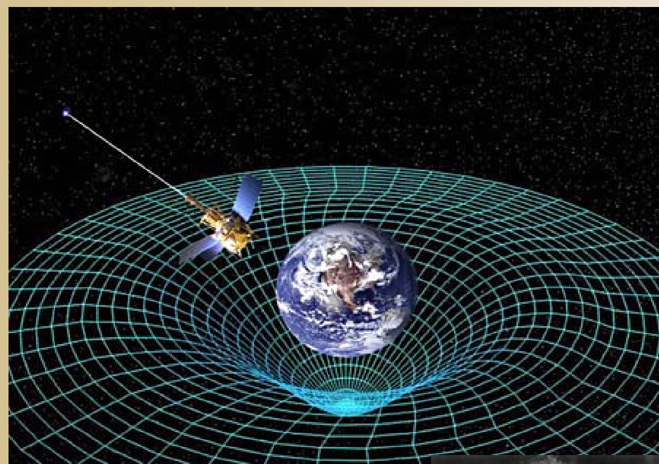
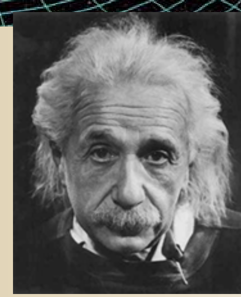
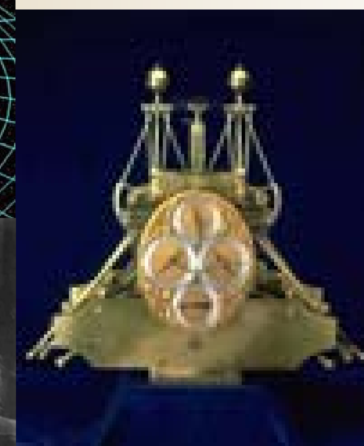
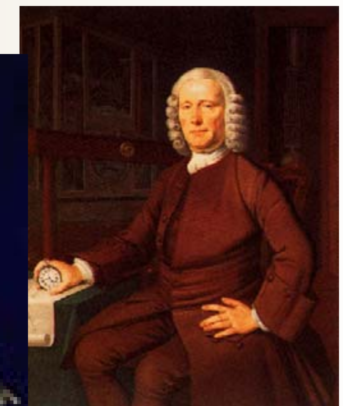
People, Pendulums and Time









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People, Pendulums and Time

Introduction

In an extensive study of science education Millar and Osborne (1998) found a large inconsistency between "school science" and the needs and interests of students. Millar and Osborne highlighted several characteristics of school science resonating from the current portrayal of science and the current mode of science education.

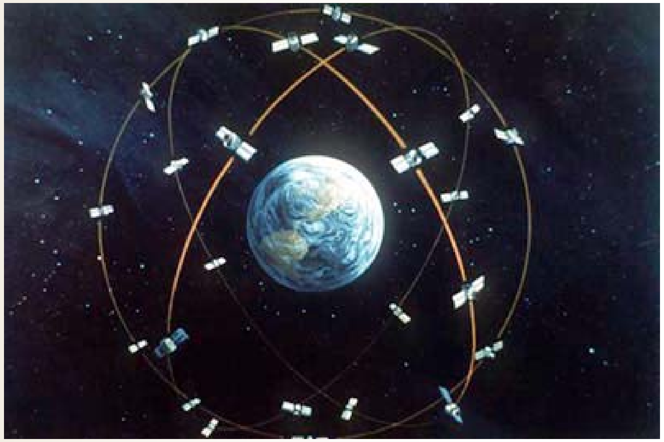
Among these characteristics we find:

- The representation of science as a ‘catalogue’ of scientific knowledge claims, principles, and laws taught independent of the contexts which provide essential relevance and meaning.
- A lack of emphasis on the significant intellectual achievements of science and how they have influenced understanding ourselves and the world around us.
- A lack of discussion or analysis of important contemporary issues.

Contextual Teaching

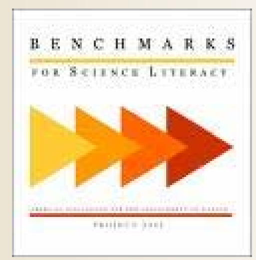
To mediate such views of everyday science and “school science”, teaching science needs to move toward a more contextual approach such that students can find more meaning and personal relevance in their science education.

