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CURRICULUM REFORM AND A SCIENCE DEPARTMENT: A BOURDIEUIAN ANALYSIS

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ABSTRACT. This article will describe the dispositions of science teachers in the context of a curriculum reform. Using Bourdieu's notions of 'habitus' and 'the field,' the analysis of the data highlights the necessity for curriculum reformers to view the field of the science department as a contested space. From this understanding flow several subsidiary issues: the need to promote disequilibrium and critical conversations around the meanings and practices of science education within the department, and the need to value and capitalise on the symbolic capital of teacher credibility. The article concludes by briefly critiquing recent curriculum reforms in Australia.

KEY WORDS: Bourdieu, curriculum reform, field, habitus, science as inquiry

Curriculum reform is not simply a case of adding new information to the existing base of teacher knowledge. It is an ongoing cultural task in which 'teachers need to restructure their knowledge and beliefs, and, on the basis of teaching experiences, integrate the new information in their practical knowledge' (van Driel, Beijaard & Verloop, 2001, p.140). This is no easy task, as periods of curriculum reform are also periods of uncertainty for teachers, as Thompson & Zueli (1999, p. 341) explain: 'teachers will have to unlearn much of what they believe, know, and know how to do while also forming new beliefs, developing new knowledge, and mastering new skills.' The majority of educational reforms fail because they do not accommodate the difficulties teachers face in negotiating shared beliefs towards the ideal of the reform. Indeed, 'all too often the attention and energies of policy makers are focused on the "what" of desired educational change, neglecting the "how"' (Rogan & Aldous, 2005, p. 313). If curriculum reforms are to have an impact on teachers' work, then teachers need to have opportunities to consider and question their own practices, the practices of others and to 'tinker' (Hargreaves, 2000) with the teaching and learning of science in their classrooms.

Anderson (2002) describes the difficulties that teachers have in reforming their practices in terms of three dimensions: the technical, political and cultural. Of these, the cultural dimension is 'possibly the most important because beliefs and values are so central to it' (p. 8). The realisation that science teachers may need to re-negotiate their beliefs, commitments and intentions is important in light of the difficulties that teachers generally have

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in implementing curriculum reforms; especially those that attempt to promote science as inquiry within schools (Yager, 2005). The recent Australian *Framing Paper Consultation Report: The Sciences* (National Curriculum Board, 2009a, p. 13) stresses the same difficulty:

> the level of preparedness of teachers ... to move from a transmission model teaching of discipline abstractions to a model with a greater emphasis on student engagement and inquiry was raised as a risk for the successful implementation of the national curriculum for the sciences.

For this article, inquiry is defined both as content, in terms of the understandings and abilities that students should develop, and the processes of learning that accompany teaching strategies oriented towards inquiry. This definition is grounded in the summation of inquiry provided by the Australian Science Teachers Association [ASTA] (2002) and the US National Science Education Standards [NSES] (National Research Council, 1996). The NSES (1996, p. 23) describe inquiry as the:

> diverse ways in which scientists study the natural world and propose explanations based on the evidence derived from their work. Inquiry also refers to the activities of students in which they develop knowledge and understanding of scientific ideas, as well as an understanding of how scientists study the natural world.

This does not mean that there is one teaching strategy for the teaching and learning of inquiry, as the ASTA (2002) makes clear:

> highly accomplished teachers are able to engage students in scientific inquiry. That highly accomplished science teachers should be able to do this is non-negotiable, but how they achieve this with their students, in their school context, is a matter for their judgement and skill ... the standards do not specify one way of doing this.

The knowledge that teachers develop through participation and negotiation in their work can be conceptualized as 'local, contextualised, personal, relational and oral' (Burroughs, Schwartz & Hendricks-Lee, 2000, p. 345). Such a conceptualization stresses the importance of both the individual and the social context of the learning. Billett (2001, p. 22) states that accounts of work based learning must acknowledge the 'independence of individuals acting within the interdependence of the social practice of work.' The recognition of these social aspects of learning is foundational to the conceptualization of subject departments as communities of practice, in which teachers negotiate and reify their shared sense of meaning, identity and practice. It is this inter-relationship between individuals and their immediate departmental context that is the focus of this article.

The department as 'field'

The teacher professional learning required for curriculum reform is not an individualistic exercise: secondary teachers work in subject departments that can be simultaneously perceived of as both communities and organisations (Melville & Wallace, 2007). Within the community, teachers can develop strong personal and professional relationships with their colleagues, and 'through these connections shape and reshape their own teaching—and bring it into line with local practice' (Bush, 1997, p. 95). As a result, teachers' practices are very much the product of their individual and collective settings and experiences, although this is problematic if 'uniformity is valued over diversity' (Eick, 2009, p. 138). The network of relationships also permits departments to act as organizations, to 'organize themselves to promote access to professional learning, maintain accountability to their standards of teaching and learning and encourage teacher leadership' (Melville & Wallace, 2007).

