

The Science Council of Canada Report, *Science for Every Student*: A Solution in Search of a Problem

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The Science Council of Canada recently completed a study, *Science for Every Student*, which examined the practices of science teaching in Canada, analyzed the curriculum materials in use, and produced position papers. The study was broad in scope, the first of its kind in Canada. Given strong provincial claims to education, The Council is to be applauded for its national inquiry. Because of its potential for influencing policy, the study deserves careful attention from academics and policy-makers. This paper will analyze the claims of the report, examine its potential for improving science teaching in the country, and draw attention to the policy issues in the field of curriculum. The analysis points to a number of shortcomings in the study. These involve questions of methodological rigor, problem identification, focus, depth, and implementation. Methodologically, the study did not appear firmly grounded; it is argued that the study is a policy statement masking as scholarship and that much confusion exists in the minds of the authors of the Science Council report over the distinction between science and technology. Of most importance, however, is the impact of the study at the classroom level. The authors of the report argue that, if the recommendations are fully implemented, an unprecedented level of activity will occur in science education in Canada. Our analysis indicates that, because the study is virtually silent on problems of implementation and because it fails to deal with the teacher's role in that process, it will have little impact on the method of science teaching in the schools.

Le Conseil des sciences du Canada a récemment mené une étude sur "la science à la portée de tous les élèves." Dans cette étude, le Conseil a examiné l'enseignement des sciences au Canada, a analysé le contenu des programmes et a fait des recommandations. L'étude, la première en son genre au Canada, avait une portée étendue, et, compte tenu des revendications des provinces en matière d'éducation, le Conseil mérite d'être félicité pour cette initiative de portée nationale. L'étude mérite de retenir l'attention de ceux qui enseignent et de ceux qui élaborent les politiques. Le but de cet article est d'analyser le contenu du rapport, d'examiner en quoi il peut contribuer à l'amélioration de l'enseignement scientifique au pays et d'attirer l'attention sur les politiques concernant les programmes. Notre analyse souligne un certain nombre de faiblesses de cette étude au niveau de la rigueur scientifique, de l'identification des problèmes, des mises au point, de la profondeur et des applications pratiques. Du point de vue méthodologique, l'étude semble s'aventurer sur un terrain peu solide dans ses affirmations. On peut dire que c'est un énoncé de politique qui veut passer pour de l'érudition, et qu'il existe dans l'esprit des auteurs du Conseil des sciences énormément de confusion quant à la distinction à établir entre "science" et "technologie." D'importance encore plus grande, cependant, est l'impact de l'étude au niveau scolaire. Les auteurs du rapport sont d'avis que, si leurs recommandations sont

mis en pratique, on assistera à un essor sans précédent dans le domaine de l'éducation scientifique au Canada. Comme l'étude passe pratiquement sous silence les problèmes de la mise en oeuvre des programmes proposés et omet de parler du rôle des enseignants à cet égard, notre analyse indique que l'étude aura très peu d'effet sur la façon d'enseigner les sciences dans les écoles.

INTRODUCTION

The Science Council of Canada¹ recently completed a study entitled *Science for Every Student* which examined the practices of science teaching in Canada, analyzed the curriculum materials used, and sampled public opinion through position papers and deliberative conferences. In terms of its scope, data collection, and the numbers of people involved, the study was very broad indeed and the first of its kind in Canada. For these reasons and because the report has been widely disseminated,² the study should attract a great deal of attention and be influential in shaping future policy in Canada. Hersom (1984), for example, in a recent analysis of the study, contends that it demonstrates a high level of maturity in curriculum scholarship. However, it has been pointed out that the report makes a number of assumptions about the role of science in society that have not been adequately addressed in the study (Nadeau & Désautels, 1984). Further, it has been argued that the study appears to have ignored a number of critical issues in implementing curriculum (Fullan, 1984). Hence, the report must receive the careful attention of science educators, curriculum theorists, and policy makers within the Canadian context.

Further, rapid technological change in the Western world provides a setting where studies of this type are, on one hand, timely but, on the other, require close examination. Curriculum developers must face the question of the role of science teaching in an increasingly technological society. The Science Council of Canada report takes the position of including more technology in the curriculum. A similar position, from a British perspective, was taken by Harrison (1980) at a symposium on world trends in science education. The position raises a number of questions and issues requiring debate and examination in any jurisdiction where rapid technological growth occurs.

In this paper we analyze the study's methodological approach and the claims made in the report.³ We also examine its potential for improving the teaching of science in Canada. Throughout the analysis, attention is drawn to the policy issues that require examination by academics and policy makers in the curriculum field.

