OVERVIEW

Characteristics of the Early Years Learner

Kindergarten to Grade 2

Early Years students from Kindergarten to Grade 2 have a natural curiosity about the world around them. They explore their world through their senses, as well as by watching and imitating others. They are strongly influenced by the adults in their lives.

At this stage of the Early Years, students are highly involved in their own inquiries, based on their guesses about how things work and act. Consciously and unconsciously, they sort, group, order, and pair objects in both their work and play. These experiences help students learn about how things are alike or different. Talking with students as they explore helps to reinforce basic science concepts and encourages students to express themselves using accurate scientific terms.

To solve complex problems, Kindergarten to Grade 2 students require sufficient time to work through the problems step-by-step, using a trial and error approach. Adults need to resist the urge to correct student errors during this problem-solving process, allowing students to work through the errors and learn from them. Students construct their own understandings through interactions with living things, objects, and events in the world and from talking about what they did and what they found out. Technological problem solving (design process) provides an excellent mechanism for students to develop problem-solving skills while working with real-life problems and concrete materials.

Kindergarten to Grade 2 students tend to be somewhat egocentric. Group work, sharing of materials and tasks, and listening to others' ideas and suggestions can be difficult for them. Providing opportunities and establishing supports and guidelines for group work helps students learn to take turns and engage in positive social interactions. The use of science centres provides students with opportunities to develop these group-work skills. For more information, refer to Appendix E: Using Learning Centres in the Science Classroom.

Students at these grades find stories that follow linear sequences easy to understand and remember (e.g., stories about seasons, human growth, and activities of an insect/animal over the course of a day). These stories can be useful teaching tools in science. See Appendix B: Selecting Science-Based Literature for more information about the role of science-based learning resources in the Early Years classroom.

Grades 3 and 4

At Grades 3 and 4, students' views of the world broaden. Their thinking is more comprehensive and tends to be based on a rationale or on logic. Students move from simple matching to more complex ways of classifying.

At these grades, students' communication skills also broaden. Students are able to make simple notes, record data, and express themselves clearly in journals and learning logs. By Grade 3, students are less egocentric and are able to work well with a partner and in small groups. Science centres promoting exploration continue to provide effective learning experiences for students.

Students at Grades 3 and 4 are able to see cause and effect relationships and begin to make simple predictions. They also start to see the cyclical nature of phenomena (e.g., life cycles, the water cycle) rather than taking a linear approach to thinking. Students are now able to design simple experiments, carry them out, analyze the results, and present their findings.

Instructional Implications for Teachers

Kindergarten to Grade 4 science teachers have marvellous opportunities to stimulate their students' innate curiosity about the world around them. Teachers do not merely disseminate information; they facilitate student progress and achievement in learning. A stimulating classroom environment prompts students to ask challenging science questions that teachers may not be able to answer immediately. Effective teachers view these situations as opportunities to work with their students to find answers. It is important that students see teachers as lifelong learners.

A Meaningful Learning Environment for All

Diversity in the Classroom

Students come from a variety of backgrounds and have distinct learning requirements, learning and thinking approaches, and prior knowledge and experiences. Their depth of prior knowledge varies, reflecting their varied experiences inside and outside the classroom. Some entry-level knowledge held by students may be limited or incorrect, impeding new learning. For new learning to occur, it is important for teachers to activate prior knowledge, correct misconceptions, and encourage students to relate new information to prior experiences.

Manitoba's cultural diversity provides opportunities for embracing a wealth of culturally significant references and learning resources in the Early Years science classroom. Students from various backgrounds bring socially constructed meanings, references, and values to science learning experiences, as well as their unique learning approaches. As noted in the *Senior Years Science Teacher's Handbook*, "To be effective, the classroom must reflect, accommodate, and embrace the cultural diversity of its students" (1997, p. 7.13).

