A critical examination of the New Zealand science curriculum document

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The New Zealand Curriculum Framework (Ministry of Education, 1993a) states as one of its principles that New Zealand curricula will encourage students to become life-long learners. In this critical examination of Science in the New Zealand Curriculum (Ministry of Education, 1993b), I shall appraise the success of the document in setting up a culture for learning in which this principle is valued.

We live in a democratic society and as such the processes of education from curriculum planning through to its interpretation in the classroom should reflect the visions of democracy held by society. The 1993 curriculum reform was the result of political re-evaluation of the future educational needs of the New Zealand economy within the setting of the world wide market (Ministry of Education,1993a).

Does the Science document reflect social ideals or those imposed by politicians, or is the vision shared? Science in the New Zealand Curriculum claims to have a learner-driven purpose. Is this compatible with these social and political visions? Does the document present a clear model for learning that supports the vision of life-long learning?

These are questions I hope to answer in the process of this appraisal. To do so I examine assumptions that underpin the philosophy, aims and content presented in the document, point out any apparent contradictions and highlight strengths and weaknesses of the document. I then present my personal viewpoint in relation to the principle of life-long learning as it is linked to the conceptions of curriculum that I identify within the Science document and, finally, I make some recommendations for the future.

Curriculum, teaching and learning are interwoven (Prawat, 1992). In New Zealand the curriculum statement of intent is centrally produced, but schools are expected to interpret and implement the statement in a manner which reflects the special nature of the communities they represent. The learner is expected to reconstruct the original intent. Therefore the factors and concept of curriculum cannot be separated for analysis. To give some structure to the process I have taken four key assumptions embedded in the science curriculum document regarding the roles of knowledge, the learner, the teacher, the school, society and curriculum. These assumptions are:

- Knowledge is dynamic and ever changing.
- New Zealand society is based on democratic principles.
- Learning is a personal construction of knowledge.
- Curriculum is a framework for learning.

I critically evaluate and compare these with other views and models.

Knowledge: Dynamic and ever changing

The structure and purpose of curricula hinge on the view of knowledge expressed in the curriculum document. The view expressed in this science curriculum is dynamic . Science is seen as a "...systematic and creative (process) of investigation (in which) scientists produce a constantly evolving body of knowledge" (Ministry of Education,1993b), knowledge that responds to change. The science document indicates commitment to the importance of children's own personal constructions of scientific ideas as they explore the subject with the support of teachers to guide and challenge their thinking (Carr et

al, 1994). When knowledge is seen as dynamic, ongoing human effort is important in its renegotiation and extension: knowledge has social relevance. Learners have a part to play in thinking about curriculum content and process. The principles of science become a description and explanation of the phenomena that are encountered along the way (Biddulph, Taylor & Biddulph, 2000; Bigelow, 1990; Morrison & Ridley,1998; Prawat,1992).

The alternative view of knowledge, that it is static and unchanging (Biddulph, Taylor & Biddulph, 2000; Irwin, 1999), values absolute "truths" that are uncovered as learning progresses along a prescribed path. This concept does not value children's ideas, nor does it give equal encouragement to all to become independent life-long learners. Science is seen as a subject to be learned, a subject that provides right answers that have always existed (Biddulph, Taylor & Biddulph, 2000; Carr et al, 1994).

The organization of all the New Zealand curricula into eight levels of achievement with specific progression clearly stated, contradicts the open, negotiable concept of knowledge embedded in the science curriculum document. This structure presumes that all children progress through a body of learning, most of them at a similar pace, dictated by the curriculum developers. There is no research base for these levels; they have merely been decided on by the members who served on the curriculum writing party. This system was modeled on the ten-level Attainment Targets scheme in the United Kingdom which has not been successful in its implementation. The levels and progressions of knowledge are purely arbitrary (Elley,1993). The professional judgment of classroom teachers as to the progress of their individual students would, in most cases, provide qualitative assessment data that would be just as accurate and more relevant.

The strengths of the view of knowledge stated in the science curriculum are:

- It values the ideas of students.
- It sustains the belief in life-long learning.
- It allows for innovation and creativity on the part of both teachers and students.

The weaknesses are that:

- The application of the levels of achievement compromise the concept of knowledge as dynamic.