THE CONTEXT

A perennial dilemma for education in Canada concerns the division of jurisdiction between the federal and provincial governments, a problem that has been resolved in most other Western countries. Historically, the provinces have had full control of education, a principle recently enshrined in the new Canadian Constitution. While there are no constitutional exceptions to this principle, recent practices have seemed to admit federal interventions, at least in terms of transfer of funds and in areas of emerging concern, such as university, bilingual, and native education. These hidden transfers, laundered through provincial ministries and directed at target areas selected federally, have grown enormously to involve billions of dollars and over 200 committees, departments, or programs within the federal government. Scholars, politicians, and others have long queried the validity of a rhetoric which camouflages the actual involvement of federal agencies in this “provincial” matter. Many have argued for a valid, open role for the government of Canada wherein its actions become visible, accountable, and relevant to national goals.

Given this context, it is little wonder that few federal agencies have ventured aggressively into the area of education. What little has been done has always taken on an aura of subterfuge. These attempts at national statements of intent or accomplishment have almost always been directed at the post-secondary sector where, in recent years, federal agencies have exercised more and more involvement. Even here, however, the federal-provincial jurisdictional debate continues.

One must applaud the Science Council of Canada for their mission of inquiry concerning science education in Canada’s public schools. Any national body attempting such a study risks at least a lack of needed cooperation from provincial agencies.

EXPECTATIONS FOR SUCH A REPORT

The avowed intentions of the study were laudable: to establish a documented basis to describe the present purposes and general characteristics of science education in Canadian schools, to conduct an historical analysis of science education in Canada, and to stimulate active deliberation concerning future options for science education in Canada. What might the science education community – teachers, science educators, scientists, and policy makers, among others – expect from a study of this nature? It is reasonable to expect that the study should meet high canons of

methodological rigor,⁴ identify the central problems of science education in the country, outline the options open to science education in Canada, make recommendations with potential for improving science teaching in the nation, and open channels of communication with stakeholders to support a commitment to improvement. Reports of this nature should emerge with recommendations having a clear potential for making a difference. If policy makers do not act upon the recommendations of a report, then the authors of the report are not at fault. If implementation of the recommendations is unlikely to make any difference, then the authors of the report are culpable. Furthermore, the process of collecting data should also develop communication channels to provide links to the stakeholders who will implement the recommendations. Our analysis of the study and its several-volume report led to the identification of numerous shortcomings and problems which must be addressed by the academic community if real change in science teaching is to occur. These involved questions of methodological rigor, problem identification, focus, depth, and implementation. They are discussed under these headings. We return to them collectively in the concluding section.

THE PROBLEM OF METHODOLOGY

The first purpose of the study was thwarted when the Council of Ministers of Education in Canada, while agreeing to co-operate with the study, decided against allowing assessment studies of science achievement which they deemed a provincial matter. Thus, a fundamental issue in the quality of science education, that of the achievement of students, was necessarily omitted from this study. Perhaps no other flaw could have greater impact on the overall utility of the effort. While other aspects of education examined in the study are important, such as the levels of curricula at work in any classroom, teacher training, attitudes, beliefs, and morale, none approach the centrality of the problem: What quality of science education is achieved by students? How can this study speak of its fundamental concern? Surely a description of present purposes and general characteristics of science education in Canadian schools is pointless unless we know something about achievement. Thus, the Council had no control over a major shortcoming of the report.

The selection of background papers for the study is also of concern. Two of these essays, one by an engineering dean (George, 1981), the other by a director of a centre for industrial research (Page, 1979), seem to have influenced markedly the study's finding that science can best be understood through practical application. It is not surprising that the authors of these two position papers would hold the view that science

should not be taught as a body of knowledge and a methodology of inquiry but rather to fit citizens for employment in the scientific-technological world. The prior structuring provided by these position papers became the “lenses behind the eye”⁵ as the study report implicitly, and frequently explicitly, asks us to abandon pure scientific thinking and to see science as technology. One’s view of science is very much related to cognition, to prior dogmas, and to accepted methods of inquiry. The authors surely understand the prior structuring provided by the study papers. It seems equally confusing that an essay which speaks explicitly to this point of epistemology (Nadeau & Désautels, 1984) did not arrive until April, 1984, a date which precluded its debate in deliberative conferences. Was there a conception of science education held by the Science Council of Canada accepted by the report’s authors without adequate debate within the academic community?

The problems of methodology do not stop there. We find the study’s lack of logical argument of particular concern. The authors sought to collect data on the curriculum as planned, as perceived, and as taught. The difficulty with such an approach is the lack of criteria or standards against which to compare such data. The question becomes, what does the mound of data mean? How does one proceed from that data to a certain line of argument and what enables one to do so? The authors of the report do not indicate how they moved from their data to conclusions. For example, it is not at all clear what forms the basis for recommending that technology education form a greater proportion of secondary school education. Thus, one could argue that the report is a political document masking as scholarship. It is political in the sense that the a priori view of science now seems to be legitimized through a nation-wide study. But as we have pointed out, despite its high profile, the study is very weak indeed in that it fails to link its recommendations to the data collected. Thus, *future discussion ought to treat the report as a position paper rather than scholarship based on research.*

THE GOALS OF SCIENCE EDUCATION

The aims of science education, according to the authors of the report, are to “develop citizens able to participate fully in the political and social choices facing a technological society; train those with a special interest in science and technology fields for further study; provide an appropriate preparation for the modern work world; [and] stimulate intellectual and moral growth to help students develop into rational, autonomous individuals” (*Science for Every Student*, 1984, p. 13).

