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RESEARCHING BALANCE BETWEEN COGNITION AND AFFECT IN SCIENCE TEACHING AND LEARNING

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ABSTRACT

This paper is based on findings from a three year collaborative action research project on classroom teaching and learning. The research, which involved 33 teachers, over two thousand students from six schools, and the authors, centred on exploring how various features of the classroom context influence teaching and learning processes. We interpret project findings as indicating the importance of balance between cognition and affect for effective teaching and learning. We advance the notion of challenge as a way of conceptualising this balance. Challenge comprises a cognitive/metacognitive demand component and an affective interest component. Nine major features of a teaching/learning event were found to interact to influence these cognitive and affective components of challenge.

INTRODUCTION

Teaching and Learning Science In Schools (TLSS) was a three-year project (1987-1989) to research secondary school science teaching and learning. It was a naturalistic study (e.g. Aksamit, Hall, and Ryan, Note 1) of the thoughts, feelings, and actions of teachers and students as they engaged in everyday science lessons. We have already reported the general aims of the project, and some initial findings (e.g. Ross et al., 1988). As the project has now concluded, we can provide a more comprehensive review of its outcomes. We consider one such outcome in this paper. It concerns the importance of balance between cognition and affect for effective science teaching and learning. In discussing this outcome, we shall also consider its genesis - the manner in which research findings were transmuted into educational theory. First, however, we present some information regarding the project, some procedures, and some findings.

RESEARCH PERSPECTIVE; STRUCTURE OF THE PROJECT

The style of our research was interpretive (Erickson, 1986), and directed to the meanings and intentions that underlie classroom teaching and learning behaviours. Three fundamental beliefs guided our choice of methods and procedures: that teachers and students should assume a central role in researching their teaching and learning; that careful, focussed reflection is necessary for enhanced understandings, confidence, and competence; and that reflection is fostered by collaborating with others.

Having teachers and students take a central role in educational research, by reflecting critically on themselves and their practice, is being advocated increasingly as a means of fostering desirable educational and professional outcomes (e.g. Hopkins, 1987; Rudduck, 1988). For us, this idea was strengthened by the success of some earlier research (Baird & Mitchell, 1986). That research also demonstrated to us the efficacy of close, protracted collaboration between teachers, students, and researchers. Collaboration for educational research and development is similarly gaining increasing support (e.g. Campbell, 1988; Druger, 1989; Erickson, Note 2; Kyle & McCutcheon, 1984).

Consistent with our beliefs, large numbers of science teachers and students collaborated with us, and each other, over the period of the project. The nature and extent of this collaboration varied widely. For some participants, collaborative reflection simply involved them in describing for us their perceptions, attitudes, and beliefs; for others, this reflection was set within action research (Baird, Mitchell, & Northfield, 1987) to improve the quality of classroom practices. Similarly, the extent of collaboration varied, from irregular and short-term (days-weeks), to more regular and protracted (months-years). Overall, 33 teachers and over 2,000 students from six schools participated in the project. Of these, 19 teachers and approximately 500 students collaborated actively for periods of at least several weeks.

SOME METHODS, PROCEDURES, AND FINDINGS

The interpretive nature of the research meant that we commonly used such methods as individual and group interviews, class discussions, written evaluations, and participant observation. Usually, these methods were used as part of one of two main types of collaborative reflection. The first type was group-based collaborative action research. Depending on the procedures used, members of the group shared ideas and information, reflected jointly, and made decisions, either during lessons or in regularly scheduled out-of-class meetings. The second type of reflection stemmed from intensive, protracted 1:1 collaboration between a teacher or student and one of the authors.

Over the three years, we completed over 25 separate investigations into aspects of science teaching and learning. We have space here to give only a scant description of six of these investigations; these, and others, are described more fully elsewhere (e.g. Baird, Fensham, Gunstone, & White, Note 3, Note 4). Our main reason for outlining these six is to provide a background to the process of theory generation, to be discussed later. We have grouped these investigations according to whether they involved inquiry by means of questionnaires, or by the repeated responses in group collaboration and in 1:1 collaboration.

Investigations based on questionnaires.

We used large-scale questionnaires regularly throughout the project. This may seem surprising given our espoused research perspective, but there were two main reasons. First, we used questionnaires to set findings from our work with individuals or small groups within the broader class, year, or whole-school context. Second, and conversely, we used them to identify issues that were then explored using more intensive, collaborative methods. By using both questionnaires and intensive collaboration, we sought both "nuance and numbers" (Miller & Lieberman, 1988).