"The curriculum should acknowledge the right of children to make informed choices and engage in critical dialogue as part of the process of curriculum development. "

Recommendation:

In the light of the theory of knowledge expressed in the New Zealand science curriculum, the need for levels of achievement and sequencing of knowlege should be reviewed.

Society: Based on democratic principals

New Zealanders, on the whole, value equity, freedom of choice and social responsibility. The science curriculum recognizes the right of all children to have equal access to learning and to have their special needs and abilities catered for. It expresses the intention to promote science as an activity that people are involved in as part of their daily lives (Ministry of Education, 1993b). This is paralleled by curriculum changes in most European Union countries where work has been done to ensure that science is accessible to everyone. The greatest effort is being put into primary school programmes, and to integrate science with other subject areas to give it greater interest and relevance to children. Parent involvement at primary level is close and it is hoped that children will take their interests and positive attitudes into their homes and the community (Solomon, 1996).

Schools and classrooms are themselves societies where social interaction is a powerful force (Biddulph, Taylor & Biddulph, 2000). Students are encouraged to think critically about science (Ministry of Education,1993). They should also, in keeping with the Social Constructivist theory of learning, which gives flavour to the curriculum without actually being stated (Irwin, 1999), be involved in curriculum development. The curriculum should acknowledge the right of children to make informed choices and engage in critical dialogue as part of the process of curriculum development. I note that this is implied in the sections that apply to extending children with special abilities and enhancing achievement, but not in the general aims. It should also encourage critical dialogue among learners to make decisions about the direction of their learning.

Currently, in New Zealand, the content decisions about the science curriculum are made centrally, implying that a central authority knows better than teachers, students and local communities what the learning needs and interests of their children are. This devalues the professionality of teachers as well as the empowering of learners.

One of the conceptions of our curriculum is that it will respond to social and economic needs. A centrally conceived, standardized curriculum cannot hope to respond to the needs of all sectors of society. We need creative and innovative thinkers to ensure the future social and economic health of the country, not people whose creativity has been suppressed by standardizing their learning. This has been one of the effects of centralization in the United Kingdom (Biddulph, Taylor & Biddulph, 2000). Solomon (1996) reported that although all European Union countries had a national curricula, they were urged to make the content relevant to the everyday lives of students. A year later it is reported that Spain was in the process of decentralization in

response to social, economic and environmental considerations (James, et al, 1997). Atkin (1998) states that curriculum content decisions in the 13 countries involved in the curriculum reform project undertaken by the Organization for Economic Cooperation and Development were made by the public, scientists who were not members of the academic community and teachers. In Sweden, the implementation of curriculum policy decisions is entrusted to teachers. It seems that political control of the New Zealand science curriculum has caused this country to lag behind Europe in the important perception of teachers as professionals and in the value of community input into curriculum. This contradiction between democracy and central control needs to be addressed and attention paid to the overseas studies I have mentioned.

The democratic nature of society, as seen in the light of the science curriculum, assumes that education is for the public good. The strength of this should be that curriculum decision making is framed in a social context involving learners, teachers and communities. The reality, however, is that central control over the purposes and content removes the potential for participatory democracy and contradicts the democratic ideal, thus turning an inherent strength into a weakness.

Recommendation:

That control of curriculum content be decentralized and involve local planning committees made up of teachers (Bell & Baker, 1997), students, and interested informed community members. Involvement of students at this level of decision making will empower them to take greater control of their learning due to a more vital and relevant curriculum.

Learning: A personal reconstruction of knowledge

There are two conflicting conceptions of school evident in New Zealand education: a technocratic model dominated by the need for standards measured against achievement objectives, competition among schools (Biddulph, Taylor & Biddulph, 2000), encouraged by the right-wing influences in the Tomorrow's Schools education reforms (Lange, 1988) and the need to control teachers by centrally imposing performance standards. This concept has flowed over into curriculum development with the inclusion of the achievement objectives and the required assessment against them.

"Co-operation and purposeful interaction are encouraged, the process of learning is valued as much as the product, and children, through the types of experiences suggested, are learning how to learn."

The alternative conception is of schools as communities of learners where, along with the value of knowledge, critical dialogue about ideas, issues and social values are considered (Biddulph, Taylor & Biddulph, 2000). The general aims of the science curriculum more closely match this concept.