We are told that these goals are based on an emerging consensus and,

indeed, it is difficult to quarrel with them though they may well oversell the role of science education for the informed citizen. A sound education in science with experience in some of the inquiry processes, the acquisition of some scientific information, and an understanding of the role of science in the intellectual and material development of society should indeed help students become rational and autonomous, but the best possible science education cannot prepare high-school graduates to undertake the scientific inquiries necessary to provide answers to important social questions – questions about food additives, pollution, drugs, and environmental management, to name a few. Experts must still undertake investigations and provide and interpret the information upon which to base decisions. At the very least, however, students should become skeptical about advice offered by experts, whether they peddle headache remedies, pesticides, a political party, creation science, astrology, or magic pyramids.

Our concern is not with these general goals. Rather, it lies in how these goals become translated into statements and recommendations in the remainder of the report. Following this statement of goals, the authors cite that part of a UNESCO report (Fauré, et al., 1972) which calls for a better understanding of technology. The authors then draw on three papers commissioned to support an emphasis on technology education. Students should learn to “achieve a desired end,” to “design, construct, and test products of social value,” and to “be tomorrow’s entrepreneurs and technical innovators.” As we pointed out earlier, it is easy to see how this emphasis arose, given the particular discussion papers commissioned. The only noneducators were people involved in technology. The report quotes extensively from the writings of corporate executives, and it seems that the writers of the report have emphasized only the technological purpose of science education. Teachers neither place this option high on their list of priorities nor do they consider technology to be among the areas they can best teach.

It will be recalled that one of the avowed intentions of the study was to stimulate discussion concerning future options for science education in Canada. *Yet only one option appears to be placed before us by the report.* Curriculum developers must debate this thrust. Students of curriculum inquiry will want to examine in detail the implications of decisions that would shift science teaching toward technology.

THE CONFUSION OVER SCIENCE AND TECHNOLOGY

A basic assumption throughout the report is that science education in Canadian schools is flawed by an overemphasis on mathematics and the

basic sciences of physics and chemistry and a neglect of technology. Little argument is provided for an assumption which constitutes the basis of some of the more significant recommendations in the report; consider, for example, 4b, which indicates that elementary science should include fields like forestry, engineering, and nutrition, and 7, which recommends that ministries develop courses in technology. The issues raised in the report are confused by the continuous use of the phrase "science and technology" as if the two were inseparable and as if it were not necessary to examine separately the function of each in the school system.

Technology is defined as "the totality of means employed to provide objects necessary for human sustenance and comfort" (p. 42). This definition is broad enough to include the occupations of assembly line worker and engineer but probably excludes the work of politicians, poets, and teachers. Science, on the other hand, is described as "the discovery and acquisition of abstract knowledge" (p. 16), "a search for explanation" (p. 37), and "a way of knowing" (p. 38). These descriptions do not provide a basis for a discussion of science education in relation to technology education. In fact, they do not even distinguish science from religion, art, philosophy, or superstition. Thus, the authors' meaning is unclear when they talk about science and technology. Do they see a distinction? The confusion over science and technology leads the authors of the report into difficulty in a number of instances.

The essential aspect of science which differentiates it from other modes of inquiry is the creation, testing, and modification of theories. The practice of the scientific enterprise results in the collection of data, the development of inquiry processes and experimental techniques, the discovery of laws, and, of course, the creation of theories. Basically, then, the purpose of technology is to make objects while the purpose of science is to make knowledge. The two are not unrelated. Technologies *can be* based upon knowledge obtained from scientific investigations. It is nevertheless true that (a) scientific inquiry is not most commonly motivated by the desire to provide information for technological development; (b) scientific inquiry has value not determined by the extent to which it results in technological development; (c) it is impossible to predict which scientific inquiries will result in useful technological developments; (d) technological developments do not take advantage of all the useful information provided in the course of scientific inquiry; (e) all technologies are not based on scientific information; and (f) scientific inquiries may be conducted, on occasion, by technologists, and technology may be done by scientists. Although the essential component of science is theory, this is precisely the component which is least important to technology. Technologies depend upon knowledge of the properties of matter and

not at all upon explanation (theories). This is why technologies developed long before science and why many technologies are currently practiced without resort to any science at all.

The aims of education in science and technology are dealt with in Chapter 2 of the report, but the lack of any differentiation between the two results in a confused analysis. An understanding of the importance of technology and of its relation to science should certainly be an important goal of education. The training of technologists also has a place in the education system. Beyond this, the questions remain: What is the role of technology education in the school system, what are its pedagogical benefits, and how does it impinge on science education?

