The effect of learning environment factors on students' motivation and learning

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Abstract

This paper reports a qualitative study of the learning environment of a Year 11 Biology class. The research was originally framed in a constructivist epistemology, but was also informed by an emancipatory interest. The main methods used for data gathering were participant observation, interviewing, and a written response survey (CES, Tobin, 1993a). It was found that, even though the students viewed the class positively, and described themselves as highly motivated to learn, the level of cognitive engagement was affected by two interrelated factors: the control the teacher had over almost all activities, and student beliefs about learning in this context. The data suggests that both intrinsic and extrinsic motivation which could lead to deep involvement in learning are constrained by a preponderance of teacher-centred methods of instruction. A model is proposed relating *intrinsic* and *extrinsic* interest to cognitive engagement. It is concluded that more activities should be used which either implicitly or explicitly reinforce positive beliefs about the need for self-direction in learning. A personal perspective has been included in this paper to indicate the non-linearity of the development of theory.

Introduction

Most teachers and researchers would like to know more about the factors which may facilitate or prevent students' deep involvement in learning. This paper is a report of research which explored this question in the context of a Year 11 Biology class.

The study grew out of a large research project investigating the relationship between psychosocial learning environment factors and deep learning in science classrooms (McRobbie and Tobin, 1995; Tobin and McRobbie, 1996; Tobin and McRobbie, In press). The project had an underlying interest in whether pedagogical factors usually associated with a constructivist epistemology were more or less likely to lead to worthwhile learning, when compared to a more transmissive method of instruction.

My training had largely been in psychology, and my implicit and explicit theories of pedagogy had been deeply affected by recent experience and professional development in adult literacy teaching, and this fact led to my research taking a different turn from that of the other researchers in the team. In particular, I was influenced by humanistic theories of learning (e.g., Rogers, 1969), as well as androgogy theory (Knowles, 1980, cited in Boud, 1987) and critical pedagogy (Freire,

1972). These theories have in common goals of increasing autonomy for learners and giving a high priority to satisfying learners' needs, but they emphasize different factors.

The humanistic school stresses the emotional factors which may inhibit learning and the need for a highly supportive and respectful environment to enable learners to validate and express their personal goals, the androgogy school stresses the importance of a high degree of learner participation in co-structuring progress towards desired ends, and the critical pedagogy school generally stresses the need for student empowerment based on increased collective, historical and political awareness (Boud, 1987). The combined effect of these theories was to lead me to suspect that emotional aspects of learning, such as feelings of self-worth and autonomy, were likely to be important factors in deep engagement.

It can be seen that the above theories and constructivism have similar implications for teaching. Both stress the importance of prior learning, increased learner control and reflection, and the social construction of meaning. Such similarities led me to embrace constructivism readily, and I thought that it was from within such a framework that I was interpreting what I perceived to be going on in the Biology classroom, and what I heard in interviews with the students and the teacher, especially since the interviews were based around a learning environment measure which was intended to tap factors which might influence student construction of meaning (Classroom Environment Survey, CES, Tobin, 1993a).

My implicit beliefs, however, were also influencing what attracted my attention as telling data. At first I mainly noticed how well-liked the teacher was and the pleasant atmosphere in the class. Then I started to become aware of the way learning was regimented according to pre-set frameworks. At the same time, I had started to notice subtle nonverbal factors which might make some students feel excluded from the group, but I dismissed these as being based on evidence which was too flimsy. Later however, when these started to accumulate, I began to think they might also have an important effect on student engagement at a deep level, even when the level of motivation was high.

This resulted in a further study (Hanrahan, 1994), in which I created and tested a new learning environment questionnaire based on my reading of the literature, but also on what I thought at the time were largely intuitive findings from this study. In it I suggested that for constructivist approaches to pedagogy to be successful, they also had to take into account the extent to which the student felt affirmed by the teacher, and the extent to which the student perceived teacher support for autonomy in thinking. I thought that these interpersonal factors might increase or decrease emotional constraints on reflection on current and prior learning, and therefore needed to be addressed at the same time as more obvious institutional constraints on student participation in decision-making about the curriculum.

Both the literature and the results I obtained with this new questionnaire supported my theory, but I still felt somewhat uneasy about the extent to which it was grounded in the original classroom study of the biology class. This earlier analysis had been somewhat unstructured and was achieved largely through regular journal writing and analytic memoranda where I analysed and tested my developing hypotheses in an intuitive rather than a more obviously systematic way. This personal writing was based on notes taken during daily observation in the classroom, and during the interviews and my frequent replaying of the audiotapes of the interviews. My concern was that I had

simply missed other telling data, even though it was present in the transcripts of the interviews, because of my selective attention to some things rather than others.

Eventually I decided I had to put away my earlier conclusions and attempt a systematic grounded theory analysis of the interviews, coding all the data collected using NUD*IST software. My concern then became one that such a piece by piece analysis might decrease the chance of creative synthesis and holistic insights. Nevertheless I thought it needed to be done to test whether the method of analysis would have a small or a large influence on the conclusions reached. The following account is the result of this second, more linear analysis of my data.

However, before recounting how the study was performed and what resulted from the analysis, I will give a brief account of the literature which provided the conscious framework for the study. Only much later was I to realize that the other theories referred to above were emerging as being implicit in the interpretation I took.

