ABSTRACT:

The discourse of formalised science in classrooms has often been criticised for alienating students and preventing them from learning in a way which would help them to understand their physical world and become citizens empowered to participate in democratic processes. In the research study being reported here, a Year 8 science teacher and I attempted to respond to students' difficulties in learning science, by introducing activities designed to help demystify tasks which often confounded students who were mainly from lower socio-economic status backgrounds and who tended to have poor academic literacy skills. We found that when these activities took place in a trusting environment where students' concerns and feelings were respected, then language, teacher-student relationships and curriculum practices were all transformed to some extent to produce a learning environment in which students became more actively involved in the curriculum and in their own learning. There are many theoretical and practical implications of these findings.

Significant problems in science education reported in the literature include alienation from science and an accompanying lack of cognitive engagement (Lemke, 1990), lowered participation in the study of science in the post-compulsory years (Fensham, in press; Tobias, 1990), as well as worrying signs that much teaching in science has failed to engage students' learning at a sufficiently deep level that they change their alternative conceptions, a problem found at all levels (Pfundt & Duit, 1994).

In research prior to that reported in this study, I had come to the conclusion that students who did not have a middle class background were often confounded by the ways of writing and talking in science (including but going beyond the technical use of language) and that some teachers were oblivious to this situation. Consequently, failure which resulted from a lack of such a literacy was not recognised as such and was too often mistakenly blamed on students' lack of "intelligence" and/or lack of a serious commitment to learn, both of which left teachers with little hope of making an impact, no matter what strategies they tried. Students who accepted these assessments of their ability and character were also likely to become discouraged and give up on themselves.

My reading of the science and broader education literature convinced me that researchers theorising about learning in science education needed to take into account both psychological and sociological factors, including students' motivational beliefs, the nature of the teacher-student interpersonal relationship, and other curricular constraints on self-regulated learning (e.g., Collins, Brown & Newman, 1989; Pintrich, Marx, & Boyle, 1993; Roth, Rosen, et al., 1992; Wubbels, 1993). I saw
possible solutions in terms of finding ways to improve students' willingness to engage with new conceptions by creating learning environments, and more specifically, learning situations, where they actively reflected on their learning in a supportive teacher-student relationship, what Watts & Bentley (1987) called a "non-threatening learning environment", or in what Roth et al. (1993) called a 'learning community'. Metacognition was a key term (Baird, 1986), but, as I saw it, this had to be broadened to include a focus on the emotional self (Borkowski, Carr, Rellinger, & Pressley, 1990; Paris & Winograd, 1990), a position which, at an intuitive level, probably also contained the seeds of an awareness that an historical and political perspective would represent an even more empowering level of metacognition (cf. O'Loughlin, 1992).

For such learning activities to work, however, ways would also have to be found to decrease teacher messages which discounted students' rights or ability to think for themselves, which Roth et al. (1993, see also O'Loughlin, 1992) argued were implicit in more task-oriented science teaching methods. Although Roth's theory of conceptual change (Roth et al., 1993) evolved out of her earlier work on discourse in science classrooms (e.g., (Roth, Anderson and Smith, 1986), it coincided with a popular constructivist movement in science pedagogy theory in other countries (Driver, 1988; Driver et al., 1994; Fensham et al., 1994; Tobin, 1993; Osborne & Freyberg, 1985; Solomon, 1994). Constructivist approaches to teaching were similar to the approach used by Roth and her colleagues in trying to build bridges between students' prior learning and new learning, and in seeing science language as being something which could not be transferred unproblematically from teacher to students but which would need to be constructed or reconstructed by the student, preferably in a meaningful social context (Bell & Freyberg, 1985; Fensham, Corrigan & Malcolm, 1989).