The flavor of the science education recommended by the authors may be inferred from references to information processing skills, environmental conservation, electronics and materials technology, the hydro-electric industry, agriculture, forestry, communications technology, and so on. The suggestion is that, even at the elementary and junior secondary levels, science classes should be devoted to geology, agriculture, botany, health sciences, and engineering.

No *understanding* of these "macro-sciences," as the report calls them, is possible, however, except on the basis of a knowledge of mathematics and the sciences of chemistry, physics, and biology. One can certainly be involved in the practice of a technology without understanding the basic sciences from which it is derived. Such involvement does not, however, confer intellectual autonomy. One cannot critically analyze the technology, nor can one hope to develop new and improved ones. Without applying scientific principles, one can, for example, learn the regimen of good diet, good exercise, and good hygiene, but one cannot explain it, criticize it, or react analytically to suggestions that it be changed.

The seductive notion of including more technology seems to have been recommended without recognizing that the important technologies of the future are unknown. They will be based upon different scientific principles, involve different processes, and require different skills and apparatus. Lasers, semiconductor microcircuits, and *nmr* imaging were unknown a few years ago, but they are the basis of important applications today. It is difficult to conceive of a system of education for technology which would prepare students to deal with technologies not yet invented, and it is equally difficult to justify using the education system to develop skills which will be out of date by the time the learners graduate.

The failure to differentiate between science and technology has led the writers of the report to emphasize *Canadian* science and technology. The argument applies to technology, but it does not apply to science: there is no Canadian science for science is international. Communication and

collaboration between scientists of different countries working in the same area are more important than communications between Canadian scientists working in different areas. Scientists from different countries meet, work together in each other's laboratories, and together publish the results of their collaborations. Hoffmann points out that

the story of the quantum is the story of a confused and groping search for knowledge conducted by scientists of many lands on a front wider than the world of physics had ever seen before, illuminated by flashes of insight, aided by accidents and guesses, and enlivened by coincidences such as one would expect to find only in fiction. (1959, p. ix)

The knowledge obtained is available to all, and it is senseless to identify Newton's Laws as British, Avogadro's Hypothesis as Italian, and insulin as Canadian. We can ascribe a national character to other cultural products of our society—our music, our literature, and our television—but scientific knowledge is *not* a product of one person or group at one time in one place. As Delbruck (cited in Fine, 1972) explained as he accepted the Nobel prize:

While the artist's communication is linked forever with its original form, that of the scientist is modified, amplified, fused with the ideas and results of others, and melts into the stream of knowledge and ideas which forms our culture. (p. 872)

Technology is a completely different matter. The development of technologies is indeed determined by national considerations—those of national culture, national politics, national economics, history, geography, climate, and natural resources. It is important to understand the interaction of this complex set of factors in the application of scientific knowledge to the development of technologies; but this science-technology-society interaction is a very sophisticated problem, and it is doubtful if a non-specialized program at the school level can treat the subject more than superficially. In any case, the problem must be analyzed and an approach developed to deal with it before it is possible to consider moving the whole thrust of science education in the direction of technology.

LACK OF PROBLEM DEFINITION

Research can sometimes be of a problem-solving nature and on other occasions problem-seeking. Indeed, increasingly it is recognized that in the social sciences and policy-making areas, problem identification is an important component of research. This study did not set out to resolve any specific problem in science education. This is perfectly legitimate

since it was the first study of its kind in Canada. Curiously, however, neither has it been a problem-seeking type of inquiry. From reading the report, one does not sense that the authors have come to grips with the problems central to science teaching in this country. Concerns are raised that too little science is being taught in the elementary school and that too few girls are enrolled in science, but these situations were known long before the Science Council study. The fact that so few girls elect science as an option is a symptom of a much deeper problem. By focussing on peripheral symptoms, the report deflects our concerns from the problems which are central to science teaching. We contend that it seriously undersells the difficulties with science education in Canada. One finds little of the sense of national crisis typical of recent U.S. reports (Sigda, 1983).

We contend that the manner of science teaching is a major problem. The report is almost silent on this question despite the fact that one of the position papers commissioned for the study identified the matter as one of major concern (Nadeau & Désautels, 1984). In senior years, science classes usually take the form of lectures which emphasize the recall of information. The development of provincial examinations based upon banks of test items strengthens this unfortunate emphasis and presents science as a rhetoric of conclusions. Such teaching is boring at best, and at worst it discourages students from continuing studies in science. Despite this, the authors recommend more science in school programs; it is difficult to know how such a recommendation can result in improvement without *a major change in the manner of teaching the subject*.

