Curriculum change in science teaching: the need to listen to teachers

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Abstract

The Victorian (Science) Curriculum and Standards Frameworks (CSF) is intended to provide the basis for curriculum planning, reporting and student achievement in Victorian schools. The basis of the approach to learning adopted in the CSF initially challenged the long held practice of School Based Curriculum Development that has been strong in Victoria for at least the past 20 years. The CSF was initially introduced to schools in 1995 and has been through two incarnations as science teachers and curriculum writers struggled with the tensions created by a curriculum that impacted on classroom practice in ways that highlighted a number of dilemmas for science teachers.

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Background

This paper is designed to illustrate some of the ways in which science teachers in schools interpreted and responded to a major curriculum change in Science. The data is drawn from a small sample of science teachers (n = 26) who were interviewed about the implementation of the Science Curriculum Standards Framework (CSF, 1995; 2000). These teachers were science coordinators, junior school, middle school and senior science teachers from both independent (private) and state schools. Some of these science teachers were involved in networks and clusters that were centrally organized in an attempt to support teachers through the implementation period, hence their ideas and views were often shaped not only by the document itself but also through their interactions with colleagues - both in their own schools and other schools.

We have organized the paper using the themes which emerged through our interviews and an important frame for these views, which needs to be at the forefront of the reader's mind, is that these themes are as a result of the teachers' perceptions of the CSF. It is also clear throughout the literature associated with change (Fullan, 1993; 1999; Senge, 1990) that perceptions are crucial in the curriculum reform process because, for many teachers, their perception is also their reality and these perceptions need to be acknowledged and appropriately challenged if the curriculum intents are to be achieved.

The structure of this paper is such that it sets out a brief of the history associated with the development of the Science CSF, followed by examples of science teaching, learning and assessment issues created for teachers through these changes and then closes with specific examples of the tensions and dilemmas of practice that teachers attempted to manage. As the introduction of the CSF comprised approximately 6 years, this research is a timely reminder (yet again) of the need for curriculum writers to pay close attention to the insights and knowledge of the end users of these documents, - the science teachers.

Introduction

For at least the last 20 years, Secondary Schools in Victoria, Australia, have been involved in genuine school-based curriculum development. It has been a long held approach to curriculum planning and development that the teachers within a school generally organized the curriculum in ways that they considered appropriate for the needs of their students. Therefore, in most cases, the science curriculum at a given school would be organized according to the teachers' (within the science department) understanding of content development and progression, and appropriate pedagogy. This planning occurred within a loose

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framework whereby some reference to the central bureaucracy (Department of Education) influenced the curriculum but it was more in terms of the philosophy underpinning science teaching rather than the actual content at particular year levels.

In 1987 a Science Frameworks document was developed which was based on a Children's Science approach (Driver, 1983; Driver, Guesne and Tiberghien, 1985; Gunstone, 1990; Osborne and Freyberg, 1985) to the teaching and learning of science. In this document, science teachers were encouraged to consider the development of schools' science curricula from four interrelated perspectives. These perspectives were: Science Knowledge and Skills, Science Technology, Science and Society, Science as Personal Development. These four areas of the curriculum were meant to inform science teachers about the perspectives necessary to influence the formulation of the teaching and learning of science in their schools. The intention was that the Frameworks offered a science platform comprising:

1. The Kind of Science: Science for All

- All students should study science, and gain value from their studies. The goals, methods and content of science education should provide for the needs and progress of all students.
- Science education should be concerned with environmental management and the survival quality of life for all.

2. Goals: Science, Technology, Society and Personal Development

- Scientific knowledge, the solution of practical problems, the cultural and human context of science, and opportunities for personal development are four aspects of science. They should be given similar emphasis at all levels of schooling, and should be integrated in their presentation.

3. Learning and Teaching: Children's Science - Beginning from Children's Perceptions

- Children (and adults!), by nature, are theorists and problem-solvers, keen to explain and interpret their experiences, to resolve issues they see as important, and to design and build. They bring their perceptions and beliefs to the learning situation.
- Children, as experienced problem-solvers, have their own strategies for learning and solving problems.
- Science teaching should identify, begin from, and build on the strategies, interests, beliefs and explanations that children bring to the classroom.

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4. The Role of Teachers: Teacher Development and Curriculum Development

- The development of both curriculum and teachers' skills in course design and implementation should occur together. Each must be allowed for in planning science education and curriculum revision.