However, whereas constructivist approaches could be seen to depict the solution largely in terms of cognitive reconstruction of conceptions, individually or socially, as though motivational beliefs could be taken for granted, Roth et al (1993) stressed the importance in the learning environment of implicit messages which would change students' epistemological beliefs in the direction of their becoming self-directed learners who would participate actively in such learning. White (1993) argued that "conceptual change" in science was about changes in beliefs and, as such, much more difficult to change than anticipated by science teachers and researchers. I surmised that this resistance to change arose because beliefs (often) have emotional components which may indicate that they are closely tied to deep-seated cultural values. In fact, I have come to believe that all human knowledge is likely to have emotional ramifications at some level, and that research in science education should take this possibility into account more than it generally has in the past, with the exception of research about gender and the study of science. My beliefs in the importance of emotions in learning combined with an interest in learning environment research led me to do research on changing the implicit messages being conveyed in classrooms which might reduce engagement in learning. Although, given the science education context, and my background in psychology, I tended to frame my research in terms used in cognitive psychology, I can now see in it an implicit sociocultural/sociolinguistic perspective which had its roots largely in my pre-PhD experiences, and which was reinforced by occasional texts I encountered while I was reading about motivation or constructivism (e.g., Blumenfeld, Mergendollar & Puro, 1992; O'Loughlin, 1992). A further reason that my research has taken the direction it has, is that as a former English teacher, French teacher and adult literacy teacher, I had a
particular perspective on how language could be taught and learnt in classrooms, which was largely the result of my experiences as a teacher putting into practice curricula which I now realise were based largely on varying combinations of immersion, 'progressivism' and genre approaches to language teaching (cf. Kalantzis & Cope, 1993; the New London Group, 1996), as well as on humanistic psychology and critical theory (Treloar, 1994). My experiences with one of my children who has had specific learning difficulties in language learning has no doubt also influenced both my 'espoused theories' and my 'theories-in-use' (Argyris & Schon, cited in Dick, 1996). When I deal with the design and methods for this research, it will become clearer why these implicit theories are also considered important in this research study.

Given my particular perspective, it was not surprising that in the earlier study mentioned above (see also Hanrahan, 1995) I had found that, especially for working class students and for low literacy students, there was a considerable gap between the language register expected by the teacher in formal situations, such as practical reports and unit tests, and the language register of students, and I saw how methods used in adult literacy teaching might help bridge this gap, so that students could have more meaningful learning experiences in such science classrooms. To some extent I saw the science classroom both as a foreign culture to which students needed a guide (cf. Aikenhead, 1996) and a learning environment which needed to become more interactive to allow more meaningful learning to take place for more students.

Methodology

The Context

The class happened to be a 'low literacy' class, with average scores on an entrance test much below those of recent years. There were 15 boys and 9 girls, with several English-as-a-second-or-other-language students among them.

The teacher was an experienced teacher of many years' standing, who also taught mathematics and senior physics, but who had come late into teaching, having had a prior career as an engineer. He believed that one could always learn more about teaching and was prepared to give even my rather unconventional research proposal a go. A particular concern of his was the poor scientific literacy of students in advanced classes and he was keen to give special attention to language skills. He taught in a largely transmissive mode, with students listening as he introduced and expanded on new concepts, keeping his audience fascinated and at times spell-bound with well-timed, often exciting, demonstrations and interesting stories.

The students tasks were to be quiet and listen, to copy down notes from the blackboard, do textbook exercises, and one day a week, during a double period, do a group practical activity in small groups, but without any follow-up discussion on it either orally or in writing. To give an idea of the scope and purpose of the language activities, Table 1 lists most of the activities we did. In general, they can be seen to fit into four language use categories, three to do with addressing specific language skills, and one to do with broadening the boundary of what is allowable in science: activities which involved active use of language by students (small group work, "Living Things" & "Forces" worksheets, whole class discussion); distinguishing the use of
language in science discourse from that of the more usual discourse in these students' lives outside the science classroom ("Living Things" and "Forces" worksheets, whole class discussion, "Helpful Hints for Tests" worksheet); raising awareness of the nontransparency of word meanings and to some extent larger chunks of discourse, such as paragraphs, pages, and chapters, and even schools, on the part of both the teacher and the students (using publishing clues to find the main points to learn on a page, getting an overview of a new topic, "Finding the Main Idea" activity, presentation revealing my ideological perspective, the worksheets on "Living Things" and "Forces", whole class discussion) arousing personal interest in students and allowing emotional responses (small group work, worksheets on "Living Things" and "Forces", presentation revealing my ideological perspective, whole class discussion, getting an overview of a new topic, suggested changes to unit review (test), choosing an interesting question.

