. The comparison will be even shaper between a class whose teacher sees observing to be central to learning and a class whose teacher holds the opposite view. In the latter class students will rarely be given tasks that require them to observe.

We do know that existing cognitive knowledge and beliefs held by an observing student influence both the nature and interpretation of his/her observations (eg. Appleton, 1990; Driver & Bell, 1986; Gunstone, 1993; Rowell & Dawson, 1988). That is, regardless of how a student construes the nature and process of observation, the observation itself is theory-laden. The observing of science graduates is also known to be theory-laden (eg Gunstone, 1994; Haslam & Gunstone, 1997). This adds to the importance of this study - not only do we know little about students' ideas and beliefs about observation in science classes, we do know that observing is not a simple matter of direct reproduction of stimuli, that "'Looking at' is not a passive recording of an image like a photograph being reproduced by a camera" (Driver, 1983, p.11). Thus we have evidence of complexity in at least some aspects of the process of observation. It is clear that these same perspectives are an appropriate way to consider observation by adults (such as practising teachers) when they are in a learning role. However there is no systemic information about the ways in which teachers conceive of observing and its use in their science teaching.

THE VIEWS OF OBSERVATION UNDERPINNING THIS STUDY

While "observation" is often described as one of the processes of science, a number of authors (eg. Millar, 1990) have noted that observation is not a process that is exclusive to science. A major consequence of this is that it is necessary to consider how observation is seen to be conducted in science. In this study we take the views of Russell et al. (1993) about what they term "scientific observation" to be an appropriate guide to the issues about observation on which this study should focus. In summary these views are:

- Scientific observation is not a process to be carried out in isolation. It forms part of

- Scientific observation has a specific meaning, and that meaning is closely related to the purpose of the investigation.
- Though it may appear straightforward, scientific observation is actually a very complex process.
- Conceptual knowledge cannot be removed from the process of scientific observation as it guides the selection and interpretation of observations made.
- The observer's perception of the purpose of the task interacts with the knowledge and experience of the observer in the observer's decisions about what features are relevant.

These views are consistent with those of other authors (eg. Driver, 1983) and indicate the ways in which we conceptualised scientific observation as we planned this study.

METHODOLOGY AND PROCEDURES

The study had three data sources: teachers, students and the science classrooms where these teachers and students taught/learnt science. Both pencil-and-paper instruments and closely related interviews were used with teachers and students; data about the classrooms of these teachers and students and their approaches to observing during science laboratory work were gained by long term observation by the first author, including some videotaping. The classroom observations informed aspects of the interview approaches.

Data collection methods: The statements about scientific observation in the previous section of this paper were a strong guide to the construction of the pencil and paper instruments and the interview schedules, as were a number of small pilot investigations. These pilots are not detailed here, but were most varied: many interviews using a variety of questions and approaches with young and adolescent students in out-of-school settings; informal interviews during laboratory classes with first year university science students; observation (including class videotaping) of final year high school science student teachers undertaking a series of observation tasks, and questionnaires completed by these student teachers about the

The pencil and paper instruments (student and teacher versions) were administered in March of the year of data collection (the school year in the system in which the study was conducted runs February-December), the classroom observations undertaken for several weeks post March, then the student interviews conducted in June-July and the teacher interviews in August. This approach was intended to allow data gathering from a wider group of students via pencil and paper and then interview data from a smaller sample, with the interview protocol informed by the observations and thus likely to have some differences from the pencil and paper instrument. The same approaches were adopted for the collection of data from the teachers - pencil and paper before any observations, observations, interview. In this paper we focus on the interview data; hence we focus in this section on the nature and development of the interview schedule.

The development of the teacher interview schedule: The initial teacher interview protocol that was created after the pilot studies and literature reviews had 6 sections. These sections were designed to probe:

(i) an actual act of observing (a piece of chocolate) and which of a number of given propositions were seen as observations (these propositions contained statements that we see as observations, eg. "The chocolate is brown", and statements that we see as not observations, eg. "The chocolate contains sugar");

(ii) what the word "observation" meant to the teachers, whether they perceived differences in the ways their students observed and what they believed observation meant to their students in different experiments, and how they saw observation in terms of the science learning of their students;

(iii) the teacher's understanding of the meaning and significance of "inference" in science experiments;

(iv) reactions to a number of statements about observing in school science experiments, presented as statements from other students;

(v) what they believed their students paid attention to while observing during science experiments;

(vi) any thinking and questioning undertaken by them during the conduct of experiments undertaken in their own science learning, and their views about questioning undertaken by their own students during experiments.

The student interview schedule was similar - it differed in that only students' views about their own observation and their approaches were sought (eg part (v) of the student interview explored what the interviewee paid attention to as he/she was observing in science experiments), and specific reference to the most recent experiment the students had done prior to their interview.

Pencil-and-paper instruments based on the interview schedules were also constructed, for both the teacher and the student versions of the interview schedule.

The classroom observations resulted in the addition of a seventh section to the interview schedules for both teacher and student, and some other minor changes. The addition probed teachers' perceptions of the impact of group size on the approaches of students to experiments and observing (and, for the student protocol, students' perceptions of the ways the groups in which they worked during science experiments proceeded with the task, and how this was influenced by the size of the group).

A copy of the final form of the teacher interview schedule is in Appendix 1 to this paper.

<u>The subjects of the study:</u> All interviewees were drawn from three Grade 10 science classes in a typical large urban government high school in Victoria (Australia). At this level of high school in Victoria, science is a single subject (rather than there being separate subjects called "physics", "chemistry" etc) and is undertaken by all students. Three classes were targeted, with a total of 37 students being selected for interview. This represented just over half of each class. Selection from each class was by the class teacher, and was based on our request to give a variety of levels of science achievement. The three teachers of these three science classes were those interviewed for the study. All interviews were conducted by the first author who,

was already well known to the teacher and student interviewees. The interviews were conducted in an office in the school. All 37 student interviews and the three teacher interviews were taped and transcribed. This paper will report analyses of these transcripts, with some additional reference to the data from the pencil-and-paper instrument which was completed by all members of the three classes. By chance all three teachers were male, thus the masculine pronoun is used throughout.

