The world as we know it today has been affected in many important ways by science and technology. It is important, therefore, that students see science and technology in this wider context — as endeavours with important consequences for people and other living things — and that they learn to connect their knowledge of science and technology to the world beyond the school. (Excerpted from The Ontario Curriculum, Grades 1-8: Science and Technology, 2007: 4-5)

Creative interdisciplinary instruction through discussion-based inquiry is a holistic pedagogical approach that covers curriculum expectations while honoring the academic aptitude, creative expression, multiple intelligences and learning style of individual students. It is an approach that values voice and choice, within a talking classroom. “By weaving big ideas and important skills from different disciplines, teachers can maximize classroom time and reinforce concepts and skills across subjects” (Park Rogers and Abell, 2007:58). This approach is in sync with theories of multiple intelligence (Gardner) and learning style preferences (Fleming). Students are able to make meaningful connections when they approach and express their understanding of big ideas from a wider perspective based on their personal experience and interests. Through a synergized pedagogical approach, educators have an opportunity to efficiently cover Ontario curriculum expectations, knowledge and skills across a broad range of subjects. This approach is focused on big ideas and frameworks, as a means to provide learning synergies, rather than teaching isolated subjects. “Interdisciplinary instruction encourages connections among disciplines to help learners construct knowledge schema” (Nuthall, 1999, in Park Rogers and Abell, 200:58). It enables teachers to deliver a broader range of subjects with greater efficiency. Students are more engaged in what they are interested in; teachers are able to cover multiple subjects and curriculum expectations within integrated lessons.
Student learning is focused on achievement of the four categories of knowledge and skills, defined within the Ontario curriculum — knowledge and understanding, thinking and investigation, communication (including creative expression) and application. A science question drives student inquiry while connecting to curriculum expectations across a range of subjects. For example, “How did Sir Isaac Newton influence our understanding of light?” From this driving question students explore the big ideas of the properties of light within the context of scientific inquiry through a learning cycle model of instruction. Educators interconnect the planning process by examining the curriculum expectations of the subjects they teach and highlighting commonalities within unified themes, application and skills. Students are afforded the opportunity to develop interdisciplinary connections while meeting overall curriculum expectations in a variety of subjects. This approach minimizes sharp subject transitions that are difficult for many students. Students are able to dig deeply into themed units related to their specific project.

My goal is to facilitate a talking classroom using the engage, explore, explain model. This hones oral communication skills and higher order thinking skills. Each lesson begins and ends with rich classroom discussion. Success criteria for discussion is explicitly taught, and an anchor chart is clearly visible in the room. I have prepared a science unit plan based on this pedagogical approach. One lesson is titled: What is the Colour of Light? The unit focus is on the fundamental concept that light is a form of energy with specific properties. The specific science curriculum expectation (2.2) is that by the end of grade four, students will investigate the basic properties of light, through inquiry. They will conduct experiments to show that light travels in a straight path, reflects off of shiny surfaces, refracts (bends) when passing from one medium to another; that white light is made up of many colours, and that light diffracts (bends and spreads out when passing through an opening). This lesson is connected to the Matter and Energy strand and tied directly to the language unit curriculum expectations covering oral communication, reading, writing and media literacy. Social studies expectations for grade four are also linked as are some expectations from visual arts, within a diorama project of Newton, set in the context of his time.

On the day this science lesson is taught, the focus of the morning language lesson is The Magic School Bus book and DVD, The Magic School Bus Makes a Rainbow: A Book About Color. Over the previous week, students were introduced to various texts about Sir Isaac Newton. These lessons came on the heels of grade four Medieval Times, Social Studies unit. Over the previous month, self-directed reading resources are introduced into a themed classroom library that includes various books about Sir Isaac Newton, the Renaissance period, Medieval Times’ innovations, a class set of The Magic School Bus Makes a Rainbow book, and a wide variety of science books about light and sound. A variety of leveled texts are included for differentiation. These resources are encouraged choices within the literacy block. During the science lesson discussion extends from the morning language lesson to focus on the main ideas of the properties of light, specifically how white light is separated into a spectrum of seven colours. Creative illustrations and plasticine models of the light spectrum are planned within arts lessons, meeting grade four visual arts curriculum expectations focus on “emphasis: use of colour intensity, contrast in value, placement and size of shapes and/or the weight of line to create a particular focal point” (The Ontario Curriculum: The Arts, 2009: 106). Sixty-minute lessons are divided into three twenty-minute segments.