[Table should go here. Please email me at m.hanrahan@qut.edu.au for the file in the format you prefer. Or check for it on my PhD web: http://www.fed.qut.edu.au/staff/mste/mhanraha/phd.htm.]

Analysis

The data used for the analysis came from my notes based on classroom observation, formal and informal discussions with the teacher and the resource teacher, student group interviews and entries in the students' journals. I would describe my analysis of the data as a "Phase 2" ethnographic approach (Woods, 1985) since considerable theorising had already been done and "grounded theory research" was no longer an accurate description of the process. As explained above, much of this took place in my analytic memoranda and journal writing, where "openness" and "creativity" (cf. Woods, 1985) were important additions to the usual self-critical criteria used for testing developing theories (cf. Strauss & Corbin, 1990, Guba & Lincoln, 1989). The student interviews, as well as featuring in my journal writing, were also analysed more systematically with the help of NUD*IST software (Richards & Richards, 1991).

Findings and Discussion

As well as listing most of the activities we tried in answer students to problems with the curriculum, Table 1 also names the kind of problems I thought I/we were addressing with these activities, the outcome I hoped it would have for the students and/or for the teacher, and the positive implicit messages I thought these activities might convey. I hoped these messages might counter some of the negative implicit messages which were inevitably part of the kind of curriculum which Lemke (1990) argues builds a false mystique around science and implies to most students they are not capable of learning it successfully and, as non-experts, have no right to be critical about anything to do with science.

At first I tried to group these beliefs (e.g., into messages about what learning and teaching are about, messages about students' rights and teachers' responsibilities, and messages about ideological beliefs) but I found this difficult because all are so closely interrelated, with epistemological beliefs, language practices, interpersonal...
relationships, and ideological beliefs being so interdependent (Lankshear, 1994). Taken as a whole the listed implicit messages amount to a different Discourse, a different "way of being in the world" (Gee 1993, cited in Lankshear, 1994), a more constructivist or democratic rather than authoritarian perspective of the world, a view which seeks to consider all students' rights to education, and not just the interests of a small elite (Lemke, 1990). Lemke, wrote that the way science is usually taught and presented, was "not as a way of talking about the world, but as the way the world is" (p. 126), in other words as being incontrovertible, objective truth. This is in contrast to the way real science is and different authors have questioned both the moral and epistemological bases of accepted scientific ways of presenting knowledge to the public (Medawar, 1969; Connolly, 1989; Kuhn, 1977, cited in Chalmers, 1990), and of how it is generally taught (Aikenhead, 1996; Fensham, in press; Lemke, 1990).

As I commented in the methodology section, my host teacher was not someone who subscribed to constructivist beliefs. Early in the research, in both interviews and in informal conversations, he talked about the necessity of covering the same content and keeping the class strictly disciplined, and about the tendency for students to be lazy and to need talking to sternly occasionally to make them work harder. For example, at one stage, when I was particularly despondent about his ever sharing my emancipatory concerns for his students, I wrote in my notes on a class,"T seems more and more fixed on the notion that students are naturally lazy and that the way to combat that is to be stricter and stricter with them, to give them demerit points, and lecture them about working harder, about school being not about having fun, but about knuckling down and getting their work done. Very much the factory style classroom environment, where tasks get done, people listen and follow instructions, the people with the best products are rewarded, and individual learning is not so prized." (Analytic memoranda, 23 July, 1995)

Later in the research he commented that my being there meant that he resisted the temptation to berate the students about "becoming slack". I was apprehensive about letting him participate in the affirmational dialogue journal writing activities, for fear he would use them as an opportunity to pass moral judgements on the standard of the work and would destroy the trust I had been building up with students in both their journal writing activities and in the group interviews I had conducted with them, and which I thought was so necessary for them to feel somewhat free to express their own ideas and opinions. On the other hand, he had invited me into his classroom, even after hearing me enthruse about "non-threatening learning environments", and had not undermined the journal writing activities but had in fact supported them, regularly giving me short bursts of time to explain my view of the activities, give students positive feedback, or introduce new activities and allow time for writing, and he had not taken advantage of what he could have learnt about students' opinions in their journal entries to given them a hard time. He seemed to be as aware as I was that trust was crucial to their success. It was as though he thought my methods were appropriate for me, and perhaps complemented his, but were not the kind of thing which would be useful to him as a science teacher.