The foundational nature of relationships in understanding school subject departments also allows departments to be considered in terms of social space, or social 'field' (Bourdieu, 1990a; 1998). The political space of the field is crucial, as it simultaneously influences, and is influenced by, those within it:

> As organizations, departments possess political power that must be tempered by the realization that power is contextualized within the community, and must therefore be responsive to the needs and desires of that community. As communities, departments are a context for the development of teacher identities, meanings and practices. This context must, therefore, provide opportunities for teachers to critically reflect on the work of both themselves and their colleagues (Melville & Wallace, 2007).

Within the field, teachers are not powerless; each possesses a stock of 'cultural capital' which can be used in competition over the specific resources located within their departments (Hodkinson & Hodkinson, 2004). Thus, the identities, meanings and practices of a department are a dynamic result of the constant competition between individuals and groups (Bourdieu, 1990a). In this article, I am utilizing Bourdieu's (1990a; 1990b; 1998) conceptions of practice as contested and productive of an individual's dispositions. Further, identities, meanings and practices 'are hierarchical and exist in a contested—either dominant or subordinate—relationship with one another' (Hardy, 2009, p. 510). This is not to say that the ongoing competition is a pejorative: it is through competition that teachers have the capacity 'to transform the power relations that are constitutive of the field' (Bourdieu, 1990b, p. 87).

In his discussion of social space, Bourdieu (1984, p. 169), proposes that individuals 'have points of view on this objective space which depend on their position within it and in which their will to transform or conserve it is often expressed.' As a consequence, social spaces are represented through the individual. From this sociological foundation, Bloomer & Hodkinson (2000) developed the notion of a learner's dispositions toward the learning opportunities with which they are presented. Within this notion, different learners 'perceive the same opportunities differently, and react to them differently, because of their different dispositions' (Hodkinson & Hodkinson, 2004, p. 176). Individuals, through their interactions and life experience, evolve these dispositions to learning over a period of time. These dispositions, or habitus (Bourdieu, 1984), are central to the discussion here. Hardy (2009, p. 511) states that an individual's habitus:

> ... is the product of a long apprenticeship into particular practices, resulting in specific, durable qualities. Such qualities are a product of the accumulation of varied resources, or "capitals", which individuals and groups build up over time, and upon which they can derive particular advantages under circumstances in which those attributes are valued.

This article will describe the dispositions of science teachers in the context of a curriculum reform.

Methodology

In this article, Bordieau's notions of the field and habitus are used to interrogate the data and highlight those conditions that may promote teachers' engagement with curriculum reforms. This data was collected during a larger study into the professional learning of a school-based department of science teachers (Melville, 2005). The participants in the research are the ten members, including the author, of a science department located in an Australian co-educational secondary (Years 7–12) school which has a strong reputation for science teaching. Nine of the ten teachers, including the author, have a university level education in science, followed by an education qualification. Two of the teachers (the author and Jenny) had Masters Degrees in science education. The tenth teacher's background was in physical education. Three of the teachers worked on a part time basis, and were often not present at departmental meetings. Of the seven regular teachers who met, six made comments directly relevant to the curriculum reform process. Prior to the commencement of the study, all participants were consulted about their potential involvement and informed written approval was obtained from the teachers and the school Principal. As part of the approval process, both teachers and the Principal were given the opportunity to conduct member checks on the data and the analysis. All names used in this article are pseudonyms.

Mindful of the level of interpretation required in qualitative research, I have endeavoured to meet the trustworthiness proposed by Lincoln & Guba (1985) These criteria can be summarised as credibility, transferability, dependability and confirmability, and the strategies that have used for meeting them are described in the larger study from which this article is drawn (see Melville, 2005, pp. 17–20).

Data for the larger study were collected by a variety of methods. The principal method was by audio tape-recording monthly science department staff meetings over a period of 2 years. Other methods included the collection of documents produced by the department, the curriculum writing teams and school newsletter articles that focused on the work of the science department.

The departmental meetings, led by the department head, were convened to discuss various matters relating to the organization and conduct of the science department, including: curriculum and assessment, organizing equipment and materials, student behaviour, professional development and the induction of new teachers. The recordings from the 2002 departmental meetings were transcribed to provide the field text for the research reported here. The decision to only use the recordings reflects my focus on the conversations through which the teachers interact with the curriculum reforms.