Background

For me, the research about to be reported grew out of a study of the effects of the learning environment on deep learning. It was based on an implicit assumption that a teaching method based on a constructivist epistemology would be more likely to lead to worthwhile learning than a "transmission" teaching method. A constructivism-based approach would include student-centred methods such as small-group discussion, building on prior learning, and encouraging student participation in decision-making about the curriculum content and processes (Driver, 1988; Driver and Easley, 1978; Tobin, 1993c).

I had been very impressed by studies done by John Baird (Baird, 1986, 1987) which had metacognition as a central theme, and the large PEEL project (Baird and Northfield, 1992), which encouraged students to take more responsibility for their learning. Another strand of literature which seemed very important was the conceptual change literature, with research such as that reported in the seminal article by Posner, Strike, Hewson and Gertzog (1982) which challenged the notion that students' prior conceptions could be easily overturned by practical experiences accompanied by logical explanations from the teacher.

However, review articles by White and associates, (e.g., White and Gunstone, 1989; White and Baird 1991) pointed out that there was a limit to how much students could be helped without their active collaboration, no matter what metacognitive strategies one gave them. It seemed that the problem of how to motivate deep engagement in learning was still far from solved in science education, and this was reflected in the fact that governments around the world were treating participation and retention in science as a major problem and funding large projects to improve the situation.

It also seemed to me that a strictly rational approach to learning, based on being very logical in assessing one's own learning did not allow for the way students might *feel* about what they found when they evaluated their own learning (Paris and Winograd, 1990).

In 1990 Roth (1990) presented her conceptual change model of instruction. The two main pillars of the model were (a) establishing a problem, and (b) providing opportunities for understanding and using scientific concepts. Suggested activities to achieve the first goal included eliciting students' varied ideas about a natural phenomenon, challenging such ideas to create conceptual conflict, and contrasting

students' naive explanations and scientific explanations. The second goal required the teacher to play the role of "cognitive coach" as implied by Collins, Brown, and Newman's (1989) model of cognitive apprenticeship.

By 1992, however, Roth was reporting that she and her colleagues (Roth *et al.* 1992) had discovered that a key ingredient for success with the model was what Collins *et al.* (1989) referred to as the "sociology" of learning, and which Roth and her colleagues made explicit by their contrasting of a "conceptual change learning community" with a "work-oriented class setting". Pintrich *et al.* (1993) also argued that classroom contextual factors were likely to have a significant effect on the motivational beliefs they thought would be necessary for Posner *et al.*'s (1982) proposed conditions for substantial conceptual change. Pintrich *et al.* (1993), named seven motivational belief factors likely to be affected by classroom contextual factors: mastery goals, epistemic beliefs, personal interest, utility value, importance, self-efficacy, and control beliefs.

Consequently, it was through the lenses of constructivism, including theories of metacognition, conceptual change, and the social construction of meaning that I set out to view the learning environment in a Year 11 Biology class. I was, however, particularly interested in where motivation fitted into the puzzle of how learning environment variables affected students' involvement in learning.

Method

The overall study of which this is a part consisted of participant observational research, with the addition of a learning environment survey measure. The particular approach I used was largely ethnographic or interpretivist. According to Erickson (1986) the essence of the interpretive approach lay in its concern with the meanings or interpretations that people ascribed to events in a particular setting. In social research in education this involved a focus on social ecology, that is, a study of the structure and processes of the microculture of the setting (e.g., a classroom) so as to understand "the ways in which teachers and students, in their actions together, constitute environments for one another" (p. 128) and produce "an enacted curriculum" (p. 129).

This approach was therefore consistent with the constructivist epistemology underlying the study; that is to say, the classroom as it was *perceived* by the students and teacher in this case study was thought to be more likely to have an effect on learning than was the classroom in some supposedly more objective sense. Although surveys are not generally used in an ethnographic study, one was used in this case both to give a snapshot of the larger picture at a particular point in time, and to focus the research on the participants' perceptions of the learning environment.

Setting

The setting was a Year 11 Biology class in a local Brisbane high school. The teacher was an experienced Biology teacher and the students were twelve girls and three boys.

Instruments

The main methods used for data gathering were continuous field observations over six weeks (two units of the curriculum), interviews with the teacher and a range of students,

and a survey about perceptions of the learning environment, the CES (Classroom Environment Survey) (Tobin, 1993a). Videos were also taken, but were not used more than incidentally for this analysis, which is more concerned with the perceptions of the students and teacher, as evidenced in their interview transcripts. The whole process was contingent with data collected in each stage informing observation, the conduct of interviews and planning decisions for further stages.

Data gathering and analysis

Although this report is largely based on a post-hoc analysis of the interview scripts, it is also informed by processes used during the data collection which are likely to ensure credibility. These have been summed up by Lincoln and Guba (1985) as (a) debriefing regularly with a "critical friend", (b) ensuring referential adequacy of the data collected, (for example, by using audiotapes of interviews), (c) member checking (in this case by asking for feedback from the teacher and students on the researcher's initial interpretations of classroom lessons), and (d) negative case analysis (re-examining all previous data to test out the validity of assertions as they are being developed).