Consequently, I was apprehensive the first time he set a journal writing exercise himself and also wrote responses to the students' entries. I needn't have worried, however, as he responded as empathetically as possible to student concerns, even
when students wrote such things as "my mark...sucks" and "I dislike science". For example one student wrote,
My mark of c3 test Biology was poor it sucks. My marks are all failers. I try god knows I try. I study, read an write nothing works I dislike science. I know for a fact that in Chapter 4 test my mark will be low. Mr Y works to fast and I dont have time to catch up. I am scared. My parents say I am the brain the most intellegent of all. but I'm just letting them down. ("Pan-Pacific", 14 August, 1995)and Mr Y replied, I believe you are very intelligent. You may find that the answer to your problem is quite simple. One main reason why people fail is because they cannot work out what the question is asking. One way would be to show me your answers to questions from the exercise. It is a start. TY.

In reply to other students' entries, he also invited them to ask him more questions, which I found ironical at the time, because I knew (from the interviews) that students complained bitterly about his going too fast, their not understanding what he was saying, and the futility of putting their hands up. One day I tried to model how to ask the teacher a clarificatory question during a demonstration (I asked could the last step in the demonstration be repeated because I didn't see it very well) and could see by the shock it caused everyone, including the teacher, that I had indeed broken an unwritten rule of classroom procedure in this class (cf. Lemke, 1990). One was meant to watch and not disturb the proceedings. Yet I thought that my perception of the teacher as having a real dialogue with the students increased as the year went on.

Whereas early on I believe that everyone took for granted that it was the teacher's agenda alone which counted, later on students' concerns seemed to become a more important predictor of the course a class would take. Some time after I had given my presentation on what I thought schooling and science education were about, the teacher began a class by telling the students why he thought it was good for them to study science, and this time, it was not to do with preparing them for the following year's study and for Year 12 (which were the reasons he gave me in our first interview), but rather to give them more choices of a career later on, a subtly different reason.

This amounts to a substantial shift in the dynamics of the curriculum. The fact that he was discussing the question was a major change in custom. Up until then, there had been no justification of why students were studying either science or the topics they studied, as though the value of learning the given curriculum was so obvious to everyone that it didn't need discussing. Now it had become something one could discuss and this may have lead the teacher to question the appropriateness of the usual curriculum. In the first half of the year, he would apologise to me on occasions because the class was getting behind, as this meant there would not be any time for us to do extra activities until he caught up, but towards the end of the second semester he blithely forewent a short unit of study, saying that it was just as well to spend more time on the current topic.

There is also some evidence that the students agreed with him. As I wrote in a letter to the teacher the following year, two quite articulate girls explained to me, in an interview near the end of the period of the research intervention, that they didn't mind getting behind the other classes, because they were getting more work done with the extra writing they had to do, and, in fact, they seemed to be implying "that it was the
teachers in the other classes who got through all the chapters rather than the students, and that their own learning had been deeper." (Personal letter, 10 March, 1996) In the words of the students: OL: We're all a chapter or a half a chapter or something behind all the other classes, but we've been doing more work, like within the BLAST book, that's why. We end up doing more work than they do, because of us doing the BLAST activities and all that. TA: The other teachers rush through it just to make sure their class is in front, you know their class is the best, they've got to be in FRONT of everyone else. [Extract from interview, 21 November, 1995]

Another sign that the curriculum was becoming more dialogical was the increasing time given to inviting students to have their own reaction to the curriculum and to ask more questions. Late in semester 2, after we had together planned and carried out many more language activities, in some of which I was able to encourage more student participation as I addressed their concerns, and in some of which I talked for too long and used language well above their level of understanding, the teacher became (gently) critical of himself as well as me for talking at great length, and started to introduce more activities focused at the level of understanding of students and concerned with connecting up with their personal interests, for example what might be called a warm-up exercise for a chapter on one occasion.