In one investigation, we used questionnaires to determine Year 6 and Year 7 students' perceptions of Year 7 Science. The results were striking, and quite concerning. Ninety-three per cent of the 208 Year 6 students wrote that they enjoyed their science work, and were looking forward to continuing it in Year 7. They believed that next year's Science would be active, interesting and fun. They were especially looking forward to doing experiments, dissections, investigations, and projects. For many students, the reality of Year 7 Science was a considerable disappointment, as is obvious in such comments as:

> We hardly do anything except copy notes that the teacher has written (not our own words) and do experiments that the teacher does for us. In other words we aren't given any real work.
>
> A lot of people are getting low marks because they are bored with the things we've been doing. All we do is sit there and watch demonstrations and listen to the teacher talk. Everyone just sits there and looks like they're listening. I hate science.

The 176 Year 7 students (88 males; 88 females) who completed this questionnaire were in eight classes. More of the negative comments were made by students who were taught by three of the five Year 7 science teachers. More girls than boys were disenchanted with Year 7 science. In response to the questionnaire item "How does Year 7 science compare with what you expected?", 50% of all the girls clearly believed that it was worse (compared with 33% for the boys). This difference was magnified in the three classes already mentioned: in these classes 29 girls, and only 9 boys, answered "Worse".

In a series of six more extensive surveys taken over the three years, over two thousand Years 7-10 students at three schools responded to questionnaires regarding their attitudes to, and perceptions of, science. One trend, observed across all schools, was that the levels of students' interest in, application to, and enjoyment of, science diminished sharply after Year 7. Depending on the school, these levels were at their lowest at either Year 8 or Year 9. Students forwarded many reasons for their disenchantment with science; these reasons are considered later.

<u>Investigations based on group collaboration</u>

Various investigations involved teachers, students, and one of the authors reflecting jointly on classroom practice, during lessons as part of the on-going action research. Two such investigations were a "Shared Perceptions" activity, and an "Agreement for Change" procedure. They are described in Baird et al. (in press), and will simply be outlined here. In the Shared Perceptions activity, teachers and students independently completed written evaluations of a series of science lessons. The students answered such questions as "How much did you understand what you were doing and why you were doing it?", and "Do you think [teacher's name] is teaching science well? Why?" Subsequently, one of the researchers reported to the class the collated student data, and the teacher's responses to similar questions. A general discussion of these results ensued. Features that were identified as diminishing students' interest, application, and enjoyment then became the basis for the second investigation, the Agreement for Change. Each class of students and their teacher spent one lesson considering the features highlighted earlier, and reaching agreement on three changes to improve classroom practice that the teacher would make to his or her classroom behaviours, and three changes that students would make to their behaviours. Examples of changes agreed to by the twelve teachers and 316 students in the fourteen Years 8-11 classes were: for the teacher -- more clarity of instruction and direction, more variety in the work; for the students -- more initiative, independence, and responsibility for completion of work.

Teachers and students then worked together, in some cases for up to fourteen weeks, to try to implement the changes, and monitor their effects on students' interest, application, and understanding. The results proved to be very positive (Baird et al., in press), seemingly because the participants considered the changes to be important, and because there was a clear path of joint responsibility for progress towards the shared goals.

Investigations based on 1:1 collaboration.
Detailed, protracted 1:1 collaboration proved to be an especially useful method of enhancing understanding of the relations between thoughts, feelings and behaviours. One investigation involved 64 Years 8-11 students at two schools in individual collaboration with one of the authors, for periods of, up to four months. This collaboration centred on a process of phenomenological reflection. It required each student, once a month, to write responses to four questions. Two of these questions were: "What is it, to be a science student? (Base your answer on how you feel). For me, it is:", and "What is science learning? (Base your answer on what you do). For me, it is:". Together with these written tasks, we interviewed each student individually or in a small group at approximately two-weekly intervals. In these interviews, students clarified and elaborated upon their written responses. Through these tasks and the interviews, students were encouraged to reflect upon aspects of their lived experiences of learning, teaching, and of being a student.

As a result, many of the students came to understand more about their feelings, beliefs, and behaviours, and they increasingly valued careful reflection as a means of personal improvement (Baird et al., in press). Also the responses of these students taught us much about the diverse factors that determine students' approach to, and progress through, their classwork (Baird et al., Note 4).

