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ABSTRACT

This paper features a summary of comments and suggestions from participants in the Alberta Science Education Leaders' Symposia on the future of secondary science education. Topics discussed include needs, challenges, and concerns in science education; suggestions for change; renewing secondary science programs; professional development of teachers; partnerships; and programs for both the Calgary and Edmonton symposia. (CCM)

Proceedings of the Alberta Science Education Leaders' Symposia

"The Future of Secondary Science Education: Charting a Course for Renewal"

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December 5, 1997, Calgary
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The primary intended audience for this document is:

Administrators	✓
Counsellors	
General Audience	✓
Parents	✓
Students	
Teachers	✓

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Introduction

Alberta's current science programs for grades 7 through 12 are a direct outcome of the 1985 *Policy on Secondary Education*. The current Grade 7 program was first made available for optional implementation in September 1989, and the Grade 12 program was implemented in September 1994. The elementary science program was implemented in September 1996.

Many events during the past decade have had an impact on science education. There have been significant changes in science, technology, the economy, post-secondary education and the world of work. For example:

- Although more young people are pursuing careers in science and technology, demand still exceeds supply in several areas.
- The Pan-Canadian Common Framework of Science Outcomes (October 1997) presents an opportunity to improve the alignment of Alberta science programs with those in other provinces.
- According to the results of national and international assessments, Alberta's science programs are setting high standards for students, and students are achieving them.
- Aligning different levels of the science program (elementary, junior high and senior high) is an ongoing challenge.
- Science teaching and learning is changing in response to the advent of technology in schools.

Consequently, the time has come to take another look at secondary science programs to ensure that they are still meeting the needs of students, employers and society as a whole. In the fall of 1997, Alberta Education began reviewing where science programs in Alberta are now and where they should be going.

Two of the components of the review process—regional meetings and a questionnaire—focused on these three questions.

1. *What are the strengths of Alberta's current science programs?*
2. *What changes should be made to the content and/or structure of these programs to better meet the present and future needs of students?*
3. *When should the programs be revised? Should work be initiated now?*

In addition, Alberta Education organized two symposia for science education leaders in the province. The first was held in Calgary on December 5, 1997, and a second in Edmonton on March 13, 1998. The goal of the symposia was to provide education partners, educators and non-educators alike, with an opportunity to share their perspectives with one another. Participants also had a chance to discuss issues and make some preliminary recommendations. The theme for these symposia was "The Future of Secondary Science Education: Charting a Course for Renewal."

The participants were science educators, scientists, engineers from business and industry, staff from post-secondary institutions and Alberta Education, school administrators, parents and students. Approximately 110 people attended the Calgary symposium; 140 participated in Edmonton.

Group discussion early in the day focused on "Needs, Challenges and Concerns in Education." Participants were asked to consider the following questions.

1. *What science education do graduating students need to live in the 21st century?*

2. *What are the strengths of our current program, and to what areas do we need to give more attention?*

3. *What challenges will we face in the process of renewing our programs?*

Later in the day, participants were asked to regroup and respond to these questions.

1. *How do we renew secondary science programs to meet* ***the needs of all students*** *and at the same time prepare some of them for later specialization and science-based careers?*

2. *What approaches do you recommend for* ***the professional development of teachers***— *approaches that will provide the background knowledge of science and contexts and an array of strategies for effective delivery of programs?*

3. *What* ***partnerships*** *do you recommend to make the best use of resources?*

The major symposium speakers and facilitators are listed below.