The science lesson begins with a twenty-minute discussion that activates prior knowledge from lessons in science, social studies, math, language and visual arts. The lesson ends with a twenty-minute consolidation discussion. The
purpose of discussion is to activate prior knowledge, hone oral communication skills and facilitate interdisciplinary connections. Daily discussion reinforces key concepts while affording students the opportunity to add insight. Students are taught to record the “big idea” of each day’s discussion on a mind map, adding detail in the form of text features such as subheadings, colour and illustrations. This daily log reinforces writing skills and serves as a cross-curricular review journal.

First, each three-part lesson begins with an engaging activity, such as: “What were the main ideas of The Magic School Bus book and DVD studied this morning? Connect Arnold’s explanation of light to Isaac Newton’s theory.” Next, students are asked to explore key concepts, in pairs. Students conduct experiments to separate the spectrum of white light. Individually, students will follow the design process of their You Are A Scientist journal to find one or many solutions to solve the challenge of separating the spectrum of colours from white light. Individually, students record their observations on their journal worksheet. Finally, during the consolidation discussion students explain and show what they know. Guiding questions are clearly posted for student reference, with reminders to use scientific vocabulary. Students discuss their experience and findings, while gaining clarification through verbal discussion. Students are then provided an opportunity to return to their science journal to add new information, clarification or insight, gained through the group discussion. In closing, students reflect on discussion, elaborate on their visual presentation of data, spelling, diagrams, use of colour and text features. Students are explicitly reminded to explain their findings with the reader in mind. By harmonizing the big ideas of science with other subjects, educators are able to efficiently synthesize the Ontario curriculum. This approach fosters higher-order thinking skills by developing oral language skills in a talking classroom. It is a fun and interesting approach that makes science make sense.

Resources


You Are a Scientist!

1. State the research question. (What is the answer you are looking for? What is the problem you are trying to solve)  Note: At the end of this science journal entry (#7), you will write the answer to this question.)

2. Explore ideas. (What and how?)
   a) What materials will you use? List materials.
   b) How will you use the materials?

4. Use your plan. (Record the steps you will follow; use drawings to help you.)

5. Test your plan. (What worked well? What is creating a challenge for you?)
6. Improve your plan. Suggest one change you will make.

___________________________________________________________________________
___________________________________________________________________________
___________________________________________________________________________
___________________________________________________________________________
___________________________________________________________________________

7. What is the answer to your question (#1)?

___________________________________________________________________________
___________________________________________________________________________
___________________________________________________________________________
___________________________________________________________________________
___________________________________________________________________________
Appendix A
Classroom Library/Student Resources. Light Books (Partial List)


Appendix B
Word Wall Glossary
Anchor Chart: Separating White Light

Separating White Light
(Source: Fullick, 2005:20-21)

White Light
The light we see is called white light (or sometimes visible light). White light is made up of different colours combined together.


Dispersion
White light can be separated into its different colours using dispersion. Dispersion is a process in which the light is passed through a special piece of glass called a prism, producing a spectrum of all the different colours.

Wavelength and Speed
Each colour of light has:
- a different wavelength and
- travels at different speeds in water and in glass
  - Blue light has the shortest wavelength
  - Red light has the longest wavelength

Bending Light (Refraction)
A prism works by refracting each colour by a different amount and bending it at a different angle.
- Red bends the least
- Violet bends the most

Spectrum of Colours
- The result of refraction is the spectrum of colours that we see in the rainbow.
- The rainbow can be reproduced on a smaller scale with a prism.
- The order of the colours is: Red, orange, yellow, green, blue indigo and violet.
- In a rainbow, each tiny droplet of water acts as a prism, splitting the sunlight into the spectrum that we see arching across the sky.

Credit: Shayla Gunter-Goldstein

Credit: Shayla Gunter-Goldstein