FINDINGS

As the essential purpose of this study was to not just investigate the ideas and beliefs of the three teachers about observation and the processes of observation in their teaching of science, but also to consider these ideas and beliefs in terms of the notions of their students, we begin our reporting of data by briefly summarising the previously reported outcomes of the investigations of the ideas and beliefs of the students. The detail of these student data and conclusions is in Haslam and Gunstone (1996). The teachers and their classes are referred to below as "A", "B", "C".

A summary of the ideas and beliefs of the students about observation

1. Many students saw observation as a teacher directed process (that is that one observed in an experiment that which the teacher indicated was to be observed). There was clear difference between the three classes, with this view being expressed by 10 (of 12) interviewees from Class C, 5 (of 14) from Class A, 5 (of 11) from Class B.
2. The meaning for "observation" given by students often reflected the influence of the context of the most recent experiment they had done. Only a small number of responses gave any suggestion of any form of processing being involved in observing, and did so via use of

words like "understand" or "know"; again there were clear class differences: 4 from A, 6 from B, 1 from C.

3. In contrast to the responses to meaning for "observing" (above), many students reported undertaking quite high levels of intellectual engagement during specific observation tasks, and did so in sufficiently general terms as to suggest that this engagement occurred across laboratory contexts. Responses that indicated thinking/questioning during experiments that was attempting to understand an observation were given by 10 (of 14) from Class A, 5 (of 11) from Class B, 4 (of 12) from Class C.
4. Observation was seen by students to be important to their learning (by 95% of both interviewees and pencil and paper respondents). Within this very commonly held belief there were differences by class again, in this case in terms of the sophistication of the reasoning given to support the importance of observing to science learning (generally more thoughtful and more elaborated from Class A students; generally briefer and less thoughtful from Class C students).
5. Observation was seen by many students to have contextual dependencies, some of which were unexpected. There were four forms of contextual dependency reported by at least some students.

   (a) The area of science involved - some students saw observing to be a different process in the different areas of science (physics, chemistry, biology).

   (b) Whether or not the experiment had intrinsic interest for the student - for many students greater intrinsic interest meant greater concern with observing.

   (c) Time required for the experiment - for some students an experiment that required considerable time was an experiment to which they did not give full attention (although this aspect of context clearly interacts with the other three).

   (d) Whether or not the content on which the experiment focussed was already known to the student - for a very small number of students knowing the content appeared to mean they would be more serious with the observation, for a greater number it meant that they took the observing tasks less seriously (on the obvious grounds that they knew what would happen).

There were no patterns evident in the responses by class on these aspects of contextual dependency, but, again, the students of Class A tended to be more thoughtful in their supporting reasoning than those of Class C.

6. Almost all (95%) of the interviewed students saw their approaches to science experiments and observing to be influenced by the size of the group in which they worked. (This issue was not explored in the pencil and paper instrument; it was included in the interview as a result of the classroom observations.) The larger the group the greater the conscious division of labour that the group adopted (eg one person to observe for all, another to record). Most students saw two as the appropriate size for a student laboratory group. There were no class differences in the responses.
7. While many students were able to distinguish statements that we saw as observations from statements that we did not see to be observations when given an observation task in interview (the task was the same as that given in Section 1 of the teacher interview - see Appendix 1), no student used the word "inference" or any reasonable alternative to describe the statements they said were not observations.

There is in the above summary a very strong trend in terms of differences between classes - Class A students consistently described views about the nature and purpose of observing that were more consistent with those we assert are appropriate for science learners than the views of students in Class C. The thinking underlying opinions was consistently more elaborated from Class A students than from Class C students. In all issues, Class B students were either similar to A, similar to C, or between A and C. Thus the student data suggest a very strong teacher effect on the views and approaches of students. It is in the context of this teacher effect that we now turn to the data obtained from the teachers.

The ideas and beliefs of the teachers

We present the outcomes of the explorations of teachers ideas and beliefs as a series of statements, with the discussion of each statement containing some sense of the data underpinning the statement. The data that are presented have all come from the interviews with teachers. Where quotes are used the question that gave rise to the quote is indicated.

1. **Teachers saw student observation as a teacher-directed process but had very different views of the nature of the teacher direction**

Teachers were unanimous in expressing the view that student observation is directed by teachers/teaching. However embedded in their elaborations of this view was a clear indication of the differing general views of teaching and learning and the roles of teachers in these processes held by each of these teachers, views that emerged across a number of sections of the interview. Consider for example the responses to "How do you think your students decide or know what to pay attention to during the observation part of the experiment?" (4[Q-1])

> I think some would look at the aim of what the experiment was. Some or most will be working from prior knowledge, whether it be right or wrong, but they would be thinking may be of something similar, that they have experienced or seen before and to some extent predict the outcome in their head, and then check the outcome against that, after they have muddled their way through the experiment. (Tr. A)

> "I pay attention to what my teacher says to pay attention to", and if they can do that I would be very happy for them, I think the second statement would apply to students those who are very smart alec.... and it applies to very good students who will be happy to observe what I ask them and observe other things. So I obviously say that this may be happening here, or this is, I would expect them to pay attention to. Maybe students may not be able to decide what [to pay attention to] because the teacher has not been clear in the sense of telling them "this is what you have to see this is what you do". A lot of decisions then rest on the students. But in some experiments the observations are a couple or just one observation, and then they have to wait a bit then, in that case a smart student will write other things. I would expect the good students maybe to observe what I said and other than the normal things. (Tr. B)

> Most of my students would pay attention to what I say to pay attention to. No matter what other interesting thing comes up in the prac[1] they are not interested in it they just want to get the job done. As far as observations are concerned they are to observe a certain thing, which I tell them to. (Tr. C)

In essence, teacher A saw the teacher direction of observing arising from "indirect" sources such as the aim of the experiment or the predictions he encouraged students to make; teacher B saw his statements to students about an experiment and what to do as helping students decide what to attend to; teacher C saw his assertions as to what to attend to as resulting in students attending to just that. These differences were seen in the classroom observations, both for what the teachers claimed about their roles in and approaches to directing observation and for the behaviour of students. The student interviews showed students to have views that closely reflected the views of their teachers (eg the only students to indicate that the aims of an experiment helped them determine what to pay attention were from class A, twice as many students from class C as from either of the other two classes indicated that they paid attention specifically to that that the teacher directed them to).