Efforts were also made to gather enough data to provide "thick descriptions" and to preserve an audit trail in the accompanying journal writing, such measures serving to aid in satisfying the trustworthiness criteria of transferability, dependability and confirmability in qualitative data analysis (Lincoln and Guba, 1985).

For this account, the relevant instruments of data gathering were interviews and the questionnaires completed by the interviewees. The class teacher was interviewed at length twice, once at the beginning and once mid-way through the period of classroom observation. Seven students were also interviewed for shorter periods, averaging 40 minutes), and they were selected progressively throughout the duration of the classroom observation to represent a wide range of students, partly on the basis of classroom observation and partly on the basis of their survey responses. The selection was constrained to some extent by the lack of willingness of some students to be interviewed, but, on the whole, represents a broad range of views.

The first teacher interview and all the student interviews were semi-structured to allow for the triangulation of different levels of data, as described by Tobin and McRobbie (1996): generalized open-ended questions, followed by more focused but still open-ended questions relating to the issues of most interest (those sampled in the survey), finally followed by probes for explanations of why the respondents had answered the survey questions in the manner that they had, both for their actual class and for their "preferred learning environment".

As part of the larger study, the Classroom Environment Survey (CES, Tobin, 1993a), developed within a constructivist epistemology, had been administered at the beginning of the research period (before I became involved), half-way through the school year, and was used to inquire into both the teachers' and students' experiences of the current learning environment, and their perceptions of their ideal learning environment. Sub-scales included items relating to student involvement, autonomy, relevance, commitment and freedom from distractions. (see Table 1 for sample items).

Table 1. Sample Items from the CES (Tobin, 1993).

Dimension	Sample item
Involvement	I talk with other students about my learning
Autonomy	I decide what activities to do
Relevance	I learn things that interest me
Commitment	I try to concentrate on learning
Inhibitors to learning	The layout of the furniture/desks makes it hard for me to learn

The survey also included a series of questions relating to science learning designed to elicit epistemological beliefs in relation to the teaching and learning of science and the production of scientific knowledge but responses to these have not been included in this study. All questions had Likert-type, five-point response scales, the learning environment ones being based on frequency and the epistemological ones based on degree of agreement-disagreement. For the purpose of this study, the survey results were analysed at a descriptive level only.

Data analysis and interpretation were based on a grounded theory method as proposed by Strauss and Corbin (1990), with NUD*IST software being used as an aid in the mechanical processes involved in the post-observation stages of analysis.

Reporting the findings

Although this report has taken account of Erickson's list of requirements for a report (e.g., empirical assertions, analytic narrative vignettes, quotes from fieldnotes, quotes from interviews, and accompanying interpretive commentary at various levels of description), the method of presentation in this case will take a shortened form, that of continuous first person statements by the teacher and a "representative student voice". Although this means that quotations are not always verbatim, it has the advantage of compensating for the out-of- context nature of individual quotations, which may be truer to the letter of what interviewees are saying are saying at any one time rather than to the spirit of the overall meaning conveyed within the relationship of the interview. It is also more efficient in terms of space, since many incomplete statements are often needed to illustrate each particular assertion being made. However, direct quotations are incorporated whenever possible, and transcripts of the quotations on which these accounts are based are available from the author on request.

Such accounts may serve to protect the anonymity of recognisable participants (in any case all names used in this paper are fictitious), but just as importantly, they may serve to convert extracts from spoken dialogue into a written form which is more faithful to the intended meaning than a collection of quotes which have been stripped of their nonverbal accompaniments as well as the immediate context in which they take their meaning, and which often appear more poorly constructed grammatically in their written form than they did as part of a dialogue. This method has been used to good effect by Tobin and his colleagues (e.g., McRobbie and Tobin, 1995; Tobin, 1993b; Tobin and McRobbie, 1996; Tobin and Tippins, 1993).

Results

Overall, I found that motivation was quite high in this class, both intrinsic and extrinsic motivation, but that this did not mean that students found it easy to get deeply involved in learning Biology. Many factors seemed to impede this, including the types of activities the teacher used, the low amount of autonomy students experienced, and internal and external distractions.

In an attempt to summarize the data, I have combined all the student evidence which seemed most consistent into a single narrative by what I shall call a "composite student" whom I have named Nicky. Individual students differed from this account in minor ways, but it is consistent with the majority of the data. I have inserted into it headings which turned out to be the main areas of focus. These headings derive in part from the semi-structured nature of the interview which was based around answers given on the survey, but it will be seen that they are only superficially similar headings, since the activities referred to had different meanings for the participants from those intended by the constructivist survey instrument.

Nicky's Account

Biology is one of my favourite classes. Miss is really good. She keeps students working, and there isn't much noise or distractions. At the same time she is really kind, like a friend, or a parent, and will always explain things to you you don't understand.

[RELEVANCE]I really like Biology because it is such an interesting subject--being all about the body, and the environment. It's really related to everyday life most of the time--not like Chemistry. For example, the kinds of things we have just been learning in reproduction and nutrition. It's useful for a lot of careers which I've considered at one time or another, like physiotherapy, pharmacy, and even for art, sport and drama.

New learning is connected with what I have learned previously, but I probably prefer not to go over the old stuff as much as we do. Because you've been doing the same things since year 7, you know, like photosynthesis, but you're not as interested in it fourth time round as the first time.