In one of the last classes I attended, he asked students to write, for homework, any unanswered questions they had about a practical investigation they had just done, and then spent the following period answering their questions, which at first came only from the most confident students, but later from other students as well. In the process he covered many of the concepts he would have covered in any case, but this time, he had the full attention of most members of the class, who were interested in other students' questions about the experience they had all shared in the previous day's activity. In contrast to the practical investigations which took place in the first term, where I was concerned that students did not get to discuss what they had been doing in relation to the concepts and technical terms being addressed, now students were getting practice in putting into words their experience of the investigation and interacting with the teacher's explanations in more technical terms.

With regard to academic results, in the unit on forces in which we had several activities intended to demystify the language of the class or the test paper, and where I negotiated to have subtle changes made to wordings of some questions (for example, to have "For scientists" inserted in front of a sentence which was to read, "Weight should be measured in ________? [Newtons]")), the top and middle-range students tended to score higher than they normally did--2 or 3 points out of 30. The teacher put it down to a good revision class he had given just before the exam, and it is also relevant to comment that the unit was physics, which he had commented was one of his favourite units. Nevertheless, the fact that so many students were attentive during this revision period is significant, and many of the students thanked me in later unprompted journal entries for helping them do better on tests and understand things better, saying such things as that I gave them "study ideas", "hints", "clues", "many ways to study for tests", "ways to revise and improve", and let them "compare words and meaning". It is possible that the creativity the teacher allowed in the teaching of this unit, was partly due to his familiarity with physics as prior research reports have shown that teachers tend to use a less transmissive approach in their areas of
expertise, when compared with areas in which they are not so familiar (e.g., Tobin, Rennie, & Fraser, 1990).

As I have suggested, the students who seemed to appreciate the activities designed to help them revise for the test tended to be the more literate students, and my impression was that the activities were too hard for many of the students. Some students commented on their difficulty in their journals when I asked them to compare the worksheets with regular text book cloze exercises, though more commented that they liked the worksheets because "the teacher will explain" them, they were "easier", "fun - had to think more", "straight-forward". A few students realised that both were necessary for success in the exams. The less successful students were nevertheless grateful for being helped even if they weren't able or willing to articulate how, and in answer to a question about what difference my being there had made, one said, "She gave us a lot of help", another, "We talked a lot. Helped us think a lot", and others that my being there was "helping us with our work", and "helping us with our learning". At the end of the year, the class performed as well as the other classes on the common final examination, in spite of their supposedly low level of general literacy, and their having missed part of a unit.

This result was also rather amazing, considering that this class had developed a reputation in other subjects for being badly behaved and capable of only the simplest tasks. The following year in May, when I was in the school to co-present with T a workshop on journal-writing, and inquired about the teacher's new Year 8 class, according to both the teacher and the subject master, the group seemed to be an extraordinarily attentive class, and could be mistaken for the top stream class. The teacher did not use journals but instead had adopted a post box system, in which he asked students from time to time, perhaps just once a month, to anonymously post comments and questions related to the units they were studying in science. My comment on this would be that once the teacher had got to know one class of students intimately, he could no longer maintain the stereotype that students didn't care and were lazy or stupid; once he had real evidence of the language skills such students were lacking, how desperately many of them wanted to pass their tests, and how demoralised they became when they failed for reasons they did not understand, he did not need to go through this process again in order to teach more responsively subsequently. On the other hand, a second inquiry of mine, this time about "our" former Year 8 class revealed that for a different teacher they had reputedly reverted to their usual form in other classes and had become almost unmanageable.

Findings in Relation to the Research Methodology

With regard to the research methodology, I believe I can say that the teacher and I found this a practicable and rewarding, even if not always comfortable and convenient, way to do research. For this to happen, however, I had to give up my ideas of forcing the research to follow the strict plan I had devised for it, at least in my dreams, and had to allow the teacher's and students' agendas priority most of the time. The teacher, in turn, had to give up some of his assumptions some of the time about what should be happening in his classroom. Both of us had to give up part of what we thought would work best, to allow the other's ideas to be put into practice, and both had to take risks that this would turn out badly for us. As a PhD student, I would have preferred to have the research happen in ways which were entirely consistent with the
thesis which was already half written, research which I could justify against the
sometimes idealistic and impractical action research criteria I had set up for the study.
The teacher would probably have preferred not to have an academic person observing
and critiquing his performance, day in and day out, whether he felt relaxed and
creative or (for example, after a school camp or a difficult weekend writing a new
work program or marking senior examination papers) feeling tired and unmotivated.
Perhaps he did not intend it for that purpose, but inviting me to take classes, and
hence expose myself to the same kind of close observation and critique while I took
risks and made on-the-spot decisions in a classroom of lively adolescents, helped re-
establish the kind of mutual regard necessary for us to have real dialogue about
curriculum and pedagogy.