2. Teachers A and B, but not C, held the view that observation during science experiments includes mental processing

During the interview teachers were asked for their own views about the meaning of observation, that is, what did the word "observation" mean to them (see App.1, 2[Q-1]).

> To use all senses to try and pull together some fact about the concept or the item or the function or the operation or whatever it is you are actually observing. (Tr. A)

> To carry out a set of instructions that you are supposed to do and after that observe the changes, these changes could be colour changes, could be like a measurement a change of state any kind of difference between the original. (Tr. B)

> What does it mean? I think it means something that they, um .. when I say seeing it may not necessarily be a visual thing, but something that they experience happening, first hand in the class. So it is something that I may have already spoken about or something that I am about to speak about, um, that they actually experience happening first hand in class. (Tr. C)

For Teacher A, observing appears to include a broader sensory use and the mental processing of sensory input; for Teacher B, observing appears to involve carrying a task and mentally processing sensory input. For Teacher C, observing appears to involve looking and experiencing something new. The expectations of the three teachers about their students' observations, as described in the first statement of results above, appear to reflect their own ideas about observation.

3. Teachers A and B, but not C, saw observation to have contextual dependency

Teachers A and B held the view that there were differences in the way that their students approached science experiments in Biology, Physics and Chemistry.

> Kids tend to be locked into subjects, more than the teachers are sometimes, most of the times. I think if you tell them it is Biology, they are more interested and more willing to look more closely at something. If you tell them it is Chemistry they might instantly dislike it a bit. If it is Physics they don't want to pursue this ever again and they are less likely to do any kind of serious observations. (Tr. A)

> I am not very familiar with Biology,... in Physics they do an experiment in one condition and

> expansion and change in volume in texture. In chemistry, it's more to do like with a gas given off basically with chemical reactions. (Tr. B)

However these content differences in observing are described in ways that are different from the ways those students who saw differences described them. Those students who asserted differences in observing by content did so from perceptions of the nature of the content (in simple terms, biology is different because there is always great time involved, so one can "switch on and off" in the observing; physics does not involve observing, it involves measuring; chemistry involves observing as things happen). Teacher A used arguments related to student interest to explain his view of difference, while Teacher B has given a rather confused reason. When directly asked if he thought that his students would see observation across different content areas differently Teacher C responded "No".

4. Teachers held the view that student observation is fundamental in science learning

When directly asked "Do you think observation is important in learning science?" (2[Q-4]) responses were: "Absolutely, it is fundamental" (Tr. A),"Very important" (Tr. B), "Yes...." (Tr. C). To "How does observation help your students to learn science?" (2[Q-5]) they said

> They get to gather data and facts for themselves, and they build up some picture, maybe a concept that gives them an idea of the operation that is taking place. (Tr. A)

> They will strengthen their theory and help them to cultivate their interest in science. It will also help them to improve their practical skills, it will also widen their interest in science. (Tr. B)

> Yes, um, because, um, if you do [Pause] if you are expected to observe. I mean you could teach, [pause] it is possible to teach any subject not just science by just getting up there and saying 'this is how it happens'. [Pause] But I think by doing practical things and observing them you see things happen for yourself. It becomes more relevant and it makes science [Pause], it breaks things a bit, and it is not [Pause] and there is no doubt then in the students' mind of what you are saying it is not true, because they see it themselves. So that there is sort of reinforcement of things, and it is not just the teacher who has to drill everything into your heads. It is a way of learning where they can discover things themselves. (Tr. C)

When asked to elaborate further, Teacher C continued with more in the same vein. We believe that Teacher C held the view that observing helped his students learn science, but did not have any substantive reasons as to why this might be so. Both Teachers A and B had reasons to advance to support their position.

5. Teachers held the view that not all students observe during science experiments

Section 4 of the Interview Protocol explored this issue in a number of ways: using given statements for teachers to indicate how they saw their students undertaking observation; asking for "something different about the way you think your students" observe; asking for "something more that can help me understand the way your students" observe.

There was clear recognition by all three teachers of the variation in student engagement with observing tasks, but rather different detail underlying this common view. This difference in detail is illustrated by some responses given to the second of the three questions in this section of the interview protocol.

> Each student probably has a different level of involvement . Some will copy others as they lack confidence in their own observation. Some students will be very precise in recording what they observe. Some will observe very well but not bother to record their observation. (Tr. A) *(Note: This is in fact the response of Tr A to the pencil and paper item completed early in the study. In interview he referred to this written response as representing his views. It is of interest that he remembered this response some months later at interview.)*

> They don't want to do the tedious part of writing down the observations, they like to connect this, do this, etc. Some interesting things happening. Most of these kids are looking for something sensational and every time you hear, sir when are we going to make a bomb? When are we going to have something interesting? They like fun, they are not interested in dry experiments. They are only interested in the experiments in the sense that they want to see what is happening but they are not concerned or bothered about writing down and they hope that they can get the observations from another group. They do the experiment because they are forced to do it, because the teacher wants them to do it. So this is what I noticed about this and they come to the conclusion that the observations are practically the same with every group so they don't have to worry about getting wrong observations, that is what most of them have the idea, which may be correct, but some observations may be different especially when the measurements are concerned. They are supposed to write their own observations, that also happens with Year 11 too, they will do the weighing and they just do the experiment and get the results from other group. Obviously when I found that out I said: "this is not on. These are not your observations." But that is what the kids are doing, they are just hoping for another group to supply them with the information and they just do it. Not for the sake of learning, but, for the sake of seeing if there is something new happening. (Tr. B)

> They don't follow the instructions, so no matter how you go through it, I mean we go through exactly what is to be done at the start, we go through the whole thing and they just are not listening and when they start doing the prac they are so excited or something and they haven't listened and don't end up doing the prac properly. It happens a lot. (Tr. C)

Each of the teachers had something to offer to the third question ("tell me something more "). Teacher A talked about the need he saw for things to happen quickly in laboratory work, a need he saw arising from the impact of television and the "two minute grab" on our culture , and from the continued time pressures that he saw operating in schools today. Both of Teachers B and C, on the other hand, talked about students not following instructions ("I cannot trust them to follow the instructions carefully", Tr. B).