A second 1:1 collaboration activity was entitled the Joint Lesson Evaluation. In this activity, four teachers from one school collaborated individually with one of the authors over a sequence of six typical science lessons. After each lesson, each partner completed an 8-page form that required detailed review of the nature of, and the interaction between, curriculum content, lesson activities, and teaching and learning behaviours and outcomes. Perceptions were then compared, and issues that arose discussed. One such issue related to the finding that the teachers, in their teaching, were paying much more attention to cognitive (content-related, competence) aspects than to affective (interpersonal, humanistic) ones. Both partners agreed that this disproportionate attention to cognitive aspects may be limiting their teaching effectiveness.

The involvement of both cognition and affect in effective science teaching and learning is the subject of this paper. As the project progressed, we (the authors) came to realize how this joint influence was pervading the findings from all of the investigations in the project. As we discuss in the next section, this nascent understanding formed part of the process by which we transmuted research findings into educational theory.

TRANSMUTING RESEARCH FINDINGS INTO EDUCATIONAL THEORY

In order that meaning and understanding can be drawn from one's observations and experiences, one must be able to discern some structure, order or regularity, upon which relationships may be based or predictions made. This process involves generalization. Erickson (1986) makes the point that, in educational research, one's research perspective determines the type of generalization considered important:

> Positivist research on teaching presumes that history repeats itself; that what can be learned from past events can generalize to future events--in the same setting and in different settings. Interpretive researchers are more cautious...[In interpretive research] the search is for concrete universals, arrived at by studying a specific case in great detail and then comparing it with other cases studied in equally great detail. (pp.129-130)

In this section, we consider our search for concrete universals. We base this consideration on the relationship between educational theory and professional knowledge; we then describe our beliefs regarding the manner in which educational theory and professional knowledge developed in this project.

In considering this relationship, Elliott (1989) cites Maxwell's two contrasting outlooks regarding the aims and purposes of the educational disciplines. The first outlook, the "philosophy of knowledge" is consistent with a rationalist view of the relationship, where "the process of theory generation is quite separate from the process of its acquisition and utilisation for practical purposes" (p.81). Here, decontextualized theory is available to be applied to inform the particulars of one's practice. The second outlook, the "philosophy of wisdom", requires practical inquiry, where "the most important and fundamental inquiry is the thinking that we personally engage in...in seeking to discover what is desirable in the circumstances of our lives, and how it is to be realized" (Maxwell, quoted in Elliott, 1989, p.83). From this perspective, educational inquiry, classroom practice, and theory generation are intertwined.

In this project, the action research we used was of the second outlook. Our method of educational inquiry aimed at linking practice with theory, teaching with research, in order to generate structure, order, regularity-our findings, our "practical wisdom" (Elliott, 1989, p.83). Central to this generation of practical wisdom was an inductive process of naturalistic generalization (Stake, 1978), carried out by the various participants (teachers, students, researchers) in the project. These naturalistic generalizations, derived from "tacit, personal, experiential learnings" (Stake, Note 5, p.2), were shared (albeit in various modified forms) by the participants as they responded to questions or entered into discussion. Subsequently, in transmuting these findings into educational theory-which is a different type of structure, order, or regularity-we (the authors and to a lesser extent, the teachers) applied formalistic generalization, which involves more formal (received) knowledge and reasoning (Stake, Note 5).

Our beliefs regarding this manner of theory generation support the contentions of Altrichter and Posch (1989) - that action research can involve processes that are more complex than the Glaser and Strauss (1967) notion of grounded theorizing. In reflecting and acting, participants draw on both personal, often tacit, professional knowledge and formal, often propositional, theory. The outcomes of this process of theory generation are our contentions, to be discussed next, regarding the importance of both cognition and affect for effective teaching and learning. A central aspect of these contentions, our theory, is the notion of challenge.