Calgary Speakers

Chair: Dr. Douglas Roberts, Faculty of Education, University of Calgary

Keynote speakers: Dr. Robert Westbury, Vice-President, Government Affairs, TransAlta Corporation; and Dr. Ian Winchester, Dean, Faculty of Education, University of Calgary

Closing remarks: Mr. Ken Myhre, Interim President, Southern Alberta Institute of Technology

Edmonton Speakers

Chair: Dr. David Blades, Department of Secondary Education, University of Alberta

Keynote speakers: Dr. Antony (Tony) Marsh, President, Canadian Microelectronics Corp.; and Dr. Wytze Brouwer, Professor of Secondary Education and Physics, University of Alberta

Closing remarks: Dr. Sam Shaw, President, Northern Alberta Institute of Technology

At both events, the luncheon speakers were Keith Wagner, Acting Assistant Deputy Minister, Alberta Education; and Jim Brackenbury, Director of Student Evaluation, Alberta Education. The closing remarks were delivered by Dr. Sam Shaw, President, Northern Alberta Institute of Technology.

Programs for the symposia are provided in Appendix A and Appendix B.

Needs, Challenges and Concerns in Science Education

1. What science education do graduating students need to live in the 21st century?

Participants identified a range of knowledge, skills and attitudes that high school graduates should have. They also supported a variety of modifications and/or enhancements to the science curriculum and other changes in the system as a whole that would assist students.

Participants frequently mentioned the need for high school graduates to have **knowledge** in the following areas:

- the connections among different disciplines of science (integration)
- the structure and purpose of business
- key science concepts required to function in our society (science literacy)

Another knowledge area that came up was understanding the ethical implications of our actions in relation to science and technology.

The most frequently mentioned **skills** for high school graduates were:

- the ability to apply school knowledge to real life—knowing how and where science fits into their lives
- the ability to think critically—a questioning attitude and open mind, the ability to identify problems that are worth solving
- strong communication skills (oral and written)
- the ability to solve problems and do open-ended problem solving
- people skills
- teamwork skills
- time management skills
- grammar and spelling skills

Participants also mentioned the need for such skills as numeracy, computer literacy, the ability to use technology as a tool for research and production, creativity/imagination, transferring knowledge from one context to another, evaluating and career planning.

The essential **attitudes** that participants emphasized included:

- love of learning—learning to learn, having a sense of wonder, taking responsibility for own learning, being prepared to learn throughout life
- a social conscience and personal ethics

Participants also discussed the importance of self-esteem and confidence, which is at the heart of successful learning and the risk-taking behaviour that is inherent in problem solving and critical thinking. Students also need to have confidence in the future, and they need to be adaptable.

2. **What are the strengths of our current program, and to what areas do we need to give more attention?**

General comments on strengths of the program

Symposium participants identified a number of strengths in the current Science 10 course and the Science 20–30 program, which:

- focuses on the practical application and relevance of science to real-life technical and social issues—providing students with opportunities to see "science in action" and "do science" through practical activities
- integrates the different disciplines of science into a coherent whole and shows the relationships among them.

Other strengths of current science programs:

- clear scope and sequence in the curriculum
- opportunities to acquire and develop research skills
- emphasis on critical thinking
- the emphasis on science, technology and society (STS)
- up-to-date content
- flexibility and creativity in the junior high school courses
- consistency across Canada—through the Pan-Canadian Project. We don't have this consistency yet. The Pan-Canadian Project may lead to more consistency.

General concerns about the program

There was a major concern about the "depth" of the program. Overall, people feel that students need to learn basic science concepts well before moving on, and that the current amount of content interferes with this process. Participants emphasized the importance of mastering and reinforcing concepts to ensure that they are learned thoroughly. There was a particular concern about the amount of content that is currently included in Science 10 course.

There was a similar debate about balancing content—factual information—with skills development—learning the processes of science.

Participants discussed at length how all students' needs could be addressed in science programs. Here are some of the concerns expressed:

- Schools tend to reward students who learn quickly and easily, and are slow to meet the needs of the 75 per cent of students who do not go on to university. (There is "too much emphasis on marks.") Students who go into the trades also need a science background.

- There is a continuing need to attract and retain more female students in science programs.

- Current social/cultural values are shifting students' time and attention elsewhere; e.g., TV, part-time jobs.

- Junior high school students have special needs; it can be difficult to keep them interested in learning science at this age.

- There is a need to adapt to individual learning styles; one comment was that this is "done better in the humanities."