[COMMITMENT]I really want to do well in the exams and I try hard to concentrate in class and to study at home, but I have to admit I drift off some of the time. I'm really willing to learn, and would call myself a committed student, but it's boring some of the time. I mean, school is just boring, you know? Listening is an important way of learning in this class and I try hard to listen most of the time but it's not good if you have a concentration problem as I seem to have.

[INHIBITORS TO LEARNING]I find I get thinking about what students were talking about before the class, or about an exam in the following class, or I just have a headache or feel lazy some days. It depends on my mood, I suppose. And then sometimes other students are chatting, or the wind's rattling the blinds, but that doesn't happen too much.

All the same, this hardly happens at all in English, where we're allowed to choose our own topic to write about and negotiate our own assessment, or in art, where you can choose your own topic and your own colours and things like that. And in drama, you're really involved because you're working with a group.

I really should try harder in Biology than in those subjects but I usually find it's the other way around. Except near exam times and then, if I decide when I wake up in the morning, `Hey, you've got to pass this exam!' then I find I can listen and concentrate and the noise doesn't really distract me.

[WORKING WITH OTHER STUDENTS]We do some working with other students in Biology, but it's more of a problem than a help, with people talking about what they did on Saturday night and so on. I find I don't really like asking other students about their learning. I don't know why, really, just a student thing. Perhaps we should all have separate desks but I wouldn't really like that--they're fine as they are.

Sometimes we do get the work done in group activities, but it's mainly the student who knows the right answer telling the others, especially if most of us don't understand what to do, or how to find the answer. Or we ask the teacher and she comes around and gives us a really good explanation. But it means waiting around while she is talking to other groups.

On the whole I don't think working with other students is much of a help, and usually I find I get more out of it if I work it out for myself. But sometimes you can learn from the questions they ask or things they say. All the same there is one student who goes too far and wastes the class time a bit, asking questions about things he's interested in which aren't really going to be on the exam.

[AUTONOMY]We don't get much say in what goes on, but that's OK. For one thing, we don't know enough to be able to choose what should be on the curriculum because we haven't learnt it yet. I would like a bit more say sometimes though. I thought Biology was going to be more about the human body and dissections, which I'd really like, but it's turned out to be about plants, and ecology a lot of the time.

Miss chooses all the activities, and has some variety, with videos, and group activities as well as listening, and doing the `Guide' questions. It would be good if we could have some say in what we do and how we are assessed, because Tina said that at the school where she was last semester, she got to do research on topics they chose themselves and that she got a lot out of that. If you're lazy, you don't even have to solve problems, because after a while Miss puts it on the board anyway and you copy it down and get away with it.

Anyone can join in the class discussion but the teacher usually asks someone who is really smart, and I find I just switch off and drift away. I can talk about my learning with a good friend, but you can't really talk about it with anyone else, especially if you don't know them very well. You can't really tell them to shut up and stop chatting. And anyway, I wouldn't like to be on my own. You can usually sit with anyone you like but sometimes we are put in groups. But you can just not go when Miss suggests. They can't really make you do things at this level, or at least they don't.

Several interesting points emerged from the data. Firstly, I found it curious that the majority of students--from the most to the least successful--identified themselves as having "concentration problems" in this subject, and this was only reduced by increasing extrinsic interest close to examination time. This was in spite of expressed intrinsic interest in the subject and may partly be due to the fact that listening seemed to be the major way in which learning was expected to happen in this class. Furthermore, group activities turned out to have little to do with collaborative construction of meaning, and only served to emphasize the students dependence on the teacher. Autonomy, was in fact, exercised only by *not* cooperating with the teacher when she suggested students work together in designated groups.

Interestingly, students claimed to be free to participate equally in class discussion and to find the teacher generally supportive, but in practice participation usually had to be nominated by the teacher, and all students did not believe that they had the same

opportunity to contribute equally to class discussion. As well, there was even a hint of its generally being seen as unacceptable to contribute too enthusiastically to such discussion. Another sociocultural constraint which militated against fuller participation, was unwritten social rules about what was acceptable in small group discussion.

What I have not been easily able to convey in the above account, is the change in energy level and tone of voice that students exhibited when talking about subjects where they felt more personally involved in the learning process. The matter-of-fact tone disappeared, and their faces lit up as they talked animatedly of what *they* had done, or could do, in such classes-- rather than about what the teacher did. The comparative lack of autonomy in Biology seemed to mean that even well-meaning students ended up depending almost entirely on the teacher, even in problem-solving activities.

My interest in this study is primarily on the classroom as the students experienced it, however, an account of the teacher's experience of the same class will serve to give a fuller picture. In particular, it demonstrates how there may be a large discrepancy between what a teacher intends and how the students experience what actually happens.

Ms Andrew's Account

You ask me what the ideal learning environment would be? I'd have all the students doing individual research, going off to research things in the library or doing different projects around the room.

[COMMITMENT] But usually I find the students are just not that motivated, you know, not really fired up by what we do. Some of them shouldn't be doing the subject, because they don't want to do microscope work, and don't really have a good basis in Junior Science. And some go to TAFE [a vocational education class] on Wednesday afternoons, which is bad, as they usually are the weak ones anyway. Biology really only should be for students who have done very well in Junior Science, but a lot of parents just want their students doing it to get an OP score [an Overall Position ranking given on the basis of Year 12 examination results, used in Queensland for discriminating between applicants who have applied to enter University courses].