THE PROBLEM OF IMPLEMENTATION

The report makes 47 recommendations directed at various groups with responsibilities for science teaching in Canada. One would expect such recommendations to be directed toward improving inadequate aspects of science teaching in the country and maintaining effective practices. This report does not fulfill these expectations. Three problems in particular stand out. First, because the key problems in science education have not been identified in the report, one finds a lack of focus and direction in the recommendations. Second, the recommendations are written as though we had learned nothing about implementation and change during the past several decades. Third, a disproportionate amount of attention, both in the recommendations and in the proposed monies allocated to them, is focussed upon those far removed from classroom teaching, thereby limiting the study's impact on instruction and learning.

The recommendations lack focus. Most appear to be saying that, if we

talk more, require more, and spend more, things will improve. Such an approach has rarely accomplished much.⁶ Recommendations 16 and 17, for example, propose that principals, ministries, and school boards initiate deliberative processes aimed at improving science education. But what is to be the focus of those deliberations? When teachers rated their own effectiveness,⁷ they considered themselves most effective in realizing those objectives deemed most important. Why then should teachers discuss means of improving their science teaching if they already see it as effective? Had future options been identified, as the report set out to do, then such deliberative processes might have had some motivation. The report does not, however, present such options for discussion. The lack of focus in both problems identified and recommendations gives little clarity to the report's intentions and to the problems that could be solved with full implementation of the recommendations.

On the matter of implementation strategies, the ultimate success of a study of this type will be the extent to which the science classrooms of the nation become better places for children to learn science. This implies change from existing practices through the implementation of more effective ways of teaching. Over the past several decades, much attention has been devoted to studying the implementation of new ideas and innovations in the life and culture of a school. Much has been learned about that process (Fullan, 1983; Hopkins & Wideen, 1984; McLaughlin & Marsh, 1979). It is now generally agreed that the process is complex and time consuming, that those involved in the change need to know the rationale and the intent of the change and to develop the necessary new skills and perceptions, that pressure for change is necessary, and that support is required. The recommendations in the report are made without benefit of these findings about change and implementation.

The first recommendation is a prime example. It proposes that "All ... ministries ... require that science be taught for at least 15 per cent (45 minutes per day) of the curriculum at the early years of school." Few would argue with this. Ministries have always had such requirements, with little effect upon the amount of science taught in the elementary school. What, then, will be the impact of the recommendation without any supporting statements concerning its implementation? Such a recommendation is of absolutely no value in changing anything occurring in the schools, and numerous other recommendations are similar. Their danger lies not only in their total ineffectiveness but also in the possibility that governments, planners, and science educators may be led to believe that legislation based on such recommendations will solve the problems confronting science teaching.

The weakness in the bulk of the recommendations is that they ignore

the complexities of the process of change, assuming that power coercive strategies⁸ of change emanating from high places will be effective. The shortcomings of such approaches were well illustrated by the curriculum reform movement of 1960s and 1970s. Attempts on the part of governments at that time to improve science teaching were massive, but they failed. The report of the Science Council of Canada does not appear to reflect what has been learned from that decade of curriculum reform.

For reform to occur, the direction of that change must be known by those affected and some pressure must exist for its implementation. It can be argued that the type of activity that would identify a direction for change and develop the pressure to maintain it should occur at a local level. The report does little to encourage this. Its lack of focus and its low-key nature create no tension or pressure to encourage change at the necessary level – the classroom. It does provide opportunities for many who are far removed from the action.

The third difficulty with the recommendations is the disproportionate attention given to groups far removed from the classroom. The bulk of the recommendations are directed at ministries of education, boards, universities, supervisors, and other similar groups. Only 7 of the 47 recommendations mention teachers directly, and those directed at other groups do not indicate how the results are to be effective in terms of classroom practice. We are not opposed to funding activities at these levels. What concerns us is the failure of the Science Council report to base such activity on classroom reality. Less than 1 % of the proposed budget is targeted for those recommendations which will affect teachers directly. One could argue that the benefits of the activity carried out by outside groups (such as the appointment of science supervisors) will eventually filter down into the classrooms. But past experience does not support the filter-down theory as a means of improving classroom practice. For example, it has been shown that the most effective means of improving practice is to encourage small groups of individuals to begin examining and improving their own practice (Olson, 1982). We see very little support for this approach in the recommendations.

The key curriculum makers in education are teachers who *are* undoubtedly influenced by external policies. However, as the report appropriately points out, such influence is limited, as the intended and the actual curriculum are quite distinct. Such a reality is always disquieting to departments of education, supervisory folk, and university professors who would wish that the benefit of their activities would help increase the effectiveness of classroom teaching. Reality tells us something quite different. The question then becomes: How does one seek improvement within this set of realities? We contend that options that seek to engage

teachers in normative reeducative strategies of classroom improvement must be encouraged by those seeking change. The Science Council report is virtually silent on this issue.

With these general comments in mind the discussion now turns to a more specific analysis of two clusters of recommendations, professional development and evaluation.