5. Curriculum Content: Sampling Scientific Knowledge

- Any school can only teach a sample of all the knowledge, skills and experiences related to science. The sample should vary from one school to another, depending on local resources, interests and needs. It should include learning selected from the broad range of scientific disciplines.
- Students should truly engage a limited number of ideas rather than seek universal coverage with superficial understanding and application.
- Students must have opportunities to feel that they are succeeding, to explore and reflect on their understanding and skills, and use them in a variety of contexts. This takes time, and limits the number of topics that can be covered. (Science Frameworks, 1987, p.9)

...Behind the Platform is a view of education as a process of personal growth, of progress towards particular learning goals. According to this view, all students are educable, and educational success depends on the extent of progress - what the learner knows and can do now compared to before the learning. Teaching is successful if the increments of learning are large, unsuccessful if zero, miseducative if they are negative. (Science Frameworks, 1987, p. 24 - 25)

It was envisaged then that science teachers would develop their Units of work, and their individual lessons, in a manner consistent with the Frameworks document. However, like many of the curriculum documents which preceded the Frameworks, the fact that teachers were not necessarily 'obligated' to incorporate this approach into their teaching inevitably meant that there was a diverse response to the way in which the Frameworks impacted on practice across schools. This range could be described as a continuum from no/little impact (where in some cases, teachers reported that the Frameworks document was never sighted in a school) through to full incorporation whereby the philosophy and foundation principles dramatically influenced the science curricula in the manner initially intended by the Frameworks developers. However, there appeared to be no discernible pattern or relationship between the degree of incorporation and the type of school.

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The introduction of the Curriculum and Standards Framework (CSF) in 1995 dramatically changed this approach to science curricula, teaching and learning.

The Science Curriculum and Standards Framework

The CSF was developed as one part of a National Curriculum change approach based around the National Profiles (1992) which were designed to influence the nature of the curriculum offered throughout Australian schools. The National Profiles were funded by the Federal Government in an attempt to bring curricula in all Australian schools into a similar pattern so that it was possible to 'know' the topic being taught at any particular year level anywhere in Australia. This was a bold move which foundered quickly as different State Governments altered the National Profiles to suit what they perceived as their Schools' needs so that the original notion of similar curricula across all Australian schools was soon lost. However, one important aspect of the National Profiles was that the Science Profile recognized the interplay between content and process and therefore acknowledged both as important in the curriculum documents. Also, in accord with all National Profiles, the Levels of Achievement were regarded as a way of demonstrating the range of learning outcomes possible across student age groups rather than as a 'measure' for a particular age group, thus reinforcing the notion that students are inevitably organized as mixed ability varying with both subjects and year level.

This approach to the National Profiles meant that different Levels of Learning existed within any cohort of students, also, that these differences similarly varied with that being studied. Hence a Year 7 student (first year of high school) may be regarded as achieving at Level 5 (approx. 14 years old) in Science, Level 3 (approx. 10 years old) in LOTE (Languages other than English), Level 4(approximately 12 years old) in Mathematics, and so on. The CSF in Science, whilst drawing on the National Profiles, adopted a very different interpretation of Learning Outcomes and Students' Progression and no longer recognized Science Processes as particularly important in terms of defining their value in teaching and learning. The CSF also redefined Learning Outcome Levels as a reflection of a particular Year Level at school (Level 1 - End of Prep Year; Level 2 - End of Year 2; Level 3 - End of Year 4; Level 4 - End of Year 6; Level 5 - End of Year 8; Level 6 - End of Year 10; Level 7 - Enrichment of those exceeding level 6). Clearly the two philosophies of learning which underpinned these approaches were not congruent and science teachers were confronted by two very different views of teaching and learning by their National and State Education Departments; two approaches almost diametrically opposed to one another.

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Interpreting the Science CSF

For Science teachers to interpret the CSF they were confronted with the (not unexpected) changes in language that often accompany such documents. For example, the traditional categories of, for example, Biology, Chemistry, Physics were re-assigned so that the new names became - Life and Living (Biology), Natural and Processed Materials (Chemistry), the Physical World (Physics) and Earth and Beyond (Earth sciences and Astronomy), each of these categories were described as Strands and the units within these strands were (not surprisingly) sub-strands.