The interrogation of these data was based on the analysis of narratives strategy described by Polkinghorne (1995). Using this strategy, narratives are interrogated using ‘concepts derived from previous theory or logical possibilities and are applied to the data to determine whether instances of these concepts are to be found’ (p. 13). For this article, the notion of the ‘field’ provided a framework through which teachers’ resistance to curriculum change was investigated.

Context of the Curriculum Reform

In 2001 the Tasmanian Secondary Assessment Board began a review of the science curriculum that was used in Tasmanian schools. The Secondary Assessment Board was a statutory authority charged with providing curriculum in Tasmanian schools, the inter-school moderation of these subjects, and the public examination of university entrance subjects. In mid-2001, expressions of interest were requested for classroom teachers from all three school sectors—state, Catholic, and independent—to be involved in the curriculum review process. Four teachers from the science department in the study school, Peter, Stuart, Zoe and Maddie, participated in this review. One decision of the review was to undertake a rewriting of the science curriculum in the subject areas of general science, physics, biology, chemistry, applied science and natural resources. This rewriting was to concentrate on developing a curriculum focussed on science as inquiry, based on themes drawn from the content base of each course. Two of the teachers from the department, Stuart and Zoe, were subsequently involved in developing new science curriculum in the areas of general science and biology, while the third, Maddie, was involved in consultations as to the form of external examination of the new physics curriculum. Peter, as the chair of the science department, participated in a number of planning meetings.

Starting in April 2002, the teachers charged with writing the curriculum met regularly over a period of 10 months. The entire curriculum writing process was suspended in February 2003, even though the teachers were close to completing draft documents in each of the content areas. The teachers involved in this research were not officially informed of the suspension of the curriculum process until March 2003. The reason for suspending the science curriculum reform process was a political decision to concentrate government resources on the implementation of a new interdisciplinary curriculum, the Essential Learnings Framework. In late 2004, the school made a decision to progressively introduce the Essential Learnings Framework, commencing with year 7 in 2005.

The Science Department Narratives

The data comprise the departmental conversations around the curriculum reforms and are presented in chronological order. The meetings were generally scheduled to occur each month, but were superseded in July and October by school level meetings. Meetings did not occur in May or August due to school holidays.

March 2002: Initial Perceptions

Although the curriculum writing process would not commence for another month, several teachers had already indicated that they would be involved with the process. Stuart and Zoe had indicated an interest in working on the general science and biology writing teams respectively and Maddie was involved in the physics subject area. Peter, the science chair, had attended some preliminary information and planning meetings. Initial indications were that the new curriculum was to be in place in time for the 2004 school year.

Peter: I guess we probably need to tidy up years 7 and 10, what we've got now and not rewrite it. There is no point in spending all that energy now.

Zoe: I can't see that they are going to come up with much that will force much change in what we do.

Stuart: It's just going to be re-badging things.

Zoe: I mean, because of the way that we've got things structured here; I don't think that we'll have big changes, some schools might … But once they get a start, any changes that you want to bring on, just keep your eye on the process, that's all.

Peter also made mention of a report that he had received at a planning meeting:
The other thing I got was this report: *The status and quality of teaching and learning of science in Australian schools*. If you want to have a read of it, it is quite readily available … It is very interesting, what they've found is that teachers believe that they are teaching in certain way, and that kids are learning in a certain way, and the teachers' opinion is totally different from the students' opinion.

At this preliminary stage in the curriculum reform process, the data appears to indicate three disconnects between the nascent reform process and the teachers who have volunteered to assist in that same process. These three disconnects are that the teachers do not appear to have high expectations of change in the curriculum, that there is a confidence in what currently exists within their own school, and that the materials that were distributed to promote critical examination of current teaching and learning in science are not being used effectively. Hargreaves (1994, p. 11), has described teachers as 'social learners,' with a capacity to either change to those practices that require change or conserve those practices that are valued. At this departmental meeting, the sentiment appears to be to conserve what is perceived to have worked in the past: in other words, the traditional focus of the department's practices is not open to challenge. This is not surprising given the similar educational experiences of the teachers.

April 2002: Reflecting on Classroom Practice

In late March, the first meetings of the science curriculum writing groups had been conducted. These meetings had mainly concentrated on setting in place the writing process. The planning meeting that Peter had attended was focussed on a conversation around the teaching and learning of science. Based on these conversations, Peter used the departmental April meeting to initiate some questions around the teaching and learning of science at the departmental level. Stuart, who had an interest in teacher professional learning, had read sections of *The status and quality of teaching and learning of science in Australian schools* report, based on Peter's previous invitation:

Peter: … in the teaching and learning of science, to us, what is important?