In the end, even though the research took a somewhat different direction from that in
my original well-defended plan, this was to my advantage, as I not only learnt much
about learning in practical situations, but I had also opened up to exploration, a whole
new, and perhaps more comprehensive, theoretical domain--that of the discourse of
language teaching and learning in science--and perhaps we all, the teacher and
students, as well as myself, gained at least as much from our insights in this area as
we did from the affirmational journal writing activities, as well as learning from the
interaction between the two different kinds of activities we researched. This action
research experience has also been very fruitful for my own research into my own
practice as a researcher, and, although it is harder to see this in oneself, I believe it has
also been transformative for me in many ways (see Hanrahan, in press-a).

Implications

The challenge...is to theorize how to define a pedagogy that is truly empowering
rather than one that merely gives the illusion of power to disenfranchised groups
while actually excluding them from power. (O'Loughlin, 1992)To be relevant,
learning processes need to recruit, rather than attempt to ignore and erase, the
different subjectivities - interests, intentions, commitments, and purposes - students
bring to learning. Curriculum now needs to mesh with different subjectivities, and
with their attendant languages, discourse, and registers, and use these as a resource for
learning. (The New London Group, 1996) I can see many implications, both
theoretical and practical, which emerge from my findings in this study. [I had to cut
down this overlong paper somehow, so have ommitted these.

Briefly there are implications for teachers, for students, for teacher educators,
researcher, curriculum develops, research granters, so I've not included them but will
willingly do so for those interested.]Theoretical ImplicationsWith regard to theory,
this study advanced my thinking about science learning as language learning, and
about science teaching as literacy teaching; it led to refinement of my theories about
learning in general, and it gave me more insight into the problems of school retention
in science and alienation of youth in general. As a reader, you will draw different
implications depending on how the above report interacts with your own current
concerns. In a little more detail, my theoretical implications include the following: .
Learning is a more human process than often allowed for in conceptual change theory.
Learning is deepest when all these processes are engaged. (Feyerabend; 1988;
Maturana & Varela, 1992; the New London Group, 1996; Fensham and Marton,
1992)
Learning is most likely to happen in a learning community. Learning needs to be seen as involving individual agency as well as being a social process. Science teaching is more likely to be successful when science teachers have a good understanding of language as a sociocultural artefact. Some features of the genres of the science classroom need to be made more explicit for some students. Genres are to do with the functional uses of language and some scientific genres may not be appropriate for the classroom. A critical literacy approach to science teaching can be fruitful for all concerned. Allowing children's voices to be heard in the curriculum may be one way of increasing meaningful retention in science education. Reducing anxiety by building trust may allow more attention to be directed towards what is unfamiliar. The Personal is an important part of research.

Practical Implications

From my point of view, there are several practical implications which can be made for science teachers, students, teacher educators, researchers, curriculum developers, for those in charge of research funding at universities.

Practical implications for science teachers.
Practical implications for students.
Practical implications for teacher educators in science education.
Practical implications for curriculum planners.
Practical implications for researchers
Practical implications for those who fund research.
Practical implications for the Creator (only joking)

Limitations of the Study

As a single case study of action research in a single classroom, this report is obviously not intended to have great implications for curriculum reform at the systemic level of curriculum change. However it does suggest that teachers who are open to learning may learn and change without leaving their own classrooms, and that this may be as successful a way of their improving their practice as taking theoretical post-graduate degrees, if not better, since it has been developed in the practical situation with most of the structural and social constraints present. I should mention that my host teacher had been doing this before he ever met me, enlisting the help of the resource teacher, and no doubt has continued to do it since, in one way or another.