Accompanying these 'name changes' was also a new way of conceptualizing both the curriculum and student learning. First there was a curriculum prescription (what would be taught) and secondly the notion of Learning Outcomes was introduced. In terms of the previous two decades of school-based curriculum development, the idea of prescribing what would be taught at each year level caused much consternation for science teachers. For science teachers, this was the first step towards a bureaucratized approach to school curriculum such that the science departments within schools were no longer 'free' to determine what they considered was appropriate for their students as a result of their intimate knowledge of the school's context, rather, the curriculum would (appear to) be prescribed and the teachers would then simply teach it. This was a problem in itself, but the next most daunting task to face science teachers was the approach to Learning Outcomes; predetermined measures of learning, something very new and different for science teachers accustomed to planning their own school based curriculum (including teaching and assessment approaches). Learning Outcomes were based on the notion that it was possible (and similarly appropriate) to prescribe the learning that would occur and therefore to be able to measure the success of this learning against the prescribed outcomes - in some ways this could be viewed as a modern day behavioral objectives approach to learning and assessment.

Perhaps one useful way of exploring this issue is through an example. Consider the following taken from the Science Strand Earth and Beyond, sub-strand Our place in Space.

Earth and Beyond
Level 3 (end of Year 4: 10 & 11 year old students)

Curriculum focus: At this level, students link more abstract ideas such as the relationship between weather and the environment, including erosion and weathering. They relate seasons and length of daylight to the relative tilt of the Earth's axis.

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Manipulative and recording skills become more developed. Students make observations using clocks and estimate the time of year from weather clues. They make measurements and use simple graphs and tables to record results from which they can extract specific information. Students express their ideas with growing confidence.

> Suitable topics include floods, a burst water main, daylight saving, and seasons.
>
> **Learning Outcomes:** At the completion of level 3, a student will be able to:
> *Discuss events caused by the tilt of the Earth's axis, including seasons and the length of daylight.*
>
> **This will be evident when, for example, the student:**
>
> - collects and discusses data on the length of daylight each day over an extended period and displays findings in a suitable chart
> - uses a globe of the world and a torch to model and compare the intensity of the Sun's energy striking various parts of the Earth's surface throughout the year and relates this to seasons
> - measures and compares the length and position of the shadow of a flagpole or other tall structure at different times during the year. (CSF, p.34)

This curriculum outline then begs the question, "What does this mean for a science teacher attempting to teach at this level according to the CSF?" It seems reasonable to assert that the Learning Outcome (discuss the events caused by the tilt of the Earth's axis, including seasons and the length of daylight) would be difficult to measure through the evidence (data collection of length of daylight, use of globe and torch model, shadow of a flagpole) because of the difference in the degree of difficulty of the concepts at this level. For example, the tilt of the Earth's axis and its influence on the seasons requires a substantial understanding of latitudes, seasonality, and the influence of weather, to say nothing of the understanding of geometry. Therefore, what does the science teacher really do? Perhaps the easiest thing to do is to teach for the answers as prescribed by the evidence that (it seems reasonable to suggest from the phrasing of the dot points above) should be apparent. If so, is the teaching of this science sub-strand genuinely exploring the phenomena under consideration or is it more so prescribing only what the curriculum providers consider appropriate? For Science teachers accustomed to school-based curriculum development and assessment, this creates a major quandary.

Expanding on this approach to Learning Outcomes, consider the same sub-strand at Level 5 (end of Year 8, 13 and 14 year old students).

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Our Place in Space
Level 5 (end of Year 8: 13 & 14 year old students)

Learning Outcomes: At the completion of level 5, a student will be able to:
Discuss events caused by the relative movements of the Sun, Moon and Earth.

This will be evident when, for example, the student:

- relates information such as tide charts to the lunar cycle
- models lunar and solar eclipses
- records phases of the Moon regularly and explains changes in phase
- suggests how to position and design a house to take advantage of passive solar heating. (CSF, p. 48)

In a similar manner to the previous example, this extract then begs the question, "How does a science teacher interpret these learning outcomes (particularly in relation to those at Level 3)?" Again, it would seem reasonable to assert that the ability to record and explain changes in phases of the moon would not create as great a conceptual difficulty for students at the end of Year 8 as attempting to describe the impact of a change in the tilt of the Earth's axis on seasons for students at the end of Year 4. In fact, it could well be argued that the Level 3 outcome could be regarded as Level 5 difficulty and the Level 5 outcomes more simply as a Level 3.

Implications

Clearly, the brief outline above using one example from one sub-strand is designed to demonstrate some of the possible tensions, difficulties and misunderstandings likely to exist for teachers through the prescription of science content and learning outcomes in the way described by the CSF - hence the terms innovation and curriculum reform become somewhat problematic.