Stuart: For example, do we take the Federal Department of Education, Science and Technology statement about scientific literacy.

Peter: Their aim is to make students science literate, being able to read something scientific in the paper, some sort of scientific study or some sort of scientific argument, be able to understand the terms that are in that article, be able to formulate some sort of opinion … or is our aim in science to teach them enough stuff to get them through year 11 and 12 science, or is it to give them skills to design and develop experiments … what is our aim?

Maddie: I think that we should be educating people to be able to make informed decisions based on what they see on television or read in the paper, and to see that to every story there are two sides to it, and to able to critically make a decision. I mean we don't want to turn out a whole lot of people who think one way, we want them to be able to form their own opinions based on the information that they get.

Peter: So if that is what we consider important … then we need to start designing our science program so that that is one of the outcomes.

Stuart: The statement defines scientific literacy as the knowledge and understanding of scientific concepts and processes required for personal decision making and participation in civic and cultural affairs and economic productivity, and from that it talks about three different aspects, scientific processes, scientific concepts and the contexts in which science is found.

Dennis: It is also an age thing, years 7's do not think critically.

Maddie: We already have it, don't we, a fairly good focus on science in everyday life?

Peter: I don't know.

Susan: I'd say that in the middle students it is, the top students, I don't know.

Peter: The top year 10 class that I teach is really focussed on knowledge and theory, because they are the students who are going to go onto year 11 and 12.

Maddie: Yes, but is that knowledge and theory being applied to practical situations?

Peter: Don't know, probably not for me, but then it's probably my fault in the way that I teach it.

Dennis: I must say that I find it difficult… because the students can't think critically.

Maddie: … when we talk about speed and velocity, do we actually use concrete physical examples, do we try and get the kids to visualise the situation. Because I find that when they do that in the physical sciences that they are hopeless, they can't… visualise the situation… They all know their formulae. But it is picking the right formulae and picking the right things to put in, and that they can't do.

Dennis: With the work which is going on with genetics, when you talk to them, they really haven't got a clue what the issues are. Even though we use the words, they don't know what they mean. If we are coming up with these sorts of problems, then perhaps we do need to look at what we are teaching. I think that the way we used to do things years ago doesn't apply anymore, because we've got a different type of student coming through, we assume that they know how to do things, but they don't.

Susan: Well, if we state something about them making informed decisions, based on some sort of understanding of the processes involved, then you can go from there … there is the scientific method.

Peter's original intention with this conversation was to try and define what the department meant by scientific literacy. The conversation, however, moves past this intention and focuses on what scientific literacy may look like in their classrooms. While not what Peter had intended, the effort to connect to their classroom experience are markers of engagement and reflective practice, and indicative of their own habitus. The heavy emphasis on grounding the discussion on classroom practice could, however, prove problematic. Phrases such as 'scientific literacy' have 'situated meanings ... rooted in embodied experience ... not "definitions"' (Gee, 2003, p. 25). While the teachers may construct their habitus as a result of different experiences, the data shows little discourse around the definitions offered by the curriculum reformers. One consequence of this may be that the teachers, with their situated meanings, may be linguistically separated from the precise definitions presented by the curriculum reformers. One result of this separation could be a department without 'the capacity and disposition to tackle problems of practice' (Horn, 2005, p. 209). One area where this lack of capacity and disposition is demonstrated is in the criterion based assessment system that was used in the school. The system was introduced in 1992 as part of the Tasmanian Certificate of Education reforms and consisted of six criteria:

1. Collect, analyse and organize information.
2. Plan, organize and undertake activities.
3. Demonstrate scientific literacy.
4. Demonstrate an understanding of ideas and concepts.
5. Recall relevant information.
6. Draw reasoned conclusions based on scientific evidence.

Consideration of these criteria was not part of the curriculum review, and the data indicates that the teachers did not make the link between their conversation and their assessment practices around scientific literacy.

This appears to indicate that strongly held dispositions to teaching and learning may effectively impede curriculum reform.

June 2002: Mixed Messages on Reform

By June 2002, Zoe and Stuart were both fully engaged in curriculum writing, and Maddie was engaged in examination writing for the physical sciences. The planning meetings that Peter had been involved with had finished in May. At the June meeting, Zoe and Stuart were asked by Peter to report to the department on the progress of the curriculum writing in their subject areas:

Stuart: These are the things that we thought were essential … an understanding of the language and structure of the subject, the basic ideas and concepts … and developing those cross subject links … We are looking at people having a good understanding of scientific literacy, which we came across at the last meeting here, and so things like the terminology and the language of science, because it is a very precise language, your scientific method, and a general knowledge of the science that they see around them.