On a small scale, it seems to have achieved many of its aims, and more, but for more lasting change on a larger scale, it would have needed to include more of the staff in this school, or elsewhere so that a there would be a group of critical friends who could support each other's efforts for change over a longer period. As Kemmis (1994) argues, although it is good for action research to start small, real lasting systemic change can only be sustained when there is involvement in the research at a broader institutionalized level. Concerted efforts (by myself, my host teacher and the resource teacher) were made to get together a group of teachers interested in collaborating to address such concerns as the widespread literacy problem in the school, especially with the boy, or centered around a theme of social justice, but these were unsuccessful
on the whole, for a number of reasons which are particularly relevant to the focus of this paper. All the same, this research was still transformational in some ways.

During our research, I had serious misgivings about the direction our research was taking. I had hoped that I could somehow be a catalyst in a transformation of the curriculum to become more relevant to the future needs of the students studying it, and yet there I was putting more and more of my creative energies into helping the teacher help students to become more successful in the current curriculum, which I did not believe had their best interests at heart. As a critical action researcher this seemed to represent giving up a critical stance and going back to a technical one. And yet the path we took apparently turned out to be more transformative than I could ever have imagined, with a teacher who seemed to become more willing to allow students to construct their own learning at their own pace, and with an authoritarian environment becoming much more dialogical and democratic.

In the short term when the curriculum could not be altered radically for this group of students, the most just action was to attempt to bridge the gap between their current level of academic skills and the literacy expected of them in the subject, a gap which those who take a sociocultural perspective on learning have argued is present when subjects are presented in the standard discourse to those not skilled in it (e.g., Lankshear & Lawler, 1987; Lemke, 1990; O'Loughlin, 1992).

From a critical literacy point of view, Lankshear and Lawler (1987) have argued that when students enter such classrooms without familiarity with the appropriate Discourse, they may in fact learn an improper school literacy which is dysfunctional in terms of both scholastic success and critically addressing structures of daily life. Hence the most just action for me in the circumstances was to try to help the students develop the appropriate literacy.

Conclusion

As with any curriculum decision, ideology is involved in determining the balance between training students to adapt to traditional beliefs about what school science is and how it should be taught, and encouraging them to become independent and critical thinkers--who may then discover that the curriculum is inimical to their interests! This raises serious social justice questions as to the purpose of science education, and whether it should serve the interests of a particular elite or be more generally relevant to the interests and needs of the majority of students, and of society as a whole (Fensham, 1985, in press; Lemke, 1990). Fensham, Lemke, and others (e.g., Aikenhead, 1996; Fensham, in press; Fensham, Corrigan & Malcolm, 1989) have argued that, rather than prepare students exclusively for careers in science, new science curricula should aim to prepare students to meet their needs as citizens. This would require critical discussion on wider (including social) issues than are currently dealt with in most science curricula, and could not happen without much teacher support for student autonomy in thinking (cf. Grolnick & Ryan, 1987).

In any case, even for those students who do go on to careers in science, many would argue that an uncritically objectivist approach to science teaching and learning is not supported by current thinking in the philosophy of science. Prain and Hand (1996)
argue this in the context of encouraging the use of a greater variety of types of writing for learning in a science curriculum with broader goals.

In conclusion, I would like to suggest that science literacy has less to do with producing correct technical terms and a logical approach to thinking, and more to do with teachers and students engaging each other in ways which are personally meaningful and which promote not only better communication in the short term, but also better personal understanding of the interaction between humans and their physical environment in the long term.

[For further information on this study, please contact Mary Hanrahan on m.hanrahan@qut.edu.au.]

References


Erickson, F. (1986). Qualitative methods in research on teaching. In M.C. Wittrock (Ed.), Handbook of research on teaching (3rd ed.) (pp. 119-161). New York: Macmillan.


Tobin, K., Rennie, L.J., & Fraser, B.J. (1990). Barriers to learning science with understanding. Perth, W.A.: Key Centre for Teaching & Research in Social Science and Mathematics (Especially for Women), Curtain University of Technology.

Tobin, K., & Tippins, D.J. (1993). A question of fit: Beliefs about epistemology, the nature of science, and the classroom learning environment. In K. Tobin (Ed.), Constructivist Teaching and Learning Approaches: Readings (pp. 151-167). Brisbane, Australia: Centre for Mathematics and Science Education, Queensland University of Technology.