I find that in a lot of cases, they haven't got the family background to make them curious about things, and to have given them a good grounding for this subject. Every now and then, though I get a student, such as Mel in Year 12, whose parents are professionals and she is wonderful to have in the class. You know, she speaks my language!

[TALKING WITH OTHER STUDENTS] Group work isn't very useful, because it needs good preparation and skills which many students don't have, and I'm not going to spend time on that--they should already have those skills at this level.

[AUTONOMY] I like having lots of discussion in my classroom, and I tell the students that that is my style right from the beginning, that I don't give out a lot of notes. I know I seem to do a lot of transmission teaching, putting up OHT's to copy, but I do have to make sure they have enough in their books to prepare for exams. I know the other teachers give a lot of notes and the students will come to me before the exam and complain if they haven't got much in their books.

[RELEVANCE] I really like to teach for understanding, and do lots of things to help students understand what they are learning but I'm not sure if I'm equipped to teach scientific thinking or can talk much about what understanding means. If the students can visualise things, then I think they have a pretty good idea. I let them put things in their own words, and only give out my answers to the Guide questions so they can check they

have the right meaning--they don't have to have it in the same words. Though I do think teaching them the language is part of what learning biology is about and I do talk about words a lot and explain how they're made up.

I'm good at asking questions and leading students to find their own answer. And sometimes they are really get charmed by something I tell them, and they'll tell me they remember it years later.

[INHIBITORS TO LEARNING] I would like a different classroom set up with lots of resources around the room.

I think the main problem, however, is the ethos, the Australian anti-intellectual thing. `It's not good to be smart' and to care about learning.

This raises several interesting points. The teacher would like to see her classroom as a place where students largely construct their own learning in a meaningful way, but the message the students seem to receive is that their main task is to be receptive and listen, and that only those who already have the "right" answers can participate in a satisfying manner.

One could see this as a chicken-egg problem about who causes what, but it would probably be more realistic to see it as a socio-cultural system in which the teacher and students play complementary roles, roles which in this case result in lowered levels of satisfaction, both on the part of the teacher and of the students, in relation to the depth of their learning.

Ms A blames the students for not being the "right" kind of students, with the exception of one or two students, and appears to think that rather than adapting the curriculum to fit the class, there is little she can do about the mismatch. Also, it can be seen that there is some correspondence between the students' beliefs that she favours the more able students and her own admission of her preference for teaching them.

She also seemed unaware that class discussion, led by her questions and tied tightly to the curriculum, was not really a time for inquiry and exploration for these students. (An exception to this was one class where the students had been unprepared for a temporary change in the timetable and consequently came to class without any books. This turned into a long and deep discussion of reproduction and contraception, with students providing anecdotes drawn from their own families about the possibilities of such events as tubular pregnancies. In this special case permission seemed to have been given implicitly for the students to break the unwritten rule to only contribute material directly relevant to the curriculum and the exams.)

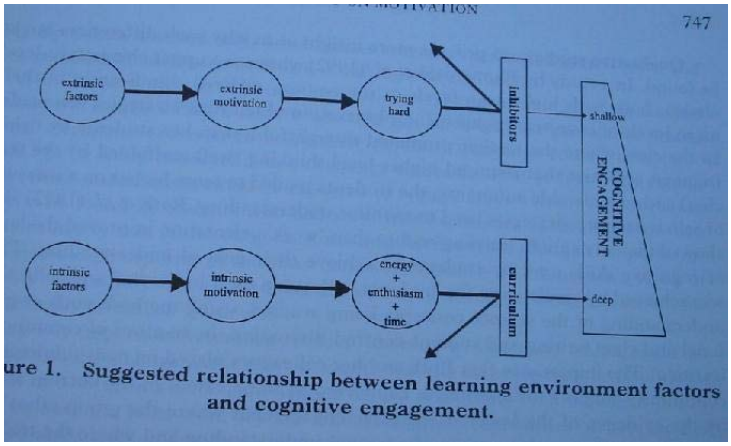

Figure 1. Suggested relationship between learning environment factors and cognitive engagement.

A motivational model of cognitive engagement

To suggest the relationships between these factors and their implications, I have constructed a model relating intrinsic and extrinsic motivation to cognitive engagement (see Figure 1). This attempts to explain how even the highly motivated students in this class rarely reached deep cognitive engagement.

It is being proposed that intrinsic motivation is related to intrinsic factors such as prior knowledge and interest in the subject matter, and as resulting in a willingness to spend extra time and energy seemingly without requiring much effort. However curricular factors such as lack of choice, lack of the opportunity to explore one's own ideas, and lack of support for autonomy may intervene between intrinsic motivation and the cognitive engagement necessary for deep learning. Similarly, it is being proposed that extrinsic motivation, related to extrinsic factors such as good student-teacher relationship, and extrinsic goals such as doing well on examinations and future employment, leads to "trying harder", and more commitment to paying attention and getting tasks done when these seem to require special effort. However, such motivation is more easily prey to sensory and mental distractions by more immediate factors such as noise and day-dreaming, and can also be weakened by perceptions that goals such as teacher affirmation may seem somewhat unattainable. It is to be noted that the model represents two types of motivation and not two types of students. Both these types of motivation will be present in any one student, to some degree.