Zoe: I don't see biology being dramatically different from what we currently do, because it is a syllabus that a lot of teachers really happy with it largely the way that it is. So it is not as if we are losing kids because the syllabus is inappropriate. One idea is to put things like aquaculture, agricultural science and geology in a framework curriculum that could be done from the point of view of a local industry. Maybe for some Year 11's, you know the sort of project science that Jack has been doing with his lower ability students, that is probably where that might fit.

After these reports, the discussion returned to the issues of science teaching and learning that had been raised at the previous meeting:

Peter: I suppose going to those preliminary science writing workshops made me sit back and think about what we are doing here, and how we're teaching it, and in particular, how I'm teaching it. I suppose I need to head towards more investigative work for students. I suppose bringing that experimental design into my teaching, with my years 9 and 10's I struggle to give them an experiment that they can design themselves. If they are top students, they shouldn't need the teacher's assistance in designing experiments. What are we covering and how we are covering it, especially how we are teaching students to be scientists and investigate and question what's happening? If we do make changes to our science program, that we most likely will, then we've got some direction as to what those changes are made towards.

Zoe: Can I put a strong plea that lower down the school experimental design is incorporated. I mean there should be some of that incorporated every year. I still get kids trying to do senior biology who really don't have much idea of really basic principles of design for experiments. It can be done quite easily, but it becomes difficult further up the school, when they have not met it. I notice a big difference now, when Tony was here, and he taught a lot of the junior science classes, they'd all arrive in Year 12 and it was very easy to teach them the more difficult stuff that you needed to do, rather than go back and teach the absolute basics in year 12 … It really should be part of how science works, isn't it.

Jenny: Yes, it is.

The June progress reports on the curriculum reform appear as an endorsement of the existing content focused curriculum. Stuart stressed the importance of content, while also acknowledging the notion of scientific literacy and referring obliquely to the processes of science. Zoe stressed the appropriateness of the current curriculum, which teachers were happy with, while also acknowledging the possibility of linking some science courses to local industries.

Peter, through his attendance at the planning meetings, challenged his own teaching and the need to introduce more inquiry-based teaching strategies. As the head of the department, he also challenges the other teachers to consider their own teaching. The challenge, however, generally falls flat, with only Zoe supporting the need for students to be given opportunities to practice the processes of science in the early secondary years. The overall tone of the data is one of teachers, and a department, who are preserving the status quo in their classroom practice: they are not grappling with the serious issues of integrating science with teaching knowledge, collaborative learning or educational change (National Research Council, 1996). Judson & Lawson (2007, p. 500) hypothesise that reform minded teachers may 'actively seek out constructive dialogue with others beyond their departments at a significantly higher rate than traditional teachers.' Clearly, without such dialogue, the field of science education will not be contested within this department.

September 2002: Content's Apparent Triumph

By September, the structure of the new curriculum had become clear. The curriculum writing groups had decided on a range of content driven end-points which specified the content knowledge that students should know. These end-points were embedded in 'levels' which equated to grade levels. Level four was to be achieved by an average student by the end of grade 10 while level six was to be achieved by students undertaking university entrance courses in grade 12.

As this structure became clearer, the teachers started to consider the structure of the curriculum for grades 7 and 8, which were not mandated by the Secondary Assessment Board:

Stuart: With the science syllabus writing we're setting out what students should be able to do at level 4 and level 6, in physics, chemistry, earth science and biology. So what we could work back from those into grades 7 and 8, and come up with something that leads into ... [the new curriculum]

Maddie: So when are you going to get those endpoints ...

Peter: You basically know what the endpoints are going to be, don't you?

Stuart: Yes, because in biology we know we have to look at cells, we know we have to look at continuity and change, we know that we have to look at biotechnology. In chemistry we know that we have to look at balancing equations, bonding and ions. In physics we know that we need to be able to manipulate data, know about motion, and also things about light, magnetism and electricity. So we've already got those marked in already.

After this short exchange, it was decided to develop the grade 7 and 8 curriculum along the same lines as the new curriculum, with science broken down into its discrete sub-disciplines. This process was to commence at the December meeting. The intention was to reflect the curriculum reform structure for grades 9–12 in the school developed curriculum for grades 7 and 8. For all intents and purposes, it appeared that the curriculum reform appears to have followed the path of so many other reform efforts: 'everyone would look first (and perhaps only) at content—and ignore all else. Too often reform and improvement is defined as new organization of materials for teachers to use' (Yager, 2005, p. 16).