The general picture here then is of Teacher A having a somewhat positive view of the differential engagement he saw among his students - "each student probably has a different level of involvement" - while Teachers B and C were much more strongly focussed on deficit forms of interpretation - what students could not or did not do.

6. Teachers held the view that when students work in groups during science experiments, the size of the student group has a significant impact on students' approaches to observing

The teachers were asked if they think that their students go about laboratory work and observing differently when they work in groups of three or four (7[Q-1]), and, if so, what is the difference (7[Q-2b]). A broadly similar position was advanced by all three teachers.

> I believe they operate differently in different sized groups. In smaller groups they are likely to do something . In larger groups they are more likely to let others do it and collectively not as much gets done. There would also be in the larger group a clear recognition by the kids in their group that maybe some are more able than others, and so you end up with two members of say a 4 group following the other two, and even then there will be one clear person who would do the observation and record for the group..
> ...generally we got too many kids and too little equipment. Mostly they will be working in groups of two to four. .. I prefer [groups of] two to one, I still run the occasional experiment where there will be one ... but that is rare. (Tr. A)

> In pairs at least 60% will tend to do their own observing. If it is more than two ... then the problem starts; you will find that only two of them will be doing and the other three will start yakking and this and that... What I notice regarding observations is that most of the times every group is doing the same experiment, which means that all the observations would be more or less the same, so, what I noticed about this is that sometimes the students do not depend on their own observations. Whatever they are doing they just do it for the fun of doing it, for having something to do, and they rely on the observations of other groups, when they know that, that particular group has good observations and they get the observations from them, although they have done the experiment they couldn't be bothered in writing their own observations, they want to do the experiment, but they do not want to do the brain part of the work. (Tr. B)

> I guess so when they are working individually they will do it, [observe] sometimes in groups there are people who lay back and do not try to contribute, and some people who dominate proceedings, so I guess you see that. (Tr. C)

There is strong consistency between these views and the views expressed by students. Here, it would seem, is an issue that, at least in terms of learning, all participants in these science classrooms see as a serious problem.

7. Teachers held the view that some students undertake self questioning when observing

In response to 6[Q-3] all three teachers said that some of their students self question. The reasons provided for holding this view again were varied, and in the same general ways that teacher variation has already been described.

> On the quality of their questions, when they do verbalise them, some of their questions would indicate that they have given a bit more thought than suddenly come up with a question, I'd say the quality of their questions would indicate how much thought they have put into composing the question. (Tr. A)

> Sometimes I have students who ask questions even though I do not discuss, a student may come up with a question which is very relevant but which I did not even conceive. I have seen students ask normally questions which are beyond the scope of what is taught at that time and questions that normally require more knowledge or more theory to explain it, explain that kind of question and I normally notice that these type of questions are asked by the students who are really interested on that subject, or sometimes even can even get a question from a student who is very average student who suddenly .. you get surprised about the kind of question that kind of student can ask.. (Tr. B)

> Natural curiosity, I am sure not all of them do. (Tr. C)

Teachers were then probed about the kinds of questions they thought their students would ask themselves as they were observing.

> They would ask how and why questions. I always ask "what" questions, look what are we doing this for, there is probably more kids asking "what" in my class than I would myself, where I am looking at it and asking "how", "why", they are looking at it and asking 'What are we doing this for'? (Tr. A)

> ... what if questions, which shows that they are keen to find out what is going on .... I would assume that the kind of questions they ask themselves would be exactly the kind of questions they ask me, what would happen if I do this and that? Normally I would try to explain that you shouldn't do this because you will not get the result we expected, or it will lead to some problems. Or I would tell them "you are not advised to do that" or I would tell them that that is beyond your scope. You are not required to do that but I can probably explain to you if you want to know or maybe it takes too long so I can explain to you later. Sometimes these kids are curious. (Tr. B)

> What? Why has this happened? What is the relevance of this, sometimes. (Tr. C)

When then asked " How many students in your class do you think already ask such questions whilst they observe? Why do you think so?" the teachers responded

> Most kids in my class at this stage are comfortable to ask a question even if it might be a dumb question, they don't really mind asking a question and some in the class will laugh if a kid asked a question , but it is a non threatening way. (Tr. A)

> It is difficult for kids to ask questions. The kids would not know what questions to ask because they know very little about the subject. For example if it is a different observation what went wrong? Or if it is a different kind of observation what do you think it is likely to happen? But

> I'd say 30% [ask questions] based that on the ratio of my students who are doing a prac with a reason and not just to say "I'd get this done" like we get the mark in the book and that is all over, students who probably have a bit of talent really. (Tr. C)

We see quite remarkable difference among the ideas and beliefs of these three teachers about their students capabilities in "thinking during observing", and parallel difference in their practice. Teacher A has communicated the need to ask 'thinking questions' to students from Class A ("I guess I try to create an atmosphere where they are comfortable with the idea of being wrong. So it doesn't really matter if you are wrong, what matters is whether or not you think about it. I think in particular in science there is no sort of right and wrong answers, and it is not as black and white as much as they think ..." "Most kids in my class at this stage are comfortable to ask a question even if it might be a dumb question, they don't really mind asking a question"). Observations in Class A confirm this. Furthermore a large number of students from Class A reported experiencing "thinking during observing". Teacher B had quite different opinions and practices ("It is difficult for kids to ask questions. The kids would not know what questions to ask because they know very little about the subject." "Normally I would try to explain that you shouldn't do this because you will not get the result we expected, or it will lead to some problems." "Or I would tell them 'you are not advised to do that' or I would tell them that that is beyond your scope."). Teacher C was also different to Teacher A in opinion and practice, but not as strongly opposed to the possibility of student reflective questions as Teacher B ("To be honest I probably haven't communicated this [the need to ask thinking questions]"). Observations of classes B and C, and the responses of students from these classes, are very consistent with the positions expressed by these two teachers.