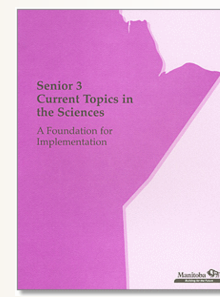
The history of science has long been advocated as a context for examining the goals of science literacy as the nature of science, science in society, culture and our personal lives. It can also be used as a conduit to address contemporary topics of considerable interest to students.



<u>**What Does Curriculum Say?**</u>

In our most recent round of curricular reforms there are many admirable statements in many curriculum documents, in many countries, that express the importance of scientific literacy in term of understanding the nature of science, the role of history and culture; and science in society and our personal lives





So what's the problem?

Story #1: A Middle School Assignment:

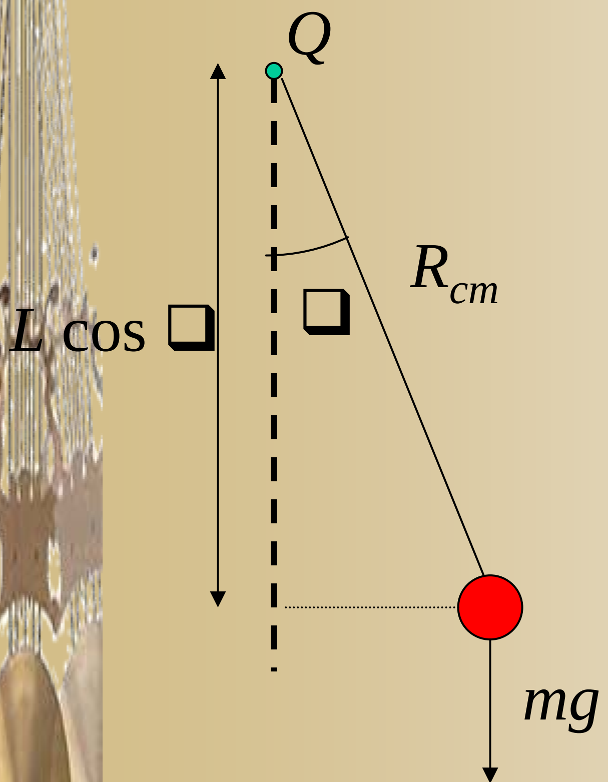
Students are to search the Internet to find the formula to determine the period of the pendulum.

> *“The representation of science as a ‘catalogue’ of scientific knowledge claims, principles, and laws taught independent of the contexts which provide essential relevance and meaning”.*

<u>Story #2: What is Physics?</u>

"In physics we take simple everyday things and express them in a mathematically complex way."

The Simple? Pendulum



$$\vec{N} = \vec{R}_{cm} \times m\vec{g}$$

$$I_Q \ddot{\theta} = -mgR_{cm} \sin\theta$$

$$I_Q = mR_{cm}^2$$

$$\ddot{\theta} = -\frac{g}{R_{cm}} \sin\theta$$

$$V(\theta) = -mgR_{cm} \cos\theta$$

$$KE = \frac{1}{2} I_Q \dot{\theta}^2 = \frac{1}{2} mR_{cm}^2 \dot{\theta}^2 = \frac{1}{2} mv_\theta^2$$

A lack of emphasis on the significant intellectual achievements of science and how they have influenced understanding ourselves and the world around us.

The solution pursued in the Manitoba Topics in Science curriculum was the development of a more general set of outcomes not unlike the visionary statements found in most front-end documents. Context and content of the actual implemented curriculum was to be the responsibility of the teacher in response to the interest of the students.

GLO A- Nature of Science and Technology

Differentiate between science and technology, recognizing their respective strengths and limitations in furthering our understanding of the material world, and appreciate the relationship between culture and the development of technologies.

SLO A1: Identify and appreciate the manner in which history, circumstance, and culture shape the science of a society and its creation or use of technologies.

SLO A2: Identify and describe how research programs in science are publicly supported, funded, and influenced by the pressures of priority, merit, and foreseeable effects in the larger society.

SLO A3: Examine and analyze an instance, either historical or present-day, where 'revolutionary' scientific change altered the fundamentals of a discipline, a research programme, or the behaviour within a scientific community.

Conspicuous by its absence is the lack of specific knowledge outcomes. In order to achieve these outcomes, teachers choose different contexts and from these contexts generate the necessary knowledge outcomes.

Many popular contexts are Science, Technology, Society and the Environment (STSE) oriented. These include many contemporary studies in science such as

- Forensic Sciences: Crime Scene Investigations

We recognize that understanding the historical, philosophical, and cultural perspective in science is an essential component of scientific literacy. By studying the historical context, students come to appreciate ways in which cultural and intellectual traditions have influenced the questions and methodologies of science, and how science, has influenced the wider world of ideas.