A MAJOR REGULARITY IN FINDINGS: BALANCE BETWEEN COGNITION AND AFFECT

As mentioned above, a major regularity in the project's findings became evident. This regularity was the involvement of both cognition and affect in influencing teaching and learning attitudes, beliefs, behaviours, and performances. The six investigations outlined above varied considerably in nature, intent, and manner of implementation. Yet certain features of the teaching/learning situation were highlighted repeatedly by the participants as influencing their approach, progress and outcomes. We found that we could assign each of these features to one of nine categories. These nine categories are the perceived:

* amount of work;
* difficulty of the work;
* importance of the work;
* relevance of the work to, and the opportunity it provides to extend, existing knowledge, abilities and interests;
* novelty or variety of the activities;
* extent of individual control over the process (which, for students, includes control over personal learning and assessment);
* opportunity for active involvement (both physical and mental) in the process;
* interpersonal (teacher-student; student-student) features of the teaching/learning context; and,
* physical features of the teaching/learning context.

Here, then, is an instance of how regularities embedded in personal experience have been transmuted, through interpretation and abstraction, into categories of influence. A further stage of interpretation and abstraction led to the notion of challenge, a notion that arose largely through a process of formalistic generalization by us, the researchers.

We contend that the nature and extent of a teacher's or learner's engagement in a task is mediated by the extent to which the person feels challenged by it. The notion of challenge, as given here, accommodates the joint influences of cognition and affect on action. We envisage challenge as comprising two main components - a cognitive/metacognitive Demand component and an affective Interest (and Enjoyment) component. The nine features listed above interact to influence the level of these two components of challenge.

Two points regarding this conceptualization need to be mentioned. First, the conceptualization is supported by the fact that at least some, and usually many, of the nine features were identified in each of the investigations in the project. Second, the notion of challenge (or, as was more often the case, lack of challenge) illuminated many of the results of these investigations. For instance, the drop-off in students' interest, application, and enjoyment after Year 7 is readily interpretable in terms of diminished level of challenge. Particularly, many project results indicate that improved quality of teaching and learning centres on striking a better balance between the cognitive and affective components of challenge (e.g. the results of the Agreement for Change and Joint Lesson Evaluation procedures mentioned above, and reported more fully in Baird et al., Note 4).

Another notion, related to challenge, is boredom. On numerous occasions at interview, in discussion, or in their written responses, students described their work as boring. The notion of challenge as described invites reflection on the possible meaning of this boredom. Boredom is usually taken to indicate simply a lack of interest or enjoyment. While it may mean this, the notion of challenge may provide for a more comprehensive perspective. Rather than a unitary lack of interest and enjoyment, boredom may arise from a more multi-faceted lack of challenge. For example, let us consider four different situations, all related to different levels of the cognitive and affective components of challenge. Let us propose that, for each situation, both (cognitive) Demand and (affective) Interest are at one of two levels -- High (but, for Demand, not too high), or Low.

In the first situation, both Demand and Interest are High. Here, the cognitive and affective components assume a desirable balance, and the student is challenged to become actively involved. A second situation is where Demand is High, but Interest is Low. In this case, the challenge is less desirable-at best, the student submits to externally-derived pressure to comply. Third, Demand is Low and Interest is High. This situation comprises a lack of challenge, possibly characterised by frustration and limited involvement. The fourth situation is where both Demand and Interest are Low. Here, challenge is absent, and the student fails to engage in the task.

Through discussion with students, it appears that they may label each of the last three situations as "boring", even though the word has a different underlying meaning in each case. In none of these three situations are cognition and affect balanced actively and productively, in a way that stimulates the student to invest a desirable level of effort. In each case, the outcomes would also be expected to be less than desired. Often, lack of (cognitive) achievement would be associated with (affective) feelings of lack of accomplishment, self-assurance, and fulfilment.

Before concluding this discussion on the need to balance cognition and affect in teaching and learning, we shall briefly mention some related research that also highlights the importance of affect. It is research into metacognition (the knowledge and regulation of one's own learning) and problem-solving behaviour. Experienced researchers in these fields are now acknowledging the interdependence of cognition and affect for these desirable educational outcomes (e.g. Brown, 1988; Flavell, 1987; Lester, Garofalo, & Kroll, 1989; Weinert, 1987).

CONCLUSION

The results of the TLSS project indicate that science teaching and learning are determined by a complex array of cognitive and affective influences. In this project we have tried to show how naturalistic research findings were transmuted into educational theory centring on the notion of challenge. According to this notion, in order that teaching and learning be effective, these cognitive and affective influences must be actively and productively balanced so as to provide for an adequate level of challenge. We consider the notion of challenge to be a worthy focus for further interpretive research, and an important goal for both teachers and students to jointly strive for in their science classwork.

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