8. Teachers saw 'student self questioning' during science experiments to be important to learning science

Not withstanding the positions just reported, all three teachers indicated that it was important to encourage students to ask "thinking questions" during science experiments.

> By getting them to ask questions, they can build up pictures by those answers of what is

> ... to make the students observe and not just partake in the experiment. I think that is a good idea. If they ask themselves such questions and write their questions, that means they are really observing carefully and they would know what they are doing during observation. A lot of them do not know what they are doing they follow instructions blindly. You will be surprised they are not knowing what they are doing, so if they ask thinking questions they will know what they are doing. (Tr. B)

> It is a sign that they are involved in the prac (Tr. C)

When then asked "During this term how have you communicated the need to ask these "thinking questions" during observations?" teachers' responses were

> I think, yes, .. no I wouldn't think that I have gone in there and said look there is really important to ask thinking questions I want you to ask lots of good questions here. The idea has got across yes, I would generate questions without giving them the answer to it. I think in a prac like the ticker tape car, I would say why these dots are this far apart and here they are this far apart, what is going on here think about it and we get a couple of volunteers, who may get some conflicting answers, and I pick out their idea until there is some sort of consensus and we look at if we had come to the wrong conclusion and go into my experience into why that is not going to work and we go back to asking the question again, and kick around again , until we get an idea that is going to fit. I guess I would say that is modelling questioning. I guess I try to create an atmosphere where they are comfortable with the idea of being wrong. So it doesn't really matter if you are wrong, what matters is whether or not you think about it. .. I think in particular in science there is no sort of right and wrong answers, and it is not as black and white as much as they think, in mathematics it is hard to escape the correct or incorrect answer in science there is more grey than people are ever aware of and we can explore that grey better. (Tr. A)

> Unfortunately not, because the concern that I have every time there is a prac that the kids do the prac properly, yes that is my main concern. I must admit that I didn't get the time to think about this. (Tr. B)

> To be honest I probably haven't communicated this. Maybe I think when we are having a chat about something, I might get into that to a degree, but certainly whilst doing the prac I don't encourage it. (Tr. C)

Despite these responses from Teachers B and C both of them, and Teacher A, had suggestions to make when asked what sorts of things could be done to encourage students to ask themselves thinking questions while they are observing.

> The format of Predict Observe Explain[2] is a good one. That has worked well for me, and kids can get very excited, very fired up. If they sort of make some sort of commitment for predicting a particular outcome whether or not the experiment is going to be performed, and some of them are going to be right and some of them are going to be wrong, then if you have 50% of class going one way and 50% going the other, I always work towards ...if I had 80 % of kids predicting a particular outcome and 20% a different outcome I would look for ways which could support the 20% over the 80%. So some kids would shift their position back so we may end up with 50% percent on either way, before I do the outcome even though the 80% was correct, I would do that. I think of many a Year 11 in Physics where I just about turned the entire class to sort of thinking the wrong way before we do the experiment; that way they are a bit devastated that they were right the first time, but then they don't worry about being wrong the next time, so much. (Tr. A)

> I normally discuss the observations in class so I test in the theory as well as on the experiments they did. Like what kind of gas is given off, what happens when you add concentrated Nitric Acid to Copper fillings, name three things that happen. So questions which are related to the experiment, I think most teachers do that. [A teacher] gives points or marks for people who ask questions [to their teacher], maybe we could [encourage]... students to ask questions to show [that] it is a good observation. You could give marks, if they ask themselves questions, the questions that they have thought whilst they observe, that means in that case they have got to observe properly, only then they can put forward good questions. (Tr. B)

> In a prac you could produce some questions and things like that about the experiment that you may be interested in answering, things like that or encouraging them to ask you some of them just don't say anything. That will be good. In the conclusion they could raise some points that they thought about. (Tr. C)

So a complex picture emerges regarding the ideas and beliefs of these teachers relating to student self questioning and the learning of science, at least for Teachers B and C. Teacher A is consistent in the views he expresses and the practices he pursues. More students from Class A than Classes B and C reported "thinking during observing", class observations confirm the use of the approaches he describes in the responses reproduced in this section. For Teachers B and C however we are less clear. Their classroom practices certainly did not show any desire to encourage self questioning, with teacher C acknowledging this and Teacher B asserting that such behaviour is not appropriate. Yet both teachers had sensible things to say about how one could attempt to develop self questioning among students.

9. Further findings

There are a number of other elements of the ideas and beliefs of these teachers that, because of space limitations, we now just list and give very brief comment. We do not provide supporting data/argument.

(a) Teacher A and Teacher C held the view that their students value observation in science learning; Teacher B held the view that his students do not value observation in their science learning. (Teacher B supported this opinion with the view that students saw laboratory work as a time to "muck around or socialise".)

(b) Teacher B and Teacher C held the view that their students do not see the difference between looking and observing

(c) Teacher A and Teacher B held the view that their students are sometimes stopped from observing during science experiments (Students in all three classes reported that they were sometimes prevented from making observations by their teacher interrupting the class, sometimes by other students' behaviour, sometimes by equipment problems.

students, sometimes by lack of time, and sometimes by lack of concern for the experiment *per se*. Teacher C did not indicate any recognition of these issues.)

Teachers and observing/inferring

Each teacher interview began by asking the teacher to examine a piece of chocolate. "I want you to touch, taste, smell and look at this chocolate. I am now going to give you a card that contains statements made by some Year 9 students about this chocolate." These statements are shown in Table 1. Teachers were asked which of these statements were "observations" and, if some statements were not seen as observations, what these other statements were. The same questions were asked in the pencil and paper instrument. Table 1 gives the responses of the three teachers to the given statements, for both pencil and paper and interview.