Toward this end, *Kindergarten to Grade 4 Science: A Foundation for Implementation* acknowledges and supports cultural diversity. Included in this document are a range of instructional strategies and conceptual links to appropriate communities and their resources, such as Aboriginal communities and agricultural communities. Teachers are encouraged to utilize the community environment and the surrounding natural habitats as these relate to particular science clusters throughout the grades. They afford opportunities to enrich the learning experience. The careful selection of learning resources that acknowledge cultural, racial, and gender differences will allow students to affirm and strengthen their unique social, cultural, and individual identities. A meaningful learning environment for all requires that teachers be sensitive to the role that diversity plays in the Early Years classroom.

Differentiating Instruction

Early Years science teachers continually ask themselves how they can meet each student's learning requirements and still make learning experiences challenging and meaningful for all. One way to help all students achieve the prescribed student learning outcomes for their grade is to differentiate the instructional strategies. (See *Success for All Learners*: *A Handbook on Differentiating Instruction, 1996.*) Through differentiating instruction, teachers can

- activate students' prior knowledge
- accommodate multiple intelligences and the variety of learning and thinking approaches
- help students interpret, apply, and integrate information

- facilitate the transfer of knowledge, skills, and attitudes to students' daily lives
- challenge students to realize academic and personal progress and achievement

Differentiating instruction does not mean offering a different program to each student. Classroom experiences can be differentiated by offering students choices and by varying instructional and assessment strategies to provide challenging and effective learning experiences for all.

Kindergarten to Grade 4 Science: A Foundation for Implementation includes cross-references to "Strategies That Make a Difference" in *Kindergarten to Grade 4 English Language Arts: A Foundation for Implementation* (1998); and *Success for All Learners: A Handbook on Differentiating Instruction* (1996). Teachers can refer to these documents for further information. Strategies that can be used effectively in the Early Years science classroom include graphic organizers (such as mind maps), knowledge charts that utilize students' prior knowledge, collaborative activities in brainstorming for solutions to design problems, information-processing strategies, science learning logs, and many others.

Learning Phases

Differentiated instructional strategies can be used in relation to the three learning phases:

- activating (preparing for learning)
- acquiring (integrating and processing learning)
- applying (consolidating learning)

These phases of learning are not entirely linear, nor are they discrete; rather, they provide teachers with a useful way of thinking and planning.

- The activating phase helps identify students' prior knowledge.
- The acquiring phase helps students to integrate new information with what they already know, adding or revising their previous knowledge as needed. Teachers help students make meaning of new information.
- The applying phase allows students to reflect on what they have learned, apply their learning in new situations, and extend their learning by drawing connections to other subject areas.

For a discussion of these three learning phases see Chapter 6, *Success for All Learners*.

Assessment

Assessment is "the systemic process of gathering information about what a student knows, is able to do, and is learning to do" (*Reporting on Student Progress and Achievement,* 1997, p. 38). Assessment involves collecting, interpreting, and communicating results related to students' progress and achievement.

In Early Years science, as in other subject areas, effective assessment is

- an integral part of instruction and learning
- continuous and ongoing
- a collaborative and reflective process
- authentic and reflective of meaningful science-learning processes and contexts
- developmentally and culturally appropriate

- focussed on students' strengths
- multi-dimensional
- based on how students learn

(Adapted from *Kindergarten to Grade 4 English Language Arts: A Foundation for Implementation*, 1998, p. 249.)

This view of effective assessment in science for Manitoba is reflective of changes in emphases in science education at the national level and is congruent with international changes in science education. The following chart summarizes, at a glance, some of the changes in the area of assessment.

Changing Emphases *

The *National Science Education Standards* envision change throughout the system. The assessment standards encompass the following changes in emphases:

LESS EMPHASIS ON	MORE EMPHASIS ON
Assessing what is easily measured	Assessing what is most highly valued
Assessing discrete knowledge	Assessing rich, well-structured knowledge
Assessing scientific knowledge	Assessing scientific understanding and reasoning
Assessing to learn what students do not know	Assessing to learn what students do understand
Assessing only achievement	Assessing achievement and opportunity to learn
End of term assessments by teachers	Students engaged in ongoing assessment of their work and that of others
Development of external assessments by measurement experts alone	Teachers involved in the development of external assessments

Formative and Summative Assessment

Assessment can be formative or summative.