Professional Development

It is well recognized that, given present conditions of restraint and social immobility, continuing professional development of teachers will be the key to science teaching improvement in most Western countries in the decades ahead. The report correctly identifies the school as the focus for this development, with the principal as central in engaging teachers in deliberative activity leading to professional growth. The six recommendations that are offered support deliberative activity, visits among teachers, and the development of personal goals and plans for improvement. One can only applaud these recommendations if only because they do focus on the teacher and the school. However they simply do not go far enough. The report admits that principals are not always trained for such roles. How then can they engage teachers in deliberative activity? Furthermore, it is well known that effective professional development is a complex process involving the presentation of theory, observation of new methods, practice, feedback, and coaching (Joyce & Showers, 1980; Wideen & Andrews, in press). These are complicated processes requiring much effort and great resources. The recommendations here, as in so many areas, appear to gloss over this complicated reality of the school. We would have been more convinced had the report targeted resources for these activities.

Evaluation

A curious characteristic of studies of this nature is the general acceptance, often without examination, of certain practices and procedures once a given framework has been accepted. This is certainly evident in the matter of evaluation. The report commends, without apparent examination, the Provincial Learning Assessment in British Columbia as a model to be introduced into other parts of Canada. To our knowledge, no meta-evaluation of the provincial learning assessment in that province has ever been conducted, and recent reports from British Columbia indicate that even the Minister of Education ignored the recommendations of the British Columbia assessment (Bateson, 1984). We are not in a position to

criticize the Provincial Learning Assessment Program in British Columbia or similar assessment programs in other jurisdictions. But we must question the utility of assessment programs which rely basically on surface data collected through multiple choice tests. Thus, to propose its implementation nation-wide without examining utility would seem misguided and perhaps even irresponsible.

Similarly, the report recommends creating a test item bank. The basis upon which this recommendation rests is not made clear. While we do *not* wish to argue the issue of testing and examinations, we do contend that before accepting item banks, which tend to measure factual content, their impact on the work of teachers and the implicit assumptions underlying their use should be examined. In a recent panel, for example, McLean (1984) questioned the value of final exams and testing on the basis of their costs, fairness, and equity. He pointed out that the money spent on final exams might better be spent elsewhere. Also, he argued that fairness and equity could not be claimed where equal opportunity of instruction was not available. Furthermore, such testing procedures could run counter to many of the more central purposes of science teaching. For example, at a time when children will need to become managers of information, it is difficult to justify testing them on information recall.

One might have expected a nation-wide study of this type to examine the value of final examinations and large assessment programs. If such investigations occurred, they were not reported. Rather, it appears that the use of test item banks and province-wide assessment programs fit well into the corporate, technological position advocated by the Science Council of Canada. What we consider dangerous is that a high level report recommends the implementation of very powerful, influential, and costly evaluation procedures with virtually no examination. We contend that policy makers and academics in all jurisdictions must examine such policies and their effects on curriculum.

SUMMARY AND CONCLUSION

We have argued that because the report of the study, *Science for Every Student* (Vol. 5), fails to meet certain canons of methodological rigor it should be seen as a position paper and not a research report as the authors claim. Hamstrung by an inability to collect data on student performance, the authors sought to examine the curriculum as planned, perceived, and taught. But, as we argued, it is not clear how the authors of the report used the data at these three levels to draw their conclusions. Such an approach does little to improve curriculum in science in the country, and little has been discovered about the problems of science education or the solutions to those problems.

We contend that two courses of action were open to the authors and may remain so to those wishing to carry out further analysis based in these data. The use of standards against which to compare the data at all three levels would have been far more appropriate in our opinion. For example, a national panel of teachers, science educators, and scientists (and possibly other stakeholders) could have been assembled to identify the type of science teaching expected in the schools, given curriculum developments during the past 20 years. The results of that deliberation would have provided some type of bench mark against which to discuss the teaching identified in the report. The deliberative conferences could have been the vehicle for this type of activity. Unfortunately, they were never charged with this responsibility.

Given these data and the lack of a conceptual framework and warrants for their interpretation, it is indeed difficult to understand how the main conclusion that more technology should be taught in the schools has been reached. As we have argued, we do not take this position as a given or a desideratum, nor do we see any data apart from a single position paper to warrant such a shift. If the Science Council of Canada wishes to take that position, then they have every right to do so. Many may disagree with our contention concerning the methodological aspects of the report. Regardless, the implicit perspectives and the lens behind the eye need to be carefully examined by academics and policy makers.

Perhaps most important is the difficulty of knowing the problems solved by the shift to more technology in the schools. As we pointed out, the Science Council report does not identify problems which seem central to the teaching of science. Problem identification is a first step in seeking improvement in any system. We contend that further inquiry is required to identify problems central to science teaching in Canada.