Science teachers in Victorian schools have long been driven by a need to respond appropriately to the needs of the students and their particular context. Learning Outcomes per se could then be regarded as introducing a new constraint to teaching, limiting what might be possible by prescribing the extent to which learning only needed to be achieved rather than as a starting point to the development of understanding.

The final two years of secondary school already carry substantial limiting factors on teaching and learning as a consequence of their results being used for Tertiary Entrance. Hence, the curriculum in the final two years of schooling (Years 11 &

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12) tends to be driven much more by assessment than in the previous year levels and perhaps approaches notions of prescribed learning in ways not quite so apparent in the previous 10 years of schooling. Therefore, as science teachers constantly noted, "We now see a similar curriculum control throughout the school system" as the Learning Outcomes as a measure of learning (assessment) begin to frame what will be done and to what extent.

This external constraint on science teachers' ability to shape the curriculum, teaching, learning and assessment for their students is then something that is obviously constraining for the professional pedagogue. Teaching to a prescription rather than from a framework changes the view and value of pedagogical knowledge. Considering all that we know about the process of change (Fullan, 1995, 1999; Fullan & Hargreaves, 1992; Senge et al., 1999) one could reasonably assume that these changes would have been introduced with all the appropriate support material and relevant teacher advice to ensure that the change would be well managed and that the philosophical underpinnings could be carefully articulated and explained.

The Teacher Course Advice was not ready for release until the end of the second year of implementation of the changes from the Frameworks document (previous less prescriptive curriculum format) to the new CSF. It is little wonder then that teachers question the curriculum intent when the implementation process does not adequately support the changes being sought.

Unfortunately in education it appears as though we do not seem to build on the knowledge we gain through our research and experience in (and of) schooling, but rather break down and rebuild in a cycle that is almost ignorant of previous gains and professional knowledge. At first glance, science teachers (without the support materials promised) questioned why after almost 20 years of developing a knowledge base about teaching for understanding in science and, knowing what we have learnt from research on a Children's Science perspective, a prescribed curriculum reverted to an approach to science teaching and learning that had been demonstrated to be less than helpful in the past.

Through the teacher interviews, these teachers' frustrations and concerns about curriculum change are now considered.

Science Teachers' views

- Process

The research literature has demonstrated that there is considerable debate about what science processes are (for example, Fensham, 1992; Millar and Driver, 1987; Millar, 1991). Nevertheless, it is clear that science teachers value students

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being able to act upon content knowledge in ways that are commonly described as including such things as: hypothesizing, observing, predicting, testing, etc. (viz scientific processes). In all of our interviews, the most common concern of science teachers was the lack of 'process' in the Science CSF document.

This perceived lack of process was of concern to science teachers because it caused them to feel as though the curriculum document itself was lacking in appropriate direction and therefore tended to undermine their confidence in the document which in turn influenced their interpretation of the documents' intention; both in terms of teaching and learning.

The science teachers we interviewed consistently criticized the CSF format because process had not been 'sufficiently highlighted'. They were disappointed with the approach of integration of process into each of the strands, as they perceived this as downgrading of the importance of particular process skills.

Warwick Process Science (1987) was a major curriculum package produced in the United Kingdom that, it could be argued, did the opposite to the CSF. It placed so much emphasis on process that it appeared as though the process itself was almost 'content-free' and therefore the importance of science knowledge was - for some - downgraded. As was the case with the Warwick Process Science package, so the CSF in highlighting some issues more than others has been interpreted by the end users of the curriculum (science teachers) as offering a less than full picture of the science curriculum.

As the curriculum writers reconsidered the value and impact of the CSF they too came to recognize that that the balance between content and process was a major area of concern and addressed it in the second version of the documents, CSF 2000. This recognition and response has been important as it illustrated clearly to science teachers that, finally, finding the appropriate balance between content and process is crucial to a science curriculum document being accepted as valid and useful to science teachers. However, it does cause one to wonder why in the first instance (CSF, 1995), despite the 'consultation process' that such an imbalance could be created. A lesson here is the need to ensure that consultation leads to classroom experts of science teaching and learning (science teachers) being 'heard' and that the reasons for their views be fully explored rather than simply dismissed or ignored. It is little wonder, in this case, that science teachers finally felt vindicated but remained frustrated at a process that chose not to act on the best available information at the time.