December 2002: Contesting the Field

At the December departmental meeting, however, the apparent direction of the curriculum was to be contested. One of the teachers, Jenny, had developed a reputation across the state for the quality of the scientific inquiries which her students produced. In terms of developing inquiry-based science instruction, Jenny's strategy was to develop students' capacity over a period of years, building on verification labs, structured and guided inquiries in years 7 to 9 and introducing open inquiries in years 10 to 12 (See Colburn, 2004). She reported that these strategies had been developed in consultation with a teacher in another state:

I was talking to a teacher from New South Wales who was going off on a bursary overseas to a university overseas to learn how to ... stand and talk to the project that they have done.

At the December meeting she raised her ideas. The data indicates that several teachers were ready to experiment with what she was proposing:

Jenny: ... start at grade 7 where the kids work through an investigation that is already done, looking at variables and whatever, and they fill in the data. In grade 8, they set up their own little hypothesis and variables and practice on answers there. And then every year, as they go on, they get more expert. And in Grade 10 they are quite good. The only problem is that by the very nature of research, it involves extending yourself out into the greater community. And very often they have to do something that then has to be the data that is not on the premises. It is very hard to coordinate ... you have got to be ready for a problem with this ... it is very rewarding when it works.

Dennis: … that's the whole thing, if we want kids to do things [inquiries] at the end of year 10; we ought to start training them early in year 7.

Jenny: Yeah, we should be starting in year 7. They do a little project in year 7, a bit bigger in 8, a bit bigger …

Dennis: We have to teach them, these basic skills. So if they already know them in 7, then by the time they get to 8 they can do more, by the time they get to year 10 they should be able to do some really good quality work.

Stuart: The biggest problem that a lot of people have is working out a question. They try and make it too complex.

Jenny: Their own curiosity. That's where you work from, that's where we need to start. But we wouldn't want to bite off more than we can chew either. It is enormous in terms of the amount of work in just keeping everyone working, because they are all doing different things. And you have to have structures for yourself to keep the ball rolling for each group … I think, in many respects that it is something to start in grade 7. Start with the year 7 classes and really structure it well and write a program up and every year just open it up a bit more.

The net result of these negotiations was to commit to a trial of Jenny's ideas in 2003, starting with the Grade 7 classes. Jenny's dialogue with teachers outside the department was the spark needed to contest the teachers' dispositions towards reform.

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In February 2003, the Secondary Assessment Board announced that the curriculum reform process had been terminated. The reason for the termination was a political decision to implement a new trans-disciplinary curriculum, the Essential Learnings Framework.

Discussion: Disequilibrium, Conversations and Credibility

Despite their involvement in the curriculum reform from the beginning of the process, the teachers in the department did not believe that there would be any great pressure on them to change in any significant way. The conversations show a department apparently comfortable with their interpretation of content driven curriculum. Indeed, there is almost smugness about their position relative to other schools: 'some schools might.' This is not surprising, given the educational biographies of the teachers: as individuals they all possess a solid grounding in the substantive knowledge base of science (Turner-Bisset, 2001) and have been teaching in particular ways for many years. This does not translate, however, to a common view of science education. Science teachers ‘do not always share the same views about what constitutes good teaching’ or the same views as to the ‘nature of science itself’ (Wildy & Wallace, 2004, p. 100). One view of science is that is ‘a set of universal truths that describe the operation of the natural world’ and the purpose of school science ‘is to deliver that knowledge’ (Wildy & Wallace, 2004, p. 109). Traditionally, this has been the view of the majority of science teachers in Australian secondary schools (Harris, Jensz & Baldwin, 2005). Concurrently, other science teachers can view science as ‘a process of personal sense making that helps people survive in their environment’ (Wildy & Wallace, 2004, p. 109).

Flowing from these two descriptions of the discipline of science come two co-existing conceptions of the science department as a field. Under the first conception, the science department may operate as ‘a tightly organized and orderly place to work [where] there is one best way of teaching and a single best way of assessing students’ learning’ (Wildy & Wallace, 2004, p. 109). Under the second conception, the science department may operate as a community, whereby ‘the goals of inquiry, individuality and freedom sought for students in the classroom are also sought for teachers in the department’ (Wildy & Wallace, 2004, p. 109). The data chronicles the contestation between these conceptions of science within the field of science education as expressed in this department. Specifically, it highlights three salient points regarding curriculum reform: the need to trigger disequilibrium, the need for critical conversations, and the need for teacher credibility in any genuine reform.