Table 1 about here

One interesting feature of these teacher responses is that, when pencil and paper and interview are compared, Teacher A had a very stable view across the several months between the two times of data collection, while Teachers B and C did not. This is consistent with Teacher A having a considered position on the nature of observation, and Teachers B and C not having such a considered position. This then is very consistent with the trends in all of the teacher data - Teacher A holding views that have underpinning thought and consistency, both in terms of the views themselves and the nature of his classroom practice; Teachers B and C have less consistency and underlying thought in views and classroom practices that reflect this.

It is interesting to note that both Teacher A and Teacher B during the interview indicated that the proposition "The chocolate contains cocoa" was an observation, although Teacher A gave a more qualified view at a later point in the interview (see footnote 2, Table 1).

The description in the interviews of those statements not seen as observations was variable. Teacher A initially indicated that he did not know what to call these, then used the term "believable assumptions" and later used the term "infer". Teacher B had no word, and Teacher C

Teacher B indicated that all propositions except 'the chocolate is made in Australia' were observations, and justified this response by saying "By tasting feeling and by looking you would be able to get a ..I mean we have been taught these kinds of sensations by taste, sight, smell and obviously these are the things we have learnt through our senses." He had no word to describe the propositions he saw as not observations: "I would not know what to call it".

Of the three, only teacher A appeared to have an adequate conception of inference.

The views of the teachers about inference during science experiments were explored more directly via Section 3 of the interview protocol (see Appendix 1). Teacher responses to the meaning of the word infer/inference (3[Q-1]) included

> If I was going to replace it with any other word I probably use the word suggests. (Tr. A)
>
> Seeing an observation and trying to use all the knowledge they have on that particular subject and come to a conclusion. (Tr. B)
>
> If they say infer it hints at what do you understand by a statement." (Tr. C)

In response to 3[Q-2] and 3[Q-3] all three teachers said that inference was important in the learning of science. The reasons given by them for holding this view were

> I think it is important that kids tell the difference between observation and inference. Going back to the chocolate tasting, if it tastes sweet does not mean it has sugar in it. So it may suggest that it has sugar in it but that it is not a concrete, ... I mean, because it tastes sweet it does not have sugar. I think they have to be able to make that very important difference, otherwise if they were to continue on with more high powered scientific studies and stuff they may be well drawing wrong conclusions....
> To come to valid conclusions. (Tr. A)
>
> A pupil will be learning science and you ask them a question which is related exactly to what they have learnt, if you give them a problem solving activity when they are faced with the problem they would look at certain observations and can relate to the topic of the study or the knowledge they are studying and then come to a conclusion. So I think it is important in that sense, that means they have tested, also it gives feedback to the teacher of what the kids have acquired from what you tried to impart to them so if the kids make good inferences they have more or less made progress. (Tr. B)
>
> Because if you are making sweeping statements in front of the class and you don't sort of pick up what the students understand by it, you would probably lose them....
> It is certainly a good way of testing students' understanding of things that you have written, things that they have read and in drawing out conclusions in topics that they have done. (Tr. C)

When asked if they used the word infer/inference when teaching science to their Year 10

B said "Occasionally, I wouldn't say most of the time, I can remember one time for example for the flame test they needed to make inferences", and Teacher C said "No".

Questions 6 and 7 of Section 3 (3[Q-6] & 3[Q-7]) asked "Are there any ideas that 'infer' involves that science students need to know?" and "If yes what are the ideas that infer involves that you think your students need to know?" Consider the responses of the three science teachers to these two questions.

> I guess yes. The idea of something suggesting something else, is possible, but it doesn't necessarily mean that is correct, yes. (Tr. A)
>
> Students have to be taught how to make inferences. You may have to spend some time in teaching them whenever it is possible say 'this is an inference'. (Tr. B)
>
> Ideally yes, I have said that is important but I also said I do not use it, ideally yes. Most things really when you are talking to them , whether you ask them orally or through a series of questions. What they got out of what you said. (Tr. C)

We see these responses as indicating an uncertainty about the questions in the minds of these teachers. The most uncertain answer came from the teacher with the most considered and cohesive views (A), something that seems a clear indicator of the complexity of these concepts and the general lack of consideration of them in formal science study by teachers.

Despite the uncertainty that is clear in the above responses, when asked how they communicate the ideas that infer involves to their science students (3[Q-8]), Teachers B and C expressed definite views. Teacher A remained uncertain. This is consistent with the possibility that Teachers B and C did not recognise the complexities in this issue.

> Never thought about it. I guess it would be in terms of prac I would try to make students aware that from certain information you can draw conclusions, and other information may suggest certain outcomes but you can't conclude. That certain results may suggest something, in some cases you can conclude it , but others you can't. (Tr. A)
>
> I don't use the word inference I use the [phrase] "What could you deduce from this?" is that the same word? In maths we use deduce, sometimes I use the word " What can you conclude, or "What kind of decision can you make? What kind of conclusion can you arrive at? I think kids can understand that better, because if you use the word deduct maybe the kids are lost, I see that in maths, but if I use the word: "From these kinds of observations what can you arrive at? they understand". When you come to Year 11/12 you have to use the word infer, in lower levels "what can you make out of it? that I think gives them the idea of infer. (Tr. B)
>
> Usually through questions to the class and then sometimes I will give them questions, and I must admit also sometimes I do that for them. I make the connections for them, specially when it seem that they don't know anything about it I make the connections for them, I might do some explaining summarising on the board. I find that most of the time I have to do

This response from Teacher C ("... I must admit also sometimes I do that for them. I make the connections for them, specially when it seem that they don't know anything about it I make the connections for them ...") is particularly revealing when placed against the opinions of some of his students that emerged in interview. Some typical examples were

Student 2C: I don't really pay attention unless I really need to ...always there for us like the teacher already explains to us why it happens

Student 11C: If I know what is going to happen, I don't look at it if I know and he [teacher] has told us I don't really look

The impact of Teacher C and his approaches to observation by students in his classes was profound, and, in terms of the ways students then approached observing, unfortunate.