Other concerns:

- Students need more relevant applications of science concepts and more opportunities for practical, hands-on activities. There was; however, a comment in support of "minds-on" as well as "hands-on" learning.

- There should be more writing in science courses.

- Students need more instruction about ethical issues in science.

- There is a need for increased access to technology and for better ways to maintain currency (technology changes rapidly).

- Students need more information about linking their science education to career options; e.g., science in the arts.

- There should be more connections with business and industry.

Comments about specific science programs

- There is a need for better connections between elementary and junior high school science programs, and between junior and senior high school. At the same time, there is a need to avoid repeating some content excessively.

- The Alberta High School Diploma requires only 10 credits in science. Some participants believe that this, along with the effects of streaming beginning in Grade 10, is another factor that may contribute to the relatively low number of students enrolled in senior high science programs. However, department data indicates that 70 per cent of all high school graduates complete one or more science courses at the 30 level (1996–1997).

- Science 16–26[1] is "only a time filler." Science 14–24 is not rigorous enough (not enough mathematics), and Science 24 is a "dead end." The gap between Science 10 and Science 14 is too great.

- The prerequisites for Science 10 need to be more stringent; i.e., Science 10 is too rigorous for some students coming out of Grade 9.

- Science 10 is not articulated well with the 20-level disciplines of biology, chemistry and physics.

- Physics 20 does not include enough real-world applications, and the reading level of the authorized textbook is too high.

- Some post-secondary institutions continue to give only limited recognition to Science 30.

3. **What challenges will we face in the process of renewing our programs?**

Professional development of teachers

Because of the many changes in science programs, teachers are having to learn new skills. For example, they must manage and integrate the knowledge component of programs with "hard" and "soft" skills, STS, ethics, career planning and so on. The role of the teacher is changing from lecturer and dispenser of information to facilitator, researcher and coordinator.

Teachers continue to be challenged by the need for sufficient and current resources, and by the need to enhance their own skills and knowledge, such as keeping up with technology, using more hands-on activities, learning about STS.

[1] Science 16–26 is intended for students in the Integrated Occupational Program. These courses can be used to meet the science requirements for a Certificate of Achievement, but not the requirements for an Alberta High School Diploma.

Many senior high school science teachers now need to know more about other science disciplines beyond their own area of specialization. A number of elementary and junior high school teachers, as well as some senior high school teachers, who are generalists without a science background, face the opposite problem—some are not trained in science at all. As the content and approach of science programs becomes increasingly sophisticated, generalist teachers become less comfortable with them.

Many teachers need more inservice education in assessment—an area that is increasingly important in all aspects of education.

School counsellors also need to learn more about careers in science and mathematics.

Resources

- More textbooks are needed to support the curriculum. In particular, there is a concern about the quality/suitability of the authorized Science 10 textbook.
- There is a lack of electronic resources, especially software.
- Many schools have out-of-date computers and their staff lack technological expertise. In addition, other schools have extensive access to up-to-date technology, so there are inequitable situations.
- A general lack of adequate science laboratory space and laboratory support staff is an ongoing challenge.
- Often, class sizes are too large for conducting hands-on activities and exploring practical applications.
- Funding/financing is a major issue.

Assessment and evaluation

Participants said that the methods of assessment need to be broadened and that the assessment tools need to be linked more closely to the current curriculum. In other words, is there enough testing of skills, as well as knowledge content?

In addition, more work needs to be done to ensure that assessment results are used as constructively as possible—that is, to the benefit of students.

There are ongoing concerns about assessment driving instruction.

The role of parents and community

Parents and the community are valuable resources, but the new relationships among schools and parents, business and others in the community require careful management to avoid abuse. The government still has a role to play and should be sharing responsibilities with local communities.

Nonetheless, business and industry have much to offer. In addition to serving as a resource to enhance student learning, they can also help students with their career planning. Business and industry can also help with the professional development of teachers; e.g., short-term work experience on site.