This model is supported by evidence from many studies. Quantitative studies have found strong relationships between student perceptions of the classroom goal orientation and their own use of deep learning strategies. With junior and high school students, Ames and Archer (1988) found evidence that the perception of students of their classroom goal orientation affected their beliefs in the relative value of effort and ability, and their use of effective self-regulatory strategies. Similar results were found at university level in my earlier survey study (Hanrahan, 1994), where student perceptions of personal empowerment and teacher support for autonomy correlated significantly with a deep approach to learning.

Qualitative studies can provide more insight as to why such differences might be

found. In a study by Blumenfeld, Mergendoller and Puro (1992) where two upper elementary level classes, both with high mean levels of motivation, differed significantly in their mean levels of cognitive engagement, observation of teaching strategies were made. In the class where the teacher promoted thoughtfulness in her students by using frequent activities that required higher level thinking (well-scaffolded by the teacher) and considerable autonomy, the students tended to score higher on a measure of self-regulatory strategies used to monitor understanding. Roth, Rosaen, Hasback, Hazelwood, Peasley, Hoekwater, Ligett, and Lindquist (1992) also showed that an explicit "learning" rather than "work" orientation improved the level of cognitive skills used by students to achieve their goal of understanding. This was achieved by challenging the students to develop their individual and collective understanding of the science concepts being studied, using methods such as personal and class writing and student-centred discussion, in an ethos of community learning. The importance that Roth and her colleagues placed on non-judgmental, community support for learning is supported to some extent in the current study by the evidence of the lowered cognitive engagement where the group ethos did not seem to support the pursuit of personal understanding and where the teacher was seen to favour the students who already understood most of what she was teaching.

Constructivist strategies for teaching and learning

In relation to constructivism, it can be seen that activities that are often seen as linked to a constructivist epistemology, are likely to fail to achieve improve conceptual development when a "right answer" orientation of the students, and perhaps also, in spite of herself, of the teacher, predominates. Thus, much of the time in this classroom, talking with other students ("involvement" in the CES survey instrument) was used to get such answers ready made, either from a knowledgable classmate or from the teacher who was available to any particular group for a small proportion of the time. The rest of the time, small group learning was used for the off-task maintenance of personal friendships. Consequently it was seen by both the teacher and the students (both the givers and receivers of answers) as a largely inefficient manner of teaching and learning, which had little to do with the personal construction of meaning. With respect to the final items on the CES, grouped above under the heading of "inhibitors to learning", student talk was considered one of the main inhibitors to learning, along with other noises.

Another important facet of conceptual change learning which is consistent with a constructivist view is the activity of relating new learning to prior learning ("relevance" on the CES). In this class, this activity was seen by some students as a chance to "drift off", unless the revision of prior learning was presented in a novel manner, otherwise it was seen as having little to do with developing their understanding.

"Commitment" at first sight would seem to represent the level of persistence usually associated with intrinsic motivation and most likely to accompany a constructivist orientation to learning. However, for this class, the CES items (including words such as "try hard", and "pay attention") evoked the meaning of performing actions one did not normally want to do. In contrast, enthusiasm which would make tasks seem relatively effortless was more likely to be engendered by tasks associated with other classes where students had more choice and more personal involvement in decision-making and evaluation.

With respect to participating in decision-making about the curriculum ("autonomy" on the CES), students who did not have implicit permission under normal circumstances even to voice their personal questions related to a topic would not be likely to respond to

a challenge to decide what or how they should study. Such assertiveness could be expected to require empowerment at a level not likely to be found in students who had very little experience of making their own decisions in any area of this subject. Ames and Archer (1988) found that performance-oriented perceptions of the classroom were associated with negative views of students' own ability and lowered self-regulation of learning--even in a school for "academically advanced" students.

Another important hindrance to deep learning in this class which could be inferred from the above participant accounts, was the inappropriate level of difficulty of tasks. Students often experienced failure, for example, in the small group tasks, because the tasks were beyond their conceptual capabilities or because the required skills were unfamiliar and were not being scaffolded sufficiently by the teacher. Socially competent students managed by eliciting early help from the teacher, but, from my observations less assertive or less proficient students were more likely to spend much time waiting helplessly for teacher support.

Conclusions

These findings have several implications for teachers and for researchers, with respect to classroom practices, and the teacher-student interpersonal relationship.

"Constructivist" activities may be counterproductive

Analysis of the data from this study indicate to me that activities which seem based on a constructivist epistemology may be counter-productive when they are not implemented in such a way as to give adequate support for student autonomy in learning and project a mastery orientation to learning. Thus small-group learning, journal-writing, whole class discussion of prior learning, and practical inquiries should not be expected to promote deep cognitive engagement in themselves. The way the teacher implements them and the way students interpret them together are of paramount importance, since the methods used may either reinforce or undermine students' positive motivational beliefs (Pintrich, Marx and Boyle, 1993).

Good planning/training for small group work

Small group work needs careful planning, for example by using structures and procedures which will help overcome "natural" patterns of relating among students in peer groups. Also needed are tasks at the appropriate level, and support which is gradually withdrawn as students become more independent. As the current study shows, without these, small group work is often a waste of time, from the perspectives of both teacher and student.