However, it is also apparent that more guidance is needed for teachers who have little background in the historical and cultural impact of their own discipline.

There exists an identifiable need for the development of more modules in the Topics in Science curriculum.

People, Pendulums and Time

In our approach we use an interrupted story form where students are given the opportunity reflect upon some interesting narratives in the history of science that connect to activities that they do in the classroom.

Narrative

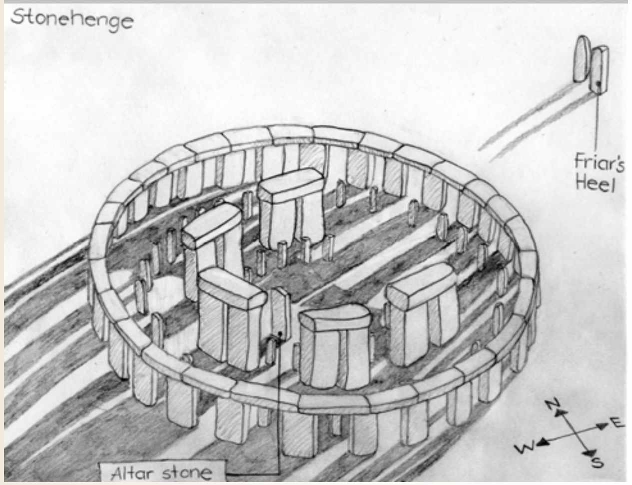
Essential Knowledge

Student Activity

Unit One: The Nature of Time

Overview

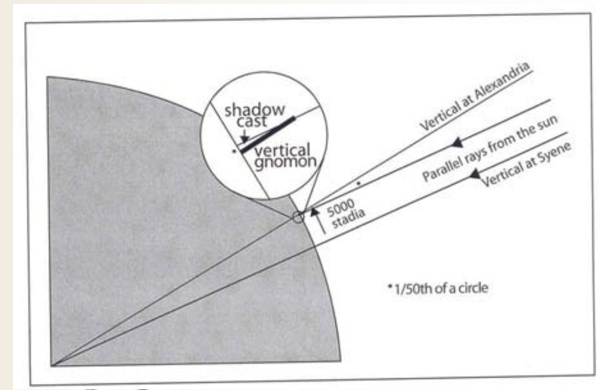
In this unit students address the fundamental question "What time is it?" The fundamental unit of time - the apparent solar day - is found using a gnomon. The importance of the solstice and the analemna are also considered. Stonehenge provides an interesting narrative.



Unit Two: The Nature of Place

Overview

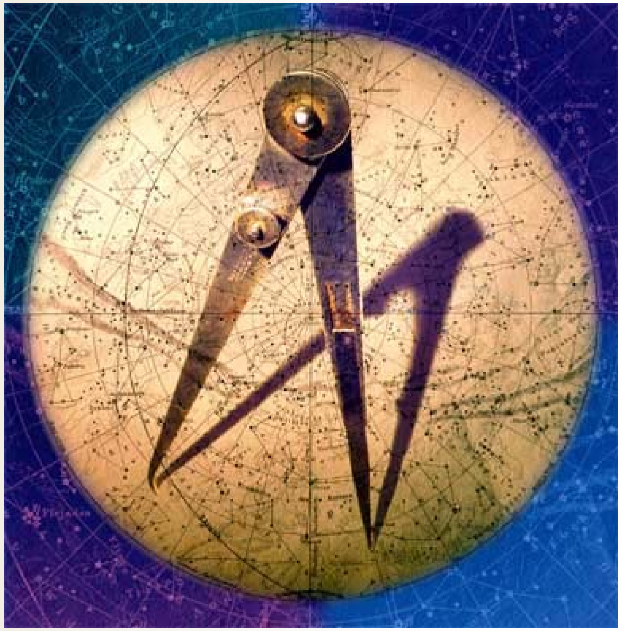
In this unit students ask the question “Where am I?“ and address the methods of locating an object in space The concepts of latitude, longitude and the size of the Earth are examined.