Participants' Suggestions for Change

1. Renewing secondary science programs

- Make more connections among the science disciplines to reflect what is happening in the scientific community outside the schools. Also, connect science; e.g., STS, with other subjects studied at school.

- Show students how science is a foundation of society and a way of understanding everyday phenomena. To make science more relevant to their lives and careers, organize and offer job-shadowing programs, work experience, career days and project work. "Go beyond the doors of the classroom."

- Teach/have students practise such communication skills as technical writing, problem solving, critical and creative thinking, teamwork.

- Limit the course content to permit more in-depth learning and more hands-on projects, particularly in Science 10 and Science 20–30. Emphasize depth instead of scope. Provide for more time on task and more exploration and problem-solving.

- Do more to address the individual needs of students—gender, social, cultural, career. For example, try single-gender classes and provide students of both sexes with role models regarding careers in science. Do more research into the causes of gender bias in science programs. Develop programs for the bottom one-third of students who do not take science beyond Grade 10; e.g., link Science 14–24 to CTS. Develop flexible (modular programs) that permit students to learn at their own pace. Promote student self-esteem and confidence.

- Include in science instruction such strategies as project work, synthesizing different types of information or knowledge, applying science concepts to real life and linking these to everyday experiences, learning about the why as well as the what, portfolios for assessment and career planning, independent learning/research.

- Broaden the methods used for student assessment, including such performance-based assessments as portfolios and lab activities, and reward students for what they already know (advanced placements).

Senior high school program structure

- Offer strong general science courses for all students after Grade 9. Design general programs specifically for students who are entering directly into the work world; stop focusing only on university preparation.

- Review the aims of science education: Citizenship or post-secondary preparation or university preparation or careers?

- Include 15 credits in science, instead of the current 10, in the Alberta High School Diploma graduation requirements.

- Review Science 14–24 and try to make it possible for Science 24 students to enter into a 20–30 level science sequence. Link Science 14–24 to the CTS program. Integrate other science courses with CTS as well.

2. **Professional development of teachers**

- Offer programs that provide all teachers with more science knowledge and science skills, and that encourage senior high school teachers to broaden their knowledge beyond a specialization in one discipline. Identify master teachers, and develop certification for a specialty in science teaching.

- Offer programs that help teachers to:
  - become computer literate
  - learn more about hands-on, classroom activities and teaching science as a process
  - learn more about gender bias in science education
  - learn more about assessment tools and methods, including the assessment of process skills.

- Support teachers by providing them with incentives in regard to their professional development:
  - inservice programs, leaves for further study
  - conferences and summer institutes
  - peer coaching
  - teacher exchanges within the province
  - cooperative education opportunities—placements or work exchanges in science-oriented business and industry
  - mentorships
  - resource manuals, lists of other resource materials, computers and laboratory equipment
  - extra pay, tax credits, time off

- professional development plans required for all teachers
- awards and recognition programs that highlight the work of innovative teachers—and consider whether or not current awards are using appropriate evaluation tools
- identify master teachers.

- Encourage the ATA Science Specialist Council to coordinate and deliver more information and resources for science teachers.

- Encourage corporations and post-secondary institutions to sponsor the training of science teachers.

- Provide a new authorized resource for Science 10, and review all currently authorized textbooks regarding their suitability for a broad range of learner needs.

- Develop software for science programs.

- Provide equitable access to hardware and provide more technical support for teachers.

3. Partnerships

- Enhance the linkages between secondary and post-secondary educational institutions to make the transition, from one to the other, smoother for students; e.g., more post-secondary participation in curriculum development and more participation in decisions about the basic education requirements for university entrance.

- Increase the number of partnerships among schools and local industry, business and other agencies, to provide students with role models, work experience, career information, and access to labs and equipment that schools do not have. Develop a list of industries and businesses that schools can contact for information, resources and support. Include in this list: parents, community agencies, post-secondary institutions, business and industry, research agencies, provincial and federal government departments, ATA specialist councils and publishers.