However, even taking as valid the directions presented by the report's authors, successful implementation of those recommendations is highly unlikely because of the stance assumed by the authors. As argued, the thrust of the recommendations is to those groups removed from the classroom where change must occur. Any remedy that does not begin with teachers is doomed to failure. The history of curriculum reform has shown repeatedly that those removed from the classroom are limited in effecting change. What does seem effective is having teachers themselves work with those who provide input and leadership so that the new ideas brought into the classroom and classroom practice itself are altered through a process of mutual adaptation (McLaughlin & Marsh, 1979). Thus, the blend between the work place and the practical knowledge of the teacher, on the one hand, and input from outside, on the other, appears to be the key to curriculum improvement in science education as in other subjects. The Science Council report has raised our awareness of

the need for change and identified some roles that can be played by external groups. The report ends with the statement that if the recommendations are fully implemented an unprecedented level of activity will occur in science education in the country. Perhaps so, but because the report has failed to deal with the teacher's role in that process, it will have little effect upon the way science is being taught in the schools.

NOTES

- ¹ The study discussed in this paper involved all ten provinces as well as the Northwest Territories. A full report can be obtained by writing to the Science Council of Canada, 100 Metcalfe Street, 17th Floor, Ottawa, Ontario K1P 5M1.
- ² The report was first released at the National Association for Research in Science Teaching annual conference in New Orleans in 1984 and has been discussed at ten provincial conferences and at major national meetings in Canada.
- ³ In conducting this analysis, our main focus was on section 36 of the report (*Science for Every Student*, 1984). Unless we specify to the contrary, all reference to the study will be to this section of the report.
- ⁴ The authors refer to the work of Tolman (cited in Roberts & Russell, 1975) who outlines the need for warrants and arguments to back the claims and conclusions from research. *Warrants* permit the drawing of inferences from data; *backing* refers to that which is taken for granted in an argument.
- ⁵ This term was coined after reading Hanson (1969).
- ⁶ The literature on change and innovation is now fairly clear on this point. See in particular Olson's (1982) discussion of the shortcomings of similar approaches in science education.
- ⁷ This information was obtained from *Statistical Database for Canadian Science Education*, vol. 2 (1983).
- ⁸ Power-coercive change strategies are described by Chin and Benne (1976) as strategies which are directed from those in positions of authority and emphasize political and economic power as a means of achieving change. They also describe normative reeducative strategies for change which rely more heavily on changing attitudes, norms, and various relationships among persons in a group.

REFERENCES

- Bateson, D. (1984, June). *Provincial examinations in British Columbia*. Paper presented to the annual meeting of the Canadian Educational Research Association, Guelph, Ontario.
- Chin, R., & Benne, K. (1976). General strategies for effecting change in human systems. In Bennis, W. G., Benne, K. D., Chin, R., & Carey, K. E. (Eds.), *The planning of change*. New York: Holt, Rinehart, & Winston.
- Fauré, E., Herrera, F., Abdul-Razzak, K., Lopes, H., Petrovsky, A. V., Rahnema, M., & Ward, F. C. (1972). *Learning to be* (Report of the International Commission on the Development of Education). Paris: UNESCO.
- Fine, L. W. (1972). *Chemistry*. New York: Appleton Century Crofts.

- Fullan, M. (1983). *The meaning of educational change*. Toronto: OISE Press.
- Fullan, M. (1984, June). Some implications for implementation. In A. Hughes (Chair), *Science Council of Canada report on science education: Analysis and critique*. Symposium conducted at the annual conference of the Canadian Society for the Study of Education, Guelph, Ontario.
- George, D. P. (1981). *An engineer's view of science education*. (Discussion paper). Ottawa: Science Council of Canada.
- Hanson, N. (1969). *Patterns of discovery*. Cambridge: Cambridge University Press.
- Harrison, G. (1980). The role of technology in science education. In C. P. McFadden (Ed.), *World trends in science education*. Halifax: Atlantic Institute of Education.
- Hersom, N. (1984, June). Some implications for teacher education. In A. Hughes (Chair), *Science Council of Canada report on science education: Analysis and critique*. Symposium conducted at the annual conference of the Canadian Society for the Study of Education, Guelph, Ontario.
- Hoffman, B. (1959). *The strange story of the quantum*. New York: Dover Publications.
- Hopkins, D., & Wideen, M. F. (1984). *New perspectives on school improvement*. London: Palmer Press.
- Joyce, B., & Showers, B. (1980, February). Improving inservice training: The messages of research. *Educational Leadership*, 37(5), 379-385.
- McLaughlin, M., & Marsh, D. (1979). Staff development and school change. *Teacher's College Record*, 80(1), 69-74.
- McLean, L. (1984, June). Reactions to a panel on final examinations. In J. Anderson (Chair), *Final examinations*. A symposium conducted at the annual conference of the Canadian Society for the Study of Education, Guelph, Ontario.
- Nadeau, R., & Désautels, J. (1984). *Epistemology and the teaching of science*. (Discussion report D84/2). Ottawa: The Science Council of Canada.
- Olson, J. (1982). *Innovation in the science curriculum*. London: Croom Helm.
- Page, J. E., (1979). *A Canadian context for science education* (Discussion paper). Ottawa: Science Council of Canada.
- Roberts, D., & Russell, T. (1975). An alternative approach to science education research: Drawing from philosophical analysis to examine practice. *Curriculum Theory Network*, 5(2), 107-125.
- Science for every student* (Science Council of Canada Report #36). (1984). Ottawa: Science Council of Canada.
- Sigda, R. (1983, May). The crisis in science education and the realities of science teaching in the classroom. *Phi Delta Kappan*, 64(8), 624-627.
- Statistical database for Canadian science education* (Vol. 2). (1983, January). Ottawa: Science Council of Canada.
- Wideen, M. F., & Andrews, I. (Eds.). (In press). *Staff development for school improvement: A focus on the teacher*. Basingstoke, Great Britain: Falmer Press.