- Prescription vs. Guidelines

A question we asked during our interviews was, "Did you read the introductory pages to the CSF?" For the majority of teachers, the answer to this question was that they had not.

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I skimmed it, but didn't really read it... you don't have time; I had to see what to teach first...

This response was both typical and understandable. For many science teachers, the constant pressure of school and their ever-increasing workloads means that teachers need to find shortcuts in order to cope with the expectations and demands of their work. Therefore, although the introductory remarks to the CSF has important information describing the nature of the document as a framework, this information typically went unnoticed by those who obviously most needed to be informed about the structure and intent of the document.

As a result, it was a common perception amongst science teachers that the CSF was "a prescriptive curriculum rather than a curriculum framework". This distinction is important for as noted earlier, Victorian Science Teachers have had a long and proud tradition of school-based curriculum development and reform. They have worked hard to develop science curricula that are appropriate and responsive to the students in their schools and have produced some remarkable resources and units of work that are exemplars of this. STAV (Science Teachers' Association of Victoria) in particular has placed a great deal of time, effort and resources into such curriculum development (eg, Better Links by Grant, Johnson & Sanders, 1990). Therefore, the CSF was not viewed favorably by science teachers who were comfortable with this school-based curriculum development approach. They felt as though their professional autonomy and expertise was being undermined by a document which was not responsive to the needs of their students.

Obviously, then the issue was influential in shaping these science teachers' views of the CSF as they perceived the document to be telling them what to teach and how, rather than serving as a framework that might help to guide their own school-based decision-making processes in their particular curriculum writing activities.

This view is in stark contrast to science teachers who were involved in networks or clusters. These teachers felt as though they 'needed to read' the introductory notes in order to participate in their networks and clusters in an informed manner. One science coordinator noted:

> **Well I had to read it, I didn't really have time, but I had to... I then was less concerned about what I thought I had to do and in my school that has made a big difference to what I think we can do as a Faculty.**

Therefore, there was a bi-modal response to the intent of the CSF. Again, in implementation of the CSF 2000 this issue was better recognized and introductory remarks (and in-service activities designed to introduce the materials) for this document helped science teachers to continue to pursue their

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teaching and learning in science in ways which they found appropriate to their particular school contexts.

- Progression

Throughout our interviews there were particular transition points within the CSF which became noticeable issues of concern for science teachers. Two points in particular were associated with the move from Primary to High school (Year 6 - Year 7 transition) and the issues associated with Mixed Vertical Grouping (MVG).

In both instances, it was apparent that teachers had recognized an important issue concerning the organization of the CSF in terms of Levels.

> **We might be able to teach in front of a Level [extend students] but it is very hard to think about going back a Level - or two!**

Science teachers in Year 7 often noted how their students were reportedly at the correct CSF Level (4) for entry into High school. However, these teachers were confident that the level of achievement was not universally commensurate with the intention of the learning outcomes at that Level. Therefore, these teachers found themselves facing a dilemma. In teaching their students, they began to question the meaning of attainment at a particular level and in science where it is common for teachers to consider learning in terms of building on particular concepts. This became an issue of concern.

This dilemma was exacerbated in schools that were organized according to Mixed Vertical Groupings. Because of the range of skills, attitudes and learning abilities represented, teachers found it very difficult to know which Level to 'teach to' in order to best address the learning needs of their students. Further, if teachers choose to teach using multiple Levels in Mixed Vertical Groups they face an additional problem in that the content areas are very different between different levels of the same strand.

Although it is well recognized that any group of students is inevitably heterogeneous (hence the development of the term mixed ability) the notion of Levels as being relatively fixed measures of Learning Outcomes corresponding to particular Year Levels causes some concern for Science Teachers.

Again, for curriculum writers, issues related to students' ability levels need to be carefully considered as classroom teachers inevitably struggle to meet policy guidelines about progress when it is incongruent with the reality of classroom practice. Perhaps in this instance, the political differences between Federal and State Education Department's unreasonably overshadowed the reality of what learning outcomes really mean. The National Curriculum Standards from which

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the CSF was initially drawn, recognized the inherent difficulties of 'controlling' the rate (and reality) of learning, but this was 'overlooked' in the transformation to the CSF due to the State Department's hopes to measure students' ability levels and to use this measure for other purposes (for example, school funding, teacher accountability).