- Increase the linkages and ease of communication between and among:
  - schools and parents
  - teachers and researchers
  - federal and provincial government departments; e.g., Alberta Education, Advanced Education and Career Development, Labour, Human Resources and Development Canada.

Appendix A: Symposium Program, Calgary, December 5, 1997

8:15 – 8:45—Registration and Coffee

8:45 – 8:55—Greetings and Welcome

Dr. Douglas Roberts, Professor, Division of Teacher Preparation, University of Calgary

9:00 – 9:50—Plenary Sessions

Dr. Robert Westbury, Vice-President, TransAlta Corporation
Theme: "Science Education and Career Preparation"

Dr. Ian Winchester, Dean, Faculty of Education, University of Calgary
Theme: "Science Education and Lifelong Learning"

Refreshments

10:00 – 11:00—Group Discussions

"Needs, Challenges and Concerns in Science Education"

- What do our graduating students need for general education, citizenship, the workplace, future studies and sustainability?
- What are the strengths of our current programs, and to what areas do we most need to give attention?
- What challenges will we face in the process of renewing our programs?

11:10 – 12:00—Progress Reports

12:05—1:25—Lunch

Mr. Keith Wagner, Director, Curriculum Standards, Alberta Education
Theme: "Working in Partnership with Other Provinces"

Mr. Jim Brackenbury, Director, Student Evaluation, Alberta Education
Theme: "National and International Science Assessments: What do the Results Show?"

1:30 – 3:00—Group Discussions

Recommendations for Change

- What changes do you recommend in order to ensure that Alberta secondary science programs meet the needs of all students and at the same time prepare the way for later specialization?
- What links do you recommend between school science and science in the community?
- What partnerships do you recommend to make the best use of resources?

Refreshments

3:10 – 4:00—Progress Reports

4:00 – 4:30—Closing Plenary

Mr. Ken Myhre, Interim President, Southern Alberta Institute of Technology
Theme: "Highlights of Discussions"

Evaluation of Symposium

Appendix B: Symposium Program, Edmonton, March 13, 1998

8:15 - 8:45—Registration and Coffee

8:45 - 8:55—Greetings and Welcome

Dr. David Blades, Associate Professor, Department of Secondary Education, University of Alberta

9:00 - 9:50—Plenary Sessions

Dr. Antony (Tony) Marsh, President, Canadian Microelectronics Corp.
Theme: "Science Education and Career Preparation"

Dr. Wytze Brouwer, Professor of Secondary Education and Physics, University of Alberta
Theme: "Science Education and Lifelong Learning"

Refreshments

10:00 - 11:00—Group Discussions

"Needs, Challenges and Concerns in Science Education"

- What do our graduating students need for general education, citizenship, the workplace, future studies and sustainability?
- What are the strengths of our current programs, and to what areas do we most need to give attention?
- What challenges will we face in the process of renewing our programs?

11:10 - 12:00—Progress Reports

12:05 - 1:25—Lunch

Mr. Keith Wagner, A/Assistant Deputy Minister, Student Programs and Evaluation, Alberta Education
Theme: "Needs Assessment and the Renewal of Secondary Science Programs"

Mr. Jim Brackenbury, Director, Student Evaluation, Alberta Education
Theme: "National and International Science Assessments: What Do the Results Show?"

1:30 - 3:00—Group Discussions

Recommendations for Change

- What changes do you recommend in order to ensure that Alberta secondary science programs meet the needs of all students and at the same time prepare the way for later specialization?
- What approaches do you recommend for teacher professional development that will provide the background knowledge of science and contexts, and an array of strategies for effective delivery of Alberta secondary science programs?
- What partnerships do you recommend to make the best use of resources?

Refreshments

3:10 - 4:00—Progress Reports

4:00 - 4:30—Closing Plenary

Dr. Sam Shaw, President, Northern Alberta Institute of Technology
Theme: "Highlights of Discussions"

Evaluation of Symposium

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