Der Science Council of Canada (Bundesbeirat für Wissenschaften) hat kürzlich eine Studie, *Wissenschaft für jeden Schüler*, abgeschlossen, die die Praktiken des wissenschaftlichen Unterrichts in kanadischen Schulen untersuchte, gängige Lehrplanmaterialien analysierte und Diskussionsmaterialien erarbeitete. Die Studie war breitangelegt und die erste ihrer Art in Kanada; vor dem Hintergrund starker Ansprüche der Provinzen auf die Erziehung

ist die landesweite Untersuchung des Science Council als lobenswerte Initiative zu sehen. Wegen ihres Potentials, Richtlinien beeinflussen zu können, verdient diese Studie sorgfältige Aufmerksamkeit seitens Akademiker und politischer Entscheidungsträger. Das Ziel dieser Arbeit besteht darin, die Hypothesen, die in diesem Bericht aufgestellt werden, zu analysieren, sein Potential zur Verbesserung des wissenschaftlichen Unterrichts im Lande zu untersuchen und die Aufmerksamkeit auf die Grundsatzfragen im Lehrplan-Bereich zu lenken. Unsere Analyse weist auf eine Reihe von Unzulänglichkeiten in dieser Studie hin. Diese schließen Fragen zur methodologischen Stringenz, Problemdefinition, Blickrichtung, Tiefe und Durchführung ein. Vom methodologischen Aspekt schien die Studie mit den von ihr aufgestellten Hypothesen nicht auf festem Boden zu stehen: es wird behauptet, daß die Studie eher eine Grundsatzerklärung – als Wissenschaftlichkeit verkleidet – ist und daß unter den Autoren des Berichts große Verwirrung über den Unterschied zwischen Wissenschaft und Technologie besteht. Von größter Bedeutung jedoch ist die Auswirkung der Studie auf Klassen-Ebene. Die Autoren des Berichts behaupten, daß, sollten die Empfehlungen völlig ausgeführt werden, ein noch nie dagewesener Grad von Aktivitäten in Kanadas wissenschaftlicher Erziehung einsetzen wird. Da die Untersuchung praktisch kein einziges Wort über die Probleme der Durchführung verliert und weil sie daran scheitert, mit der Rolle des Lehrers in diesem Prozeß umzugehen, deutet unsere Analyse darauf hin, daß die Studie nur eine geringe Wirkung auf die Art und Weise, wie Wissenschaften in den Schulen gelehrt werden, haben wird.

El Consejo de ciencias del Canadá ha terminado recientemente un estudio acerca de la Ciencia al alcance de todos los alumnos. Este estudio que examinó la enseñanza de ciencias en Canadá analizó el contenido de los programas y estableció su posición frente a los mismos. Este proyecto, que es el primero de su tipo en Canadá, fué de amplio alcance y, en vista de las fuertes reivindicaciones de las provincias en cuanto a educación, el Consejo merece felicitaciones por esta iniciativa de alcance nacional. El estudio merece la atención de los enseñantes y de los elaboradores de políticas. El propósito de esta comunicación es el de analizar las aserveraciones del informe, de examinar lo que se puede hacer por mejorar la enseñanza científica en el país, y de atraer la atención sobre las políticas que afectan los programas. Nuestro análisis desea subrayar varios puntos débiles de este estudio a nivel del rigor científico, de la identificación de los problemas, del enfoque, de la profundidad, y de sus aplicaciones prácticas. Desde el punto de vista de la metodología, las aseveraciones del estudio parecen aventurarse en un terreno no muy sólido. Se podría decir que se trata de un enunciado de políticas que pasa por erudición, y que en el espíritu de los autores del Consejo existe una marcada confusión en cuanto a la diferencia entre "ciencia" y "tecnología." Lo que tiene aún mayor importancia es el efecto del estudio a nivel escolar. Los autores del estudio creen que de aplicarse sus recomendaciones, veríamos un florecer sin precedentes en el campo de la educación científica en el Canadá. Dado que el estudio virtualmente pasa en silencio los problemas de la implantación de los programas propuestos y omite hablar del papel de los enseñantes en el proceso, nuestro análisis indica que tendrá muy poco efecto sobre la enseñanza de ciencias en las escuelas.

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