All students' learning valued

Furthermore, as both Collins, Brown and Newman (1989) and Roth, Rosaen, Hasback, Hazelwood, Peasley, Hoekwater, Ligett, and Lindquist (1992) suggest, a neglected aspect of the classroom learning environment which may enhance positive motivational beliefs, may be a sociological one. These theorists stressed the importance of belonging to a community which values not only the end goals but also all progress towards them. Such

a community provides models and makes explicit the strategies needed for success, and supports gradual progress towards independent, self-regulated action. These sociocultural factors allow for the gradual change in implicit theories or motivational beliefs necessary for deep conceptual change, and may also foster intrinsic motivation and significant cognitive engagement. The implication is that the curriculum should allow such a supportive learning community ethos to develop. Roth and her colleagues showed that this was possible for the study of science at Year 5 level, and the current study and others referred to above (e.g., Ames and Archer, 1988; Collins, Brown and Newman, 1989) suggest that such a community-based learning goal orientation may be important at the junior and senior secondary school levels, but be counteracted by a product-oriented curriculum.

More choice and more voice for students

The study reported also validated the importance of giving all students the chance to be involved personally, whether in small-group learning, personal research projects or class discussion. Support for student autonomy and participation in decision-making about the curriculum would seem to be related to increased intrinsic motivation as well as increased time and energy devoted to the subject. However, there is a caveat: it may not be realistic to expect student participation in the larger decisions about content or methods of assessment, where students do not even have significant implicit permission to contribute personally to class discussion.

Methodological implications

At the micro level, this research provides evidence that the meanings respondents attach to questionnaire items in one context needs to be re-explored for different respondents in a different context, since the meanings that were attached to the items by their author in another setting were not the meanings placed on them by the participants in this setting. Nevertheless, in this study the questionnaire items provided useful triggers for a qualitative study exploring student perceptions of their learning environment.

At the macro level, it needs to be stressed that this is a single case study, and although a model has been developed to explain the relationships between factors as observed in this study, the extent to which such findings can be applied to a new situation, must be based on a judicious comparison of the two contexts.

I would like to restrict the generalizability of the findings in this research even further. During this research, I came to question the extent to which a researcher could actually present the point of view of the participants although this had been my original intention. For example, I may have wished to represent the students' and the teacher's point of view, but since I had a particular theoretical perspective, what I focused on, and what I found was relative to frameworks largely set in place before the research began, frameworks which were possibly very different from those of the students or the teacher I was researching. Hence, they might agree with the facts of the case item by item, and yet disagree with the overall essence of what was being reported (c.f., Erickson, 1995). However, not being as skilled in analysing and talking about research methodology, they are not in a strong position to negotiate meaning with the researcher (for example, during a "member check"), and consequently may defer to the researcher's interpretation. Hence I cannot claim more for the interpretation I am presenting than that it is a convincing one for someone with my theoretical background.

As well, I became more aware of how an observer can be an active participant in a social setting, even though she is apparently only collecting data. I could see how a teacher and students could be changed by the research: in depth interviews getting them to articulate and justify their views would have helped them clarify and explore their practice in more detail, making explicit what had been implicit and unquestioned before, thus helping them see that theories they were claiming to espouse may have clashed with what they had done that day in the classroom.

I would like to sum up by making two points: one about the relationship between student learning and deep engagement and a related one about learning from research. I would like to assert firstly that the teacher-student interpersonal relationship, including the degree to which the teacher affirms the worth of students and supports autonomy in student learning, is an important factor in student involvement in classroom learning.

I would also like to suggest a parallel concern about the nature of the power relationship between researcher and co-participants in classroom research, a concern which led me, subsequent to this study, to turn to collaborative action research, so that teachers also could learn actively rather than be the passive recipients of the results of someone else's learning. I came to believe that if teachers and students collaborated in a more active way in the interpretation of what was taking place, then all participants might be able to contribute to a research account (or perhaps several accounts) which would be meaningful to and advance the learning, not only of the university researcher, but of all directly and indirectly concerned in the research, including future teachers who might read such reports.

The nature of my involvement in this study strengthened in me a view of knowledge which meant that, rather than being something which one person could pass on to others without involving them personally, learning was something which was more dynamic and interpersonal. Consequently, I believed that teachers had to give more importance to the nature of the teacher-learner relationship, particularly as it affected students' learning-related motivational beliefs. The deceptively objective nature of science content did not mean that science teachers could be exempt from addressing the motivational beliefs of their students or from taking into account the psychosocial implications of their classroom practice.

References

AMES, C. AND ARCHER, J. (1988) Achievement goals in the classroom: Students' learning strategies and motivation processes. *Journal of Educational Psychology*, *80*, 260-267.

BAIRD, J. R. (1986) Improving learning through enhanced metacognition: A classroom study. *European Journal of Science Education*, *8*, 263-282.

BAIRD, J. R. (1990) Metacognition, purposeful inquiry and conceptual change. In E. Hegarty-Hazel (ed), *The Student Laboratory and the Science Curriculum*, (London: Routledge), 183-200.

BAIRD, J. R. and NORTHFIELD, J. R. (eds) (1992) *Learning from the PEEL Experience*. Melbourne, Australia. (Published by Editors).