1. Disequilibrium.

Bourdieu (1998) viewed the field as simultaneously a ‘field of forces’ in which individuals are imposed upon, and a ‘field of struggles’ in which individuals confront each other, and consequently, conserve or transform the structure of the field. Traditionally, curriculum reform efforts that are seen as imposed on teachers have been co-opted by teachers to simply preserve teachers’ existing practices: for this department the initial reaction was that the reform was ‘just going to be re-badging things.’ As Stigler & Hiebert (1999, p. 103) explain, this adaptation of curriculum reforms is one of the reasons that ‘so little has actually changed inside … classrooms.’ To challenge this perpetuation of teachers’ attitudes and practices requires ‘substantial disequilibrium in teachers thinking’ (Wheatley, 2002, p. 9).

Disequilibrium is needed if teachers are to dislodge ‘well-established routines and practices that do not align with the current reform effort’ (Edwards, 1996, p. 27). For science teachers, this means a shift from emphasising the transmission of ‘teaching knowledge and skills by lecture [to] one of inquiry into teaching and learning’ (Yager, 2005, p. 17). To challenge teachers’ beliefs about practice often requires that teachers begin to question their desire to teach. Desire provides the basis for teachers’ ‘creativity, change, commitment and engagement’ (Hargreaves, 1994, p. 12) to teaching. Desire is at the heart of all good teaching, as it is desire that connects good teachers ‘with their students, their colleagues and their work’ (Hargreaves, 1994, p. 12).

The data indicates that this curriculum reform did instil a limited disequilibrium into the department, but did not provide sufficient disequilibrium to substantially challenge the teaching practices of either individual teachers or the department as a whole.

In terms of their beliefs, commitments and intentions towards the curriculum the data suggests a nascent struggle with how to emphasise ‘an inquiry into teaching and learning’ (National Research Council, 1996, p. 72). This tentative struggle, first verbalised in April, centred on how teachers could transform their ‘subject matter knowledge, so that it can be used effectively and flexibly in the communication process between teachers and learners’ (van Driel, Verloop & de Vos, 1998, p. 675). For Peter, the disequilibrium was to move beyond giving students the content knowledge that they would need in the senior science classes. For Dennis, there was a difficulty with student’s maturity levels to consider when discussing scientific literacy. For Maddie, an issue was how to teach students to visualise a situation in physics, while Susan was concerned about teaching the processes of science. While this conversation was limited to those involved in the curriculum reform and two other teachers, it does point to an important implication for curriculum reformers. The reform process must involve strategies to promote disequilibrium and struggle within the field of the department. In this case, the strategy appears to have been the planning meetings that Peter attended, and the materials he was given. However, this appears to have been limited in its efficacy, especially in the face of the inertia inherent in the current content driven curriculum. Recent literature has made clear that “educational reform efforts are doomed to fail if the emphasis is on developing specific teaching skills, unless the teachers’ cognitions, including their beliefs, intentions, and attitudes are taken into account” (van Driel et al. 2001, p. 140). This leads to the second salient point raised by the data, the need for teachers to engage in critical conversations. For it is in these types of conversations that the field is conserved or transformed.

2. Critical conversations and the need for teacher credibility.

Bourdieu (1984, p. 169) has proposed that individuals within a social space 'have points of view on this objective space which depend on their position within it and in which their will to transform or conserve it is often expressed.' For subject specialist teachers, the field is delineated by the subject, with the identities of science teachers being defined by the subject matter to a 'greater or lesser degree' Helms (1998, p. 831). Consequently, secondary teachers do not respond to reforms in isolation, they respond in subject departments that can provide a community of practice in which meanings, identities and practices can be negotiated and reified (Hodkinson & Hodkinson, 2002). The importance of conversations in shaping the responses of teachers to educational reforms should not be underestimated (Judson & Lawson, 2007). For these science teachers, however, there is a struggle to move those conversations forward into the types of teaching and learning advocated by the NSES (National Research Council, 1996) Part of this difficulty appears to be how the teachers construct their habitus as they engage in the conversation.

The science backgrounds of the teachers in this department are similar to the majority of Australian secondary science departments, in that the overwhelming majority of science teachers are initially qualified through science faculties rather than education faculties (Harris et al. 2005). The dominance of initially science-educated teachers reflects the 'academic orientation' of science teacher education, an orientation that favours a perception of the 'teacher's role as intellectual leader, scholar, subject matter specialist [and stresses] the importance of teachers' academic preparation' (Feiman-Nemser, 1990, p. 22). One consequence of this discipline based education is that secondary teachers find it difficult to move towards the teaching and learning of science as inquiry. Teachers have an 'allegiance to teaching facts and to following the role model of college professors' (Welch, Klopfer, Aikenhead & Robinson, 1981, p. 40). The conversations in the April meeting demonstrate this: the discussion on scientific literacy was grounded in existing practice, with little inclination to examine how the reformers' definition on scientific literacy may have promoted disequilibrium. While the conversations from April to September show evidence of some disequilibrium, the net result of the teachers' conversations was to reinforce the primacy of the content: 'Yes, because in biology we know we have to look at cells, we know we have to look at continuity and change, we know ...' The curriculum reform, by September 2002, appeared 'to ignore the essence of science and to relegate its teaching to the topics too often characterizing curriculum frameworks, textbook chapters, the "agreed upon" concepts too often packaged in discrete disciplines' (Yager, 2005, p. 20).