The teacher's role is to interpret and implement the curriculum, make decisions about learning, be innovative, and develop a classroom culture in which learning about science takes place alongside learning about learning. Teachers must, in fact, reconstruct their own understanding about learning in the face of the technocratic model.

A Constructivist learning model is implied in this document, based on the building of cooperative communities in which learners (including teachers) interact in a purposeful, more or less non-hierarchical way. Children work both independently and co-operatively, from the base line of prior experience and understanding, constructing and reconstructing knowledge through critical dialogue with each other and their teacher (Biddulph, Taylor & Biddulph, 2000; Carr, et al, 1994; Driver, et al 1994; Prawat,1992).

In research exploring constructivist learning in science, concepts that children constructed as part of the Carr et al (1994) research and an Australian project at secondary school level (Schulz & McRobbie, 1994) showed that science learning had become both relevant and manageable for the groups. The Schulz and McRobbie research also gathered statistical data showing a significant increase in learning as a result of interaction among students. Biddulph and Carr (1999) emphasize the importance of the teacher's role in moving children along from their own ideas to more sophisticated thinking. Teachers have a vital role in the interactive learning process.

The sections of the curriculum document that are relevant to this model of learning are scattered through the document and need to be more closely linked. References to the construction of personal meaning are buried throughout the essential skills section. Aspects of the section applying to children with special abilities should be applied to all learners: all children should be learning at their own pace once they know what this is; open-ended activities which encourage creative thinking will enhance learning for any child; co-operative and problem solving approaches are important skills that all children need to be successful learners. These are characteristics of constructivist learning and should not be restricted in their application.

The implications for learners and teachers in this document are positive. Co-operation and purposeful interaction are encouraged, the process of learning is valued as much as the product, and children, through the types of experiences suggested, are learning how to learn. Such attitudes and skills are learned for life.

The weakness here lies in the structure of the document which is like a jig-saw of important concepts that must be reassembled to make the whole. This has come about through the conflict of interests between the document's political conception and the beliefs of the writers.

Recommendation:

Revision of this document should contain a clear description of its intention and purpose. The levels should be replaced with a range of suggestions for supporting teachers in the making of qualitative judgments about children's progress that can be clearly understood by everyone.

Curriculum: A framework for learning

I have examined aspects of the roles of the people involved in curriculum development and implementation in detail. What about the role of the science curriculum itself?

The intention of the curriculum is to provide a framework for learning that provides a direction for learning that is progressive and seamless throughout the years children spend at school (Ministry of Education, 1993). Also stated is the purpose of enrichment and empowerment of students in their ability to take control of their own learning, to improve themselves and the future of society (Biddulph, Taylor & Biddulph, 2000) . These purposes are reiterated in the science document and the addition made of the intention to establish the relevance of science to the lives of children and society. The success of this role is weakened by the inclusion of achievement objectives that give a more finite feeling to an otherwise open-ended curriculum, and by the stated need to accumulate judgmental, summative data on student achievement . Emphasizing assessment of set objectives for accountability purposes implies a lack of trust in teachers to make decisions about learning and assessment of children (Holt, 1996), an attitude which has reached out into the community and is frequently reinforced by the media.

Our current curriculum has incorporated the "best" of earlier curricula, according to the framework document (Ministry of Education, 1993a). This includes some remnants from the Behaviourist learning theory, namely the hierarchical structure of the levels, the progressive mastery of achievement objectives, the expectation that teachers will assess each objective for summative purposes. By contrast, one of the advantages of working in close interaction with children along Constructivist lines, I have found, is the richness of qualitative assessment data that is constantly available. This form of assessment contributes to the big picture of learning and is of more interest, when backed up by work samples, to parents at reporting time. I feel it is time that New Zealand moved on from behaviourist learning ideas.

In my experience, as a framework for learning, the science curriculum document did not meet with immediate success. The first stages of implementation involved a great deal of in-service training to help teachers understand the changes in format, educational jargon, the purpose of the levels, the issues that had to be coped with, and how to integrate the strands. Some social development is also required (Bell & Baker, 1997) to support teachers in skills such as active listening and critical thinking. If the document had been consistent and not contradictory in terms of the underlying learning theory, it could actually have supported teacher development instead of complicating it.

Recommendation:

Future revisions of this document need to be consistent in the application of learning theory to purpose, making sure that theories complement each other.

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