In fact, in many ways, the events in the United Kingdom in the late 1980s and early 1990s (Turner and Bash, 1999) whereby the introduction of the National Curriculum and the ensuing implications associated with assessment, school funding, and the development of 'League Tables' (Head, Maguire and Dillon, 1997) certainly loomed large in the minds of many Victorian teachers. Implementation of the CSF created a sense of uncertainty about other changes that might be introduced as a result of the extra 'possibilities' that might emerge - standardized testing at two stages in primary schooling was one immediate outcome.

- Learning Outcomes

Following on from the issue above, an important feature of the CSF, which was new to many science teachers, was the introduction of the language of Learning Outcomes. In many ways the application of Learning Outcomes was perceived as a return to 'Behavioral Objectives' and therefore created confusion for teachers as they did not necessarily believe that just because they had 'taught' a topic that students would have 'learnt' that which was intended. The previous Science Frameworks Document (1987) had highlighted for science teachers much of the research knowledge associated with Children's Science (Osborne and Freyberg 1985; Gunstone, 1990) and alternative conceptions (Driver, 1983; Driver, et al., 1985). Therefore, the approach to Learning Outcomes seemed almost paradoxical. Further, throughout our interviews we continually asked the question, "Could you give an example of how you teach for a particular Learning Outcome?" and this question was rarely answered in a confident manner.

One effect of teachers' lack of confidence in teaching using a Learning Outcomes approach was the more widespread use of textbooks in science classes (a major shift for teachers accustomed to developing their own curriculum). Textbooks that purport to cover the relevant content areas and Learning Outcomes of the CSF came to be more relied upon by teachers to ensure that the demands of the CSF could be met.

An ongoing dilemma for CSF 2000 has been to find ways to illustrate particular approaches to teaching towards a Learning Outcome(s) so that exemplars of such practice might be recognized and highlighted for other science teachers. Clearly, in describing and articulating such practices the nature of Learning Outcomes would become clearer and more useful to science teachers and would also be

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most helpful in addressing the dilemma noted in the previous section (Progression). It does, however, cause one to wonder how such a fundamental issue could be overlooked in developing curriculum documents that challenged existing approaches to practice in such a confronting manner.

- Assessment vs. Reporting

An ever-present issue in our interviews was the disjunction between assessment and reporting. This is an issue that may well be regarded as being a constant in many schools and that the CSF simply exacerbated it for many science teachers. Many of the schools in which we conducted interviews were operating on a timeline that involved moving from curriculum auditing processes and into implementation of new reporting procedures - designed around the CSF format. In the overwhelming majority of cases, schools were under pressure to produce new report formats that reflected the CSF and this internal pressure was reflected in a somewhat superficial approach to reporting on assessment. For example, it was not uncommon for schools to be busy constructing new reporting formats that reflected the CSF learning outcomes despite the teachers themselves either disagreeing with the underlying assessment requirements, or simply not understanding how these learning outcomes could be understood or reported in a meaningful way at all.

Most science teachers were coming to understand the possibilities associated with reporting in relation to the 'achievement' categories of: beginning; consolidated; and, established. However, in many cases, the completion of a particular Level was related to the amount of content completed. Hence, it was common for a science department to decide that students could not be regarded as having satisfactorily completed a Level until they had completed all of the content within the strands at those Levels - exacerbating further the reporting problems noted in the previous paragraph. Therefore, assessment of Levels was synonymous with the completion of content rather than the level of achievement of learning within that content.

In this instance, assessment is not appropriately informing reporting and this is an issue of concern to science teachers as they work to meet policy requirements but struggle to interpret these appropriately in practice. The difficulty with this issue is that it has the potential to drive science teaching to be more transmissive (Barnes, 1976) and hinder the important growth in understanding of science teaching which has emerged in the past two decades that has challenged this 'knowledge delivery' approach to science teaching. One important example of this growth in understanding the development of science teaching was the McClintock Collective (1988) which placed inclusive teaching procedures on the agenda for science teachers and pre-service science teacher programs. With a perception of a shift back to more traditional teaching, it is interesting to ponder

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what will become of the advances of programs such as the McClintock Collective and other science support materials that better linked science education research to classroom practice.

The development of assessment strategies and their relationship to progression through the CSF is an issue that is important for science teaching and learning. Further, these developments need to inform the reporting practices which are consequently adopted and refined. In the CSF 2000, these issues have subsided as teachers have had a chance to better align the curriculum and its intended outcomes to the report formats, but the underlying philosophical issue of what is being reported and what it represents continues.