Clearly, the disequilibrium of the curriculum reform did not provide sufficient impetus for an ongoing critical conversation about the teaching and learning of science. If teachers are to move beyond their established practices and attitudes, then there is a need for critical conversations that bring greater contestation to the field. The data suggest that such contestation relies, not on imposed attempts at reform, but on the demonstration of teacher credibility, a valued symbolic capital within the field. Jenny possessed this capital, and through it, the capacity to influence the conversation. Over a number of years, Jenny had developed a teaching repertoire that emphasised science as inquiry. This development had occurred, in part, through collaboration with a teacher outside the school. Jenny's disposition towards the teaching and learning of science, her habitus, gave her capital with which to now contest, and profoundly influence, the field. This influence appears to be directly connected to the personal experience, both positive and negative, that she brings to the conversation: 'It is very hard to coordinate ... you have got to be ready for a problem with this ... it is very rewarding when it works.' For teachers, experience is 'the currency of credibility' (Coulter & Orme, 2000, p. 6). More importantly, in terms of the curriculum reform, Jenny is recognised as: 'Being a credible source for advice on instructional matters wherein one's expertise is acknowledged ... and thus, the person finds themselves in a leadership role' (Judson & Lawson, 2007, p. 501).

Challenging the Field: Implications for Reformers

The analysis of the data highlights one overarching issue for reformers: the necessity to view the fields which are science departments as contested spaces. From this understanding flow several subsidiary issues: the need to promote disequilibrium and critical conversations around the meanings and practices of science education within the department, and the need to value and capitalise on the symbolic capital of teacher credibility. From these issues, it is possible to draw out an important implication for curriculum reformers and how they interact with the fields that science departments represent.

Despite the regularly scheduled meetings, this department appeared to move slowly with respect to the curriculum reform. Although the conversations recorded here started in 2002, the teachers were still working on the Essential Learnings reforms in 2005. The case of Jenny offers a potential explanation for this lack of movement. While the other teachers struggled to move away from their conceptualisations of science teaching, Jenny had been in contact with at least one other reform-minded teacher, and more importantly, had been implementing science as inquiry in her classroom. She did not, however, formally share her knowledge and beliefs around science teaching for 10 months. This appears to corroborate the findings of Judson & Lawson (2007), that teachers with a disposition towards science as inquiry do not exercise their full leadership potential.

Difficult as it would be to operationalise, curriculum reformers may be well advised to seek out reform minded teachers when seeking to build teacher support and input for curriculum reform efforts. Such a task would require curriculum reformers to be in more ongoing contact with reform-minded teachers than is currently the norm. A second advantage of a closer relationship between reformers and departments would be to build the credibility valued by teachers. Teachers in departments are in possession of 'fine-grained information about learning outcomes' (O'Day, 2002, p. 23). Such information is not usually available to larger organizations, where it suffers through aggregation. Departments are thus in possession of information that more directly connects reform strategies to their effectiveness. This is important, given the time lag between the implementation of a reform and the first evidence of its efficacy.

Unfortunately, the current drive for an Australian national science curriculum appears to perpetuate an ignorance of the role of secondary science departments in the implementation of any reforms. The *Shape of the Australian Curriculum: Science* (National Curriculum Board, 2009b) highlights two examples that relate directly to this article. Section 6.3.1 states that the curriculum 'needs to be easily read by experienced teachers and a source of clear, succinct information for beginning teachers ... and must allow all readers to know the purpose of learning particular aspects.' This appears to ignore that fact that science teachers situate the meanings of words in their practice, and that those meanings are open to contestation on the 'field.' Further, Section 7.4 extols the virtues of science as inquiry, while concurrently presenting an oversimplified conceptualisation: 'The ability to pose and investigate questions is an important part of science inquiry.' As Windschitl (2009, p. 3) explains, a more sophisticated view stresses that the teaching and learning of science as inquiry also relies on 'evidence, causal explanation, and the testing of models.' Simplified conceptualisations, while 'easily read,' are unlikely to promote the disequilibrium needed to inspire teachers to critical conversations about teaching and learning.

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