Unit Three: Navigating the Globe

Overview

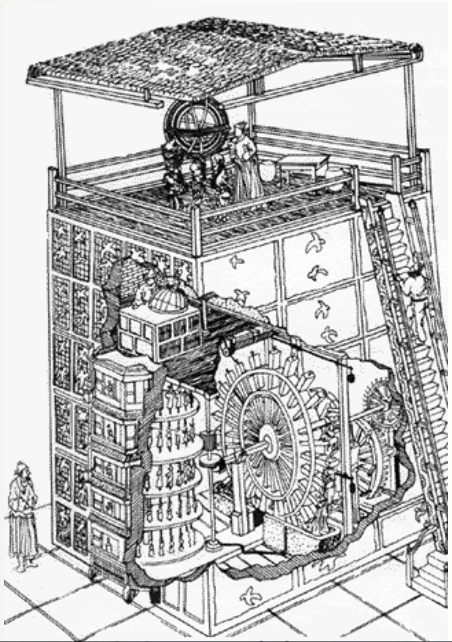
In this unit students address the question "How do I get there?" Students investigate early navigational techniques including dead reckoning and using a coordinate system of latitude and longitude. The historical problem of longitude is introduced.



Unit Four: Keeping Time

Overview

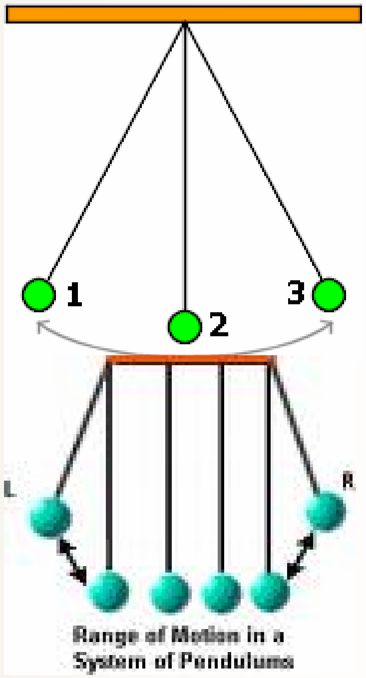
In this unit students examine and experiment with various methods for keeping time such as the water clock, natural rhythms and the pendulum.



Unit Five: Exploring the Pendulum

Overview

The applications and variety of pendulums are investigated.