Conclusion

This overview of science curriculum reform highlights a number of important issues that should be seen as timely reminders for curriculum writers and education bureaucrats - science teachers' understanding and knowledge of the intricacies of teaching and learning should not be overlooked. As end users of curriculum documents they do not function as technicians simply following a 'protocol'. Science teachers are informed professionals who are responsible for helping their students to better learn and understand the world around them.

It is an ongoing matter of concern that in education we seem to continually confront problems that are (in many ways) of our own making. The example of the Science CSF in Victoria highlights how, eventually, some congruence between curriculum intent and classroom practice was achieved. However, it was through a 7-year implementation process driven by a major re-orientation of the purpose of curriculum documentation and a development of a centralized decision-making process that was often at odds with the reality of schools and classrooms.

This is not to suggest that science teachers now fully agree with the directions of the Science CSF 2000, but that they have come to know how to use it better in relation to their perceived needs and responsibilities in schools. It seems to us that the lesson to be learnt from the Victorian experience is for curriculum development to proceed in ways that are informed by our knowledge of the change process. Further, that in the case of science, that which we have learnt through research should continually shape our attempts to influence approaches to teaching and learning in positive ways so that our science teachers feel confident that what they are asked to do, and what they know they need to do, are truly convergent.

References

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Barnes, D R. (1976). *From Communication to Curriculum.* London: Penguin Books.

Driver, R. (1983). *The Pupil As A Scientist.* Open University Press. Milton Keynes.

Driver, R., Guesne, E., and Tiberghien, A. (Eds.). (1985). *Children's Ideas In Science.* Open University Press. Milton Keynes.

Fensham, P. J. (1992). Science and technology. In P. W. Jackson (Ed.), *Handbook of research on curriculum.* New York: Macmillan.

Fullan, M. (1993). *Change forces: Probing the depths of educational reform.* London: Falmer Press.

Fullan, M. (1995). The limits and potential of professional development. In T. Guskey & M. Huberman (Eds.), *Professional development in education: new paradigms and practices* (pp. 253 - 267). New York: Teachers College Press.

Fullan, M. And Hargreaves, A (Eds.) (1992). *Teacher Development and Educational Change.* London: Falmer Press.

Fullan, M. (1999). *Change Forces: the sequel.* London: Falmer Press

Grant, P., Johnson, L., and Sanders, Y. (1990). *Better Links: teaching strategies in the science classroom.* Melbourne: STAV Publishing

Gunstone, R. F. (1990) 'Children's Science': A Decade Of Developments In Constructivist Views Of Science Teaching And Learning. *Australian Science Teachers Journal 36* (4) 9 - 19

Head, J., Maguire, M., and Dillon, J. (1997). Teaching in a new ERA. In Justin Dillon and Meg Maguire (Eds.) *Becoming a Teacher: Issues in Secondary Teaching.* Buckingham: Open University Press.

Malcolm, C. (1987). *Science Framework* Melbourne: Curriculum Branch, Ministry of Education.

McClintock Collective (1988). *Getting into Gear: gender inclusive teaching strategies.* ACT: Curriculum Development Centre.

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Millar, R., & Driver, R. (1987). Beyond processes. *Studies in Science Education, 14*, 109-118.

Millar, R. (1991). A means to an end: The role of processes in science education. In B.Woolnough(Ed.). *Practical Science.* Milton Keynes:Open University Press.

Ministry of Education (1987). *Science Frameworks P - 10*, Melbourne: Ministry of Education (Schools Division).

Osborne R., and Freyburg, P. (1985). *Learning in in Science.* Auckland: Heineman Press.

Science CSF (1995). *Curriculum and Standards Framework: Science.* Melbourne: Board of Studies.

Science CSF (2000). *Curriculum and Standards Framework 2000: Science.* Melbourne: Board of Studies.

Screen, P. (1987). *Warwick Process Science.* Southampton: Ashford Press Publishing.

Senge, P M. (1990). *The Fifth Discipline: The Art and Practice of the Learning Organisation.* Sydney: Random House.

Senge, P M., Kleiner, A., Roberts, C., Ross, R., Roth, G., and Smith, B. (1999). *The Dance of Change: The Challenges of Sustaining Momentum in Learning Organisations.* London: Nicholas Brearly Publishing.

Turner, M., and Bash, L. (1999). *Sharing Expertise in Teacher Education.* London: Cassell Education.

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