BLUMENFELD, P. C., MERGENDOLLER, J. R. and PURO, P. (1992) Translating motivation into thoughtfulness. In H. H. Marshall (ed), *Redefining Student Learning: Roots of Educational Change* (Norwood, NJ: Ablex), 207-238.

COLLINS, A., BROWN, J. and NEWMAN, S. (1989) Cognitive apprenticeship: Teaching the crafts of reading, writing and mathematics. In L. Resnick (ed), *Knowing, Learning and Instruction: Essays in Honour of Robert Glaser* (Hillsdale, NJ: Erlbaum), 453-493.

BOUD, D., (1987) A facilitator's view of adult learning. In D. Boud and V. Griffin (eds), *Appreciating Adult Learning: From the Learners' Perspective*, (London: Kogan Page), 222-237.

DRIVER, R. (1988) Theory into practice II: A constructivist approach to curriculum development. In P. Fensham (ed), *Development and Dilemmas in Science Education* (London: Falmer).

DRIVER, R. and EASLEY, J. (1978) Pupils and paradigms: A review of literature related to concept development in adolescent science students. *Studies in Science Education*, *5*, 61-84.

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

ERICKSON, F. (1995) *Thoughts on the Evolution of Qualitative Approaches in Educational Research.* Keynote addressed presented at the Annual Meeting of the Australian Association of Educational Research, Hobart.

FREIRE, P., (1990) *Pedagogy of the Oppressed* (Ringwood, Victoria, Australia: Penguin), Translated by Myra Bergman Ramos.

HANRAHAN, M. U. (1994) Student beliefs and learning environments: Developing a survey of factors related to conceptual change. *Research in Science Education*, *24*, 156-165.

LINCOLN, Y. S. and GUBA, E. G. (1985) *Naturalistic Inquiry* (London: Sage).

MCROBBIE, C. and TOBIN, K. (1997) A social constructivist perspective on learning environments. *International Journal of Science Education,* 19 (2), 193-208.

MCROBBIE, C. and TOBIN, K. (1995) Restraints to reform: The congruence of teacher and student actions in a chemistry classroom. *Journal of Research in Science Teaching, 32*(4), 373-385.

PARIS, S. G. and WINOGRAD, P. (1990) How metacognition can promote academic learning and instruction. In B. F. Jones and L. Idol (eds), *Dimensions of Thinking and Cognitive Instruction* (Hillsdale, NJ: Erlbaum), 15-51.

PINTRICH, P. R., MARX, R. W. and BOYLE, R. A. (1993) Beyond cold conceptual change: The role of motivational beliefs and classroom contextual factors in the process of conceptual change. *Review of Educational Research*, *63*, 167-199.

POSNER, G. J., STRIKE, K. A., HEWSON, P. W. and GERTZOG, W. A. (1982) Accommodation of a scientific conception: Toward a theory of conceptual change. *Science Education*, *66*, 211-227.

ROGERS, C. R. (1969) *Studies of the Person. Freedom to Learn (A View of What Education Might Become)* (Colombus, OH: Charles E. Merrill).

ROTH, K. J. (1990) Developing Meaningful Conceptual Understanding in Science. In B. F. Jones and L. Idol (eds), *Dimensions of Thinking and Cognitive Instruction* (Hillsdale, N.J: Erlbaum), 139-175.

ROTH, K. J., ROSAEN, C., HASBACH, C., HAZELWOOD, C., PEASLEY, K., HOEKWATER, E., LIGATT, C. and LINDQUIST, B. (1992) *The Role of Writing in Creating a Science Learning Community* (Elementary Subjects Center Series No. 56.) (East Lansing, MI: Michigan State University, The Centre for the Learning and Teaching of Elementary Subjects). (ERIC Reproduction Service No. ED 352 259)

STRAUSS, A. and CORBIN, J. (1990) *Basics of Qualitative Research: Grounded Theory Procedures and Techniques* (London: Sage).

TOBIN, K. (1993a) *Applications of Qualitative and Quantitative Data in Interpretive Research*. Paper presented at the International Conference on Interpretive Research in Science Education, Taipei, Republic of China, November.

TOBIN, K. (1993b) *The Mediational Role of the Teacher in the Classroom*. Paper presented at the annual meeting of the American Educational Research Association, Atlanta, GA, April.

TOBIN, K. (ed) (1993c) *The Practice of Constructivism in Science Education*. Washington, DC: AAAS Press.

TOBIN, K. and MCROBBIE, C. (1996) Cultural myths as constraints to the enacted science

curriculum. *Science Education, 80*(2), 223-241.
TOBIN, K. and MCROBBIE, C. (1997) Beliefs about the nature of science and the enacted science curriculum. *Science and Education,* 16, 355-371.
TOBIN, K. and 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* (Brisbane, Australia: Centre for Mathematics and Science Education, Queensland University of Technology), 151-167.
WHITE, R. and BAIRD, J. (1991) Teaching for learning: the view from cognitive psychology. In J. Biggs (ed), *Learning to Think and Thinking to Learn* (Hawthorn: ACER), 146-176.
WHITE, R. T. and GUNSTONE, R. F. (1989) Metalearning and conceptual change. *International Journal of Science Education*, *11*, 577-586.