CONCLUSION

Not surprisingly all three teachers saw observing as of great importance for science learning. However they expressed quite different reasons for this view. Teacher A saw observation as important in the process of individual construction of knowledge, Teacher B talked of strengthening their theory and fostering interest, Teacher C described learning as directly coming from observation (in rather Baconian terms). Again these differing views were quite consistent with the ways these teachers differed in their classroom approaches to the use of experiments, and with the trends in the views expressed by their students.

Given the importance attached to observing, it is again not surprising that all three teachers saw some forms of direction to student observation (from teacher or teaching approaches) to be appropriate. However there were clear and significant differences between the teachers in terms of the sources they saw for this direction, differences consistent with both the above teacher reasons for the importance of observation in science learning and the nature of the classroom practices adopted by the teachers. The student data is also most consistent with the views of the teachers about how direction of student observing did/should occur: Class A students the only ones to recognise the "indirect" forms of direction argued by Teacher A; most Class C students seeing the direct teacher direction advocated by Teacher C as the sole determiner of their approaches

All three teachers believed that at least some of their students undertook some form of self questioning when they were observing; both Teachers A and B supported this view by discussing the asking of questions by their students during experiments; Teacher C could only talk of "natural curiosity and had no thoughts as to how he might know if such self questioning was occurring. Again there was substantial consistency between these views, the views expressed by their students, and what was observed in their classrooms. Only Teachers A and B clearly indicated that they saw forms of mental processing involved when they themselves were observing in a science experiment. All three saw forms of mental processing such as self questioning during observation as important for the learning of science; all three had suggestions of some real value to make about how one could encourage students to undertake such metacognitive approaches to observing. Yet both the interview data and the classroom observations make it clear that Teachers B and C did not do anything to attempt to foster student self questioning, and both teachers clearly recognised that they did not do this. Teacher C appeared to suggest that he thought he should; Teacher B was very clear in stating that he should not because of the difficulties he saw in keeping students on task in the laboratory (and, by inference, he thus saw the teaching of approaches to self questioning as likely to generate more off task behaviour!). As in so many of the perspectives that emerge from this study, we note that Teacher A had clearly articulated, cohesive and justified views on mental processing and self questioning, and both his classroom practices and the opinions of his students were strong reflections of these views.

One of the surprising results from the student interviews was that many students saw observing as a different process in each of the different areas of science - Physics, Chemistry, Biology. Teachers A and B also believed that student observation was undertaken differently across different areas of science, but they did not see the nature of the differences in the same way as their students. Teachers saw these hypothesised differences in terms of student interest and engagement, students tended to see the process of observation itself as different in each of the three areas of science.

All teachers recognised that not all students engage with observing tasks during an experiment. Where large laboratory groups of students were involved, all teachers recognised the division of labour that is commonly adopted by students. When judged in terms of science learning, teachers and students had very similar views about the optimal size of a student laboratory group and the negative consequences of groups greater than two. When the issue of student engagement with observing was considered more generally (that is beyond the context of group size) again all teachers saw that not all students engaged with observing. Teacher A saw this in terms of differential student interest in the tasks and in the specific processes of observing, recording etc; Teachers B and C saw this as a matter of what students chose to not do.

The teachers differed in their views about inference and its significance to science learning. While all saw this as important, the views of Teachers B and C contained a certainty that suggested an inadequate recognition of the complexity surrounding this issue and was clearly inconsistent with their classroom practices.

The above brief summaries suggest that the three teachers might be regarded as A being the "best" of the three and C the "worst". Across all data (teacher and student interviews, pencil-and-paper instruments, extensive classroom observations) this trend is most consistent:

- the ideas and beliefs of Teacher A are consistently more informed, more cohesive, more consistent, and more substantially justified than is the case for Teacher C, while Teacher B is always with A or with C or between;
- the students of the three classes expressed views that followed the same patterns;
- within the classrooms the engagement of students with experiments followed the same patterns.

The overall cohesiveness of the various data sources in this way indicates that the impact of teachers on the views of their students about observing and its purposes is indeed substantial and, much more importantly, predictable given the ideas about observing and experimenting held by the teacher.

REFERENCES

Appleton, K. (1990). A learning model for science education: Deriving teaching strategies. Research in Science Education, 20, 1-10.

Driver, R. (1983). The pupil as scientist. Milton Keynes: Open University Press.

Driver, R. & Bell, B. (1986). Students' thinking and the learning of science: A constructivist view. School Science Review, 67, 443-456.

Gabel, D. (1994) (ed.) Handbook of research on science teaching and learning. New York: Macmillan.

Gunstone, R. (1993) Constructivism and metacognition: Theoretical issues and classroom studies. In R. Diut, F. Goldberg & H. Neidderer (eds.) Research in physics learning: Theoretical issues and empirical studies. Keil,: IPN.

Gunstone, R. (1994). The importance of specific science content in the enhancement of metacognition. In P. Fensham, R Gunstone & R. White (eds.) The content of science: A constructivist approach to its teaching and learning. London: Falmer.

Haslam, F. & Gunstone, R. (1996, April). Observation in science classes: Students' beliefs about its nature and purpose. Paper given at the meeting of the National Association for Research in Science Teaching, St. Louis.

Haslam, F. & Gunstone, R. (1997, July). Ideas about observation held by science graduates. Paper given at the conference of the Australasian Science Education Research Association, Adelaide.

Malcolm, C. (1987). The science framework P-10: Science for every child. Melbourne, Australia: Ministry of Education.

Millar, R. (1990). A means to an end: The role of processes in science education. In B. Woolnough (ed.) Practical science. Milton Keynes: Open University Press.

Rowell, J. & Dawson, C. (1988). What's in a solution? A look at logic and belief in problem solving. Research in Science Education, 18, 143-151.

Russell, A., Black, P., Bell, J., & Daniels, S. (1993).Assessment matters: No. 8 - Observation in school science. Her Majesty's Stationery Office, London: School Examinations and Assessment Council.

White, R. & Gunstone, R. (1992). Probing understanding. London: Falmer.