- **Formative assessment** is based on data collected before an instructional unit is completed. Its purpose is to improve instruction and learning by
  - — providing students and teachers with information about students' progress in accomplishing prescribed learning outcomes
  - — evaluating the effectiveness of instructional programming content, methods, sequence, and pace
- **Summative assessment** (evaluation) is based on an interpretation of the assessment information collected. It helps determine the extent of each student's achievement of prescribed learning outcomes. Evaluation should be based on a variety of assessment information. Summative assessment is used primarily to
  - — measure student achievement

* Source: *National Science Education Standards*, p. 25. © 1996 by The National Academy of Sciences. Reproduced with permission of the National Academy Press.

— report to parent(s)/guardian(s), students, and other stakeholders

— measure the effectiveness of instructional programming

Kindergarten to Grade 4 Science: A Foundation for Implementation suggests a range of assessment strategies. The same strategy can be used for both formative and summative assessment, depending on the purpose of the assessment.

A detailed discussion of the suggested assessment strategies included in this document follows:

- **Observation —** Observation of students is an integral part of the assessment process. It is most effective when focussed on skills, concepts, and attitudes. Without record keeping, however, observations and conversations can easily be forgotten. Making brief notes on index cards, self-stick notes or grids, as well as keeping checklists, helps teachers maintain records of continuous progress and achievement. (Refer, for example, to BLM 7: Student Observation Record, BLM 8: Student Evaluation Sheet, and BLM 9: Checklist.)
- **Interviews —** Interviews allow teachers to assess an individual's understanding and achievement of the prescribed student learning outcome(s). Interviews provide students with opportunities to model and explain their understandings. Interviews may be both formal and informal. Posing science-related questions during planned interviews enables teachers to focus on individual student skills and attitudes. Questioning students about how they solved problems or answered science questions reveals their thinking processes and their use of skills. Using a prepared set of questions ensures that all interviews follow a similar structure. It is important to keep a record of student responses and/or understandings.
- **Group/Peer Assessment —** Group assessment gives students opportunities to assess how well they work within a group. Peer assessment gives them opportunities to reflect on one another's work, according to clearly established criteria. During the peer assessment process, students must reflect on their own understanding in order to evaluate the performance of another student.
- **Self-Assessment —** Self-assessment is vital to all learning and, therefore, integral to the assessment process. Each student should be encouraged to evaluate her/his own work. Students apply known criteria and expectations to their work and reflect on results to determine their progress toward the mastery of a prescribed learning outcome. Participation in setting self-assessment criteria and expectations helps students to see themselves as scientists and problem solvers. It is important that the teacher model the self-assessment process before expecting students to assess themselves. (Refer to BLM 5: How I Worked in My Group.)
- **Performance Tasks —** Performance tasks provide students with opportunities to demonstrate their knowledge and thinking processes. The tasks require the application of knowledge and skills related to a group of student learning outcomes. A scoring rubric that includes a scale for the performance of the task helps organize and interpret evidence. Rubrics allow for a continuum of performance levels associated with the task being assessed.

- **Science Journal/Learning Log Entries —** Science journal writing and learning log entries provide opportunities for students to reflect on their learning and to demonstrate their understanding using pictures, labelled drawings, and words. These can be powerful tools of formative assessment, allowing teachers to gauge a student's depth of understanding. In this document direct questions/scenarios frame the science journal suggestions.
- **Paper and Pencil Tasks —** Paper and pencil tasks can be used as discrete assessment tools or as part of larger assessment experiences. Paper and pencil tasks may include items such as multiple choice questions, true or false questions, long answer questions, matching questions, and completion of a drawing or labelled diagram.

The foregoing assessment suggestions are not meant to be limiting. Teachers are strongly encouraged to develop their own assessment for Early Years science based on their students' learning requirements and the requriments of the prescribed student learning outcomes. *Reporting on Student Progress and Achievement: A Policy Handbook for Teachers, Administrators, and Parents* (1997) contains further information related to reporting on student progress.