Unit Six: Time and Space Today

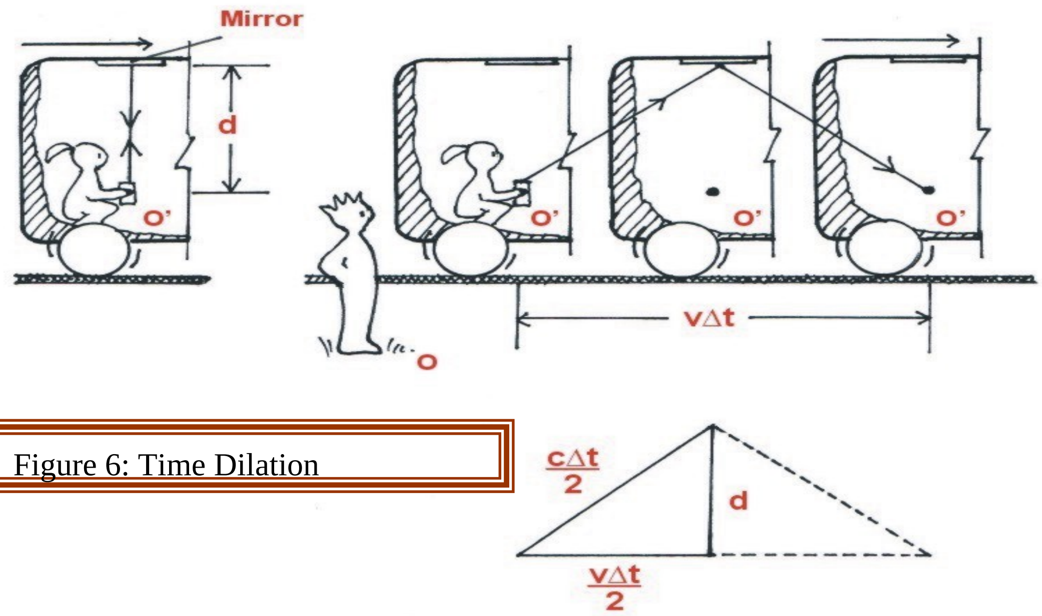


Figure 6: Time Dilation

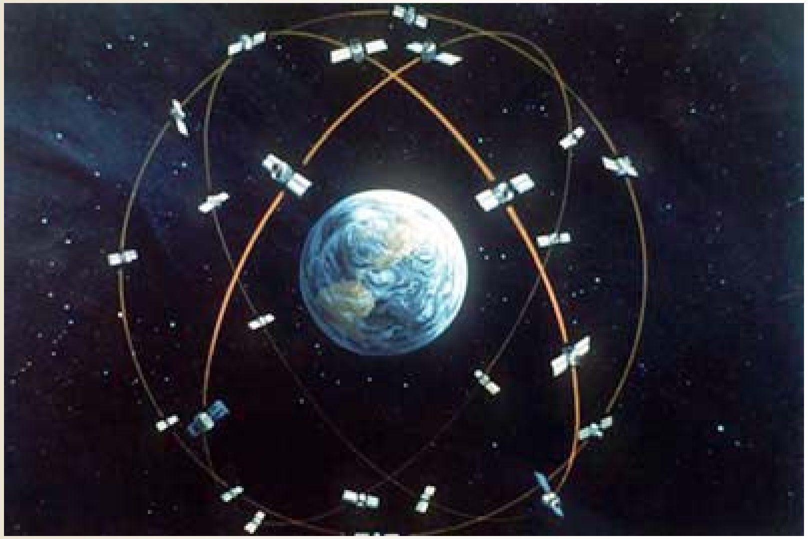
Global Positioning System

Military technology

Privacy

Geocache

Confluence project

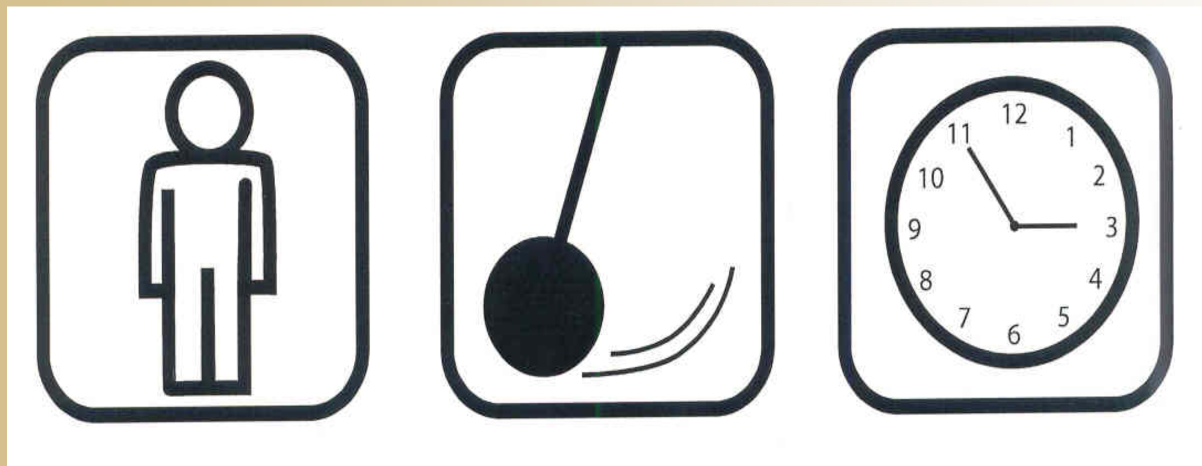


Unit Seven: People, Pendulums and Time

Overview

Students research and report on a topic that extends the ideas presented in this module.

Implementation: People, Pendulums, and Time



Pilot Phase: Includes teacher evaluation, student attitudes about previous experiences in science education and current experience.

Assessing Student Attitudes

1. What Is Happening In This Class (WIHIC)

The *What is Happening in this Class* (WIHIC) questionnaire (Aldridge & Fraser, 2000; Fraser, 1998b) is used to describe classroom learning environment and the teachers' behaviour in the classroom. The WIHIC contains seven eight-item scales and has been used successfully in its original form or in modified form in large scale studies in Australia, Canada, Singapore (Chionh & Fraser 1998).

Three scales Investigation, Openendedness, and Attitudes were chosen.

2. Constructivist Learning Environment Survey (CLES)

The Constructivist Learning Environment Survey (CLES) (Fraser, 1998b; Taylor, Fraser & Fisher, 1997) was developed to assist researchers to assess the constructivist dimensions of classrooms.

Two scales: Learning about the world and Learning about science were chosen.

3. Academic Efficacy (Dorman, 2001)

Some References

Aldridge, J. M., & Fraser, B. J. (2000). A cross-cultural study of classroom learning environments in Australia and Taiwan. *Learning Environments Research*, *3*, 101–134.

Fraser, B. J. (1998b). Classroom environment instruments: Development, validity, and applications. *Learning Environments Research*, *1*, 7–33.

Taylor, P. C., Fraser, B. J., & Fisher, D. L. (1997). Monitoring constructivist classroom learning environments. *International Journal of Educational Research*, *27*, 293–302.

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