Table 1: Propositions about the piece of chocolate and the responses of teachers

Propositions about the piece of chocolate	The response of		
	Teacher A	Teacher B	Teacher C
1. The chocolate is light brown	√ •	√ •	√ •
2. The chocolate is made in Australia		√	√
3. The chocolate is hard	√ •	√ •	√ •
4. The chocolate must contain some sugar		•	
5. The chocolate will melt easily	√ •	√ •	
6. The chocolate contains cocoa	√ •[3]	•	√

Note: Statements ticked in response to the pencil and paper teacher instrument are indicated by a "√ ". Statements selected as observations during the interview are indicated by a "•"

[3] In another part of the interview Teacher A said "and the chocolate contains cocoa is again … maybe a fairly believable assumption"

APPENDIX 1: INTERVIEW SCHEDULE FOR TEACHERS

KEY: I = Interviewer
Q-C. = Question Card, used by interviewer
E-C. = Event Card (refers to the event presented in the scenario of the section), placed in front of interviewees

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Section: 1
EXAMINING A PIECE OF A CHOCOLATE

Scenario: 1 (An unwrapped piece of chocolate is given to the teacher)

I: I want you to touch, taste, smell and look at this chocolate. Here is a card that contains statements made by other people about this chocolate. Read the statements aloud and tell me which statement, or statements is or are observations.

E-C: 1

Statements made by other people about this chocolate.

1. The chocolate is light brown.
2. The chocolate was made in Australia.
3. The chocolate is hard.
4. The chocolate must contain some sugar.
5. The chocolate will melt easily.
6. The chocolate contains cocoa.

Q-C: 1

1. Read the statements aloud and tell me which statement, or statements is or are observations.
2. Why did you say that this statement/these statements is/are observations? Explain to me.
3. What are the other statements?
4. Why do you think they are -------------------? Why do you say so?

Section: 2
TO OBSERVE

Scenario: 2

I: You have asked your students to conduct observations during science experiments.

E-C 2

OBSERVATION

Q-C: 2

1. During science experiments what does the word observation mean to you?

3. If yes what are they?
4. Do you think observation is important in science?
5. How does observation help your students to learn science?

Section: 3
INFERENCE

Scenario: 3
I: Sometimes some science teachers use the word infer or the word inference, these words also appear in science text books.

E-C 3

INFER

INFERENCE

Q-C: 3

1. What does the word infer mean to you?
2. What does the word inference mean to you?
3. Do you think inference is important in science learning? Yes or No?
4. Why do you think inference *is important* in learning science?
4. Why do you think inference *is not important* in learning science?
5. In what way do you think inference is important in learning science?
6. Do you use the word inference when you teach science to Year 10 science students?
7. Are there any ideas that "infer" involves that science students need to know?
8. If yes what are the ideas that infer involves that you think your science students to know?
9. How do you communicate these ideas to your science students?

Section: 4
WAY OF DOING THE OBSERVING

Scenario: 4
I: A few days ago, in another school I was talking to some students about the way in which
they perform their observations during science experiments. Some of their responses have been written on this card.

E-C 4

1. Christina: Only one person does the observing.
2. Tonia: Every person does her own observing, in our group.
3. Brendan: My science teacher does not ask us to observe individually , so we copy the observations of the person who does the observing.
4. Jenny: The person who does the observing dictates the observations ..... and others copy.
5. Ian: Sometimes I copy the observations made by others, and sometimes I do the observing.
6. Michael: Only one member of the group does the observing, but in our group, we discuss

7. Nadia: We do not discuss during the observation part of the experiment, only after the observations are copied by all of us in the discussion part.

Q-C 4

1. Which of the above statements, about the way students "do their observing during science experiments", do you think applies to most of your students in your science class 10__-?
2. Tell me something different about the way you think, your students do, the observing during science experiments.
3. Tell me, something more which can help me understand the way your students do the observing during science experiments.

Section : 5
PAYING ATTENTION

Scenario: 5

I: When talking about paying attention to a particular thing whilst observing during science experiments, some students said. " I pay attention to only what my teacher has asked me to pay attention to," and others said: "I pay attention to what I think I should pay attention to."

E-C: 5

- I pay attention to only what my teacher has asked me to pay attention to.
- I pay attention to what I think I should pay attention to.

Q-C: 5

1. How do you think your students decide/know what to pay attention to during the observation part of an experiment?

Section: 6
THINKING DURING OBSERVING

Scenario: 6

I: I was trying to explore ideas that year 10 science students have about observation during science experiments. Whilst we were talking about the thinking that goes on during observing, Mark said:" I do two different things, one in my mind, and the other to write down in the Prac. report. In the Prac. report I write what the teacher wants , but in the mind, I ask questions and wonder, I understand what I am learning after this wondering."

E-C: 6

Whilst we were talking about the thinking that goes on during observing, Mark said:" I do two different things, one in my mind, and the other to write down in the Prac. report. In the Prac. report I write what the teacher wants , but in the mind, I ask questions and wonder. I understand what I am learning after this wondering."

Q-C: 6

Here, Mark refers to the questions that he asks himself in his mind.

1. Has this happened to you, whilst you were observing a science experiment in your own learning?
2. What sorts of questions do you ask? Tell me about them.
3. Do you think your students do this?

3b. Why do you think so?

4. What sorts of questions do you think your students ask themselves whilst they are observing an object or event? Tell me about them.
5. How many students in your class do you think already ask such questions whilst they observe?

5b. Why do you think so?

6. Do you think it is important to encourage students to ask such 'thinking questions' during science experiments?

6b. Why do you think so?

7. During this term how have you communicated the need to ask these 'thinking questions' during observations?
8. What sorts of 'things' do you think you have done or we can do to encourage students to ask themselves "thinking questions" whilst they are observing an object or event? Tell me about them.

Section: 7

GOING ABOUT DIFFERENTLY

Scenario: 7

I: When I was watching the videotapes of your Year 10 - class I thought that your students were going about the prac differently when they were working in groups of three or more.

E-C: 7

When I was watching the videotapes of your Year 10 - class I thought that your students were going about the prac. differently when they were working in groups of three or more.

Q-C: 7

1. Do you think your students go about their prac differently?

If "Yes"

2. What do you think is the difference?

2. What do you think could have given me that impression?

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