SCIENTIFIC LITERACY

The Foundations for Scientific Literacy

Kindergarten to Grade 4 Science: A Foundation for Implementation is designed in accordance with the vision for scientific literacy articulated in the *Common Framework of Science Learning Outcomes K to 12: Pan-Canadian Protocol for Collaboration on School Curriculum* (1997) (hereafter referred to as the *Pan-Canadian Science Framework)*.

The *Pan-Canadian Science Framework*

> is guided by the vision that all Canadian students, regardless of gender or cultural background, will have an opportunity to develop scientific literacy. Scientific literacy is an evolving combination of the science-related attitudes, skills, and knowledge. Students need to develop inquiry, problem-solving, and decision-making abilities, to become lifelong learners, and to maintain a sense of wonder about the world around them.
>
> Diverse learning experiences based on the [Pan-Canadian] framework will provide students with many opportunities to explore, analyze, evaluate, synthesize, appreciate, and understand the interrelationships among science, technology, society, and the environment that will affect their personal lives, careers, and their future. (p. 4)

To develop scientific literacy, science learning experiences must incorporate the essential aspects of science and its related applications. These essential aspects, the foundations for scientific literacy, have been adapted from the *Pan-Canadian Science Framework* to address the needs of Manitoba students. Manitoba science curricula are built upon the following five foundations for scientific literacy:

A. Nature of Science and Technology
B. Science, Technology, Society, and Environment (STSE)
C. Scientific and Technological Skills and Attitudes
D. Essential Science Knowledge
E. Unifying Concepts

For more background on each of these foundation areas, consult *Kindergarten to Grade 4 Science*: *Manitoba Curriculum Framework of Outcomes* (1999) (hereafter referred to as *K—4 Science Manitoba Framework*).

Manitoba's vision for scientific literacy, as reflected in the five foundation areas, represents a paradigm shift in science education also evident across North America and Western Europe. The chart on the following page highlights some areas in which there are changing emphases.

CHANGING EMPHASES*

The *National Science Education Standards* envision change throughout the system. The science content standards [or student learning outcomes] encompass the following changes in emphases:

LESS EMPHASIS ON	MORE EMPHASIS ON
Knowing scientific facts and information	Understanding scientific concepts and developing abilities of inquiry
Studying subject matter disciplines (physical, life, earth sciences) for their own sake	Learning subject matter disciplines in the context of inquiry, technology, science in personal and social perspectives, and history and nature of science
Separating science knowledge and science process	Integrating all aspects of science content
Covering many science topics	Studying a few fundamental science concepts
Implementing inquiry as a set of processes	Implementing inquiry as instructional strategies, abilities, and ideas to be learned

CHANGING EMPHASES TO PROMOTE INQUIRY

LESS EMPHASIS ON	MORE EMPHASIS ON
Activities that demonstrate and verify science content	Activities that investigate and analyze science questions
Investigations confined to one class period	Investigations over extended periods of time
Process skills out of context	Process skills in context
Emphasis on individual process skills such as observation or inference	Using multiple process skills—manipulation, cognitive, procedural
Getting an answer	Using evidence and strategies for developing or revising an explanation
Science as exploration and experiment	Science as argument and explanation
Providing answers to questions about science content	Communicating science explanations
Individuals and groups of students analyzing and synthesizing data without defending a conclusion	Groups of students often analyzing and synthesizing data after defending conclusions
Doing few investigations in order to leave time to cover large amounts of content	Doing more investigations in order to develop understanding, ability, values of inquiry and knowledge of science content
Concluding inquiries with the result of the experiment	Applying the results of experiments to scientific arguments and explanations
Management of materials and equipment	Management of ideas and information
Private communication of student ideas and conclusions to teacher	Public communication of student ideas and work to classmates

* Source: *National Science Education Standards*, p. 18. © 1996 by the National Academy of Sciences. Reproduced with permission of the National Academy Press.