

River City and the Massachusetts Science and Technology/Engineering Curriculum Framework

The River City Project is a simulation environment for learning scientific inquiry and 21st century skills sponsored by the National Science Foundation and housed at Harvard University. River City is an interactive computer simulation of a river town, based in the late 1800s, that combines digitalized Smithsonian artifacts with an inquiry-centered curriculum to engage middle and high school students. The River City curriculum meshes with the Massachusetts science and technology frameworks in several ways.



Skills of Inquiry

Primarily, this project concentrates on the areas of inquiry and experimentation. These areas, formerly a separate strand in the original frameworks of 1995, are now expected to be fulfilled through the content strands, “Scientific inquiry and experimentation should not be taught or tested as separate, stand-alone skills...*what* is known does not stand separate from *how* it is known” (p 5). However, these areas are delineated in the frameworks. This project focuses on the following skills of inquiry, listed for the middle school years. According to the [Massachusetts Science and Technology/Engineering Curriculum Framework](#) of May 2001, students are expected to:

- Formulate a testable hypothesis;
- Design and conduct an experiment specifying variables to be changed, controlled, and measured;
- Select appropriate tools and technology and make quantitative observations;
- Present and explain data and findings using multiple representations, including tables, graphs;
- Draw conclusions based on data or evidence presented in tables or graphs, and make inferences based on patterns or trends in the data.
- Communicate procedures and results using appropriate science and technology terminology;
- Offer explanations of procedures, and critique and revise them. (p. 7)

In this project, students encounter clues to problems plaguing a 19th century river city. As they explore, they are encouraged to form and then test their hypothesis regarding the health and environmental issues they have discovered. They design a procedure with a control and an experimental group, using both current and historically accurate tools, to investigate their hypothesis. Finally, all students demonstrate their understanding of scientific inquiry and disease transmission by independently writing evidence-based, scientific reports to the Mayor of River City. Their reports include explanations of why so many residents are becoming ill and recommendations of how to alleviate the problem by drawing on their River City experiences. The Report to the Mayor is not a trivial, academic assignment. On the contrary, it is purposefully designed to gauge the student's understanding and to ask students to do something that puts their understanding to work. As a result of this performance assessment, students both demonstrate and deepen their understanding of this complex socioscientific situation.

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Guiding Principles

There are seven pertinent guiding principles (the Massachusetts Science and Technology/Engineering Curriculum Framework, May 2001) that support this project:

Guiding Principle II: An effective science and technology/engineering program builds students' understanding of the fundamental concepts of each domain of science and their understanding of the connections across these domains and to basic concepts in technology/engineering. (p. 9)

The River City project is interdisciplinary in scope, crossing into the domains of ecology, health, biology, chemistry, earth science as well as history.

Guiding Principle III: Science and technology/engineering are integrally related to mathematics.(p. 10)

Students are asked to mathematically analyze, including using appropriate graphs, the data that they collect in the world, and use that analysis to support or refute their hypothesis.

Guiding Principle IV: An effective program in science and technology/engineering addresses students' prior knowledge and misconceptions.(p. 11)

This principle is played out in several different arenas in the River City project. For example, students typically believe that there are single right answers to science experiments. In this project, we have multiple threads that students could follow, leading them to very different hypotheses and experiments. At the conclusion when students share their analysis, they learn the multivariate nature of the problem.

Guiding Principle V: Investigation, experimentation, and problem solving are central to science and technology/engineering education. (p. 11)

This is a major focus of the River City world, as explained above. This project was designed to help teach students how to 'see' a problem that needed solving, something that most students have particular difficulty with, and then to attempt to solve that problem.

Guiding Principle VI: Students learn best in an environment that conveys high academic expectations for all students.(p.12)

The River City project offers a complex environment for students to explore and investigate. Students are not led to anyone area, nor are they given the information. Much like real scientists, the students are expected to discover clues and information that they can use to diagnose the problems of this town.

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Guiding Principle VIII: *An effective program in science and technology/engineering gives students opportunities to collaborate in scientific and technological endeavors and communicate their ideas. (p. 13)*

During this project, each student will have their own 'avatar' in the world and will be working with a team of students. The students will communicate with each other via real-time chat, and have the ability to investigate different parts of the world simultaneously and share what they have learned.

Guiding Principle X: *Implementation of an effective science and technology/engineering program requires collaboration with experts, appropriate materials, support from parents and community, ongoing professional development, and quantitative and qualitative assessment.(p. 14)*

The River City project has been designed with advice from experts in learning theory, biological sciences, and educational technology. It is in its second year of assessment, and is evaluated with quantitative and qualitative means. Information on its previous evaluation can be found at http://muve.gse.harvard.edu/River_City2003/documents/DedeKetelMUVEaera03final.pdf . In addition, teachers implementing this unit will be offered a minimum of 8 hours of professional development.

Strands and Standards

As the main focus of this project is to teach skills of inquiry, it is more loosely associated with specific strands and standards. However, as the frameworks assert, inquiry needs to be and is embedded in content so that students learn that the how, what and why of science are intertwined.

Earth Science Strand:

- *Mapping the Earth: Recognize, interpret, and be able to create models of the earth's common physical features in various mapping representations, including contour maps (p. 29).*
 - Students are led to understand that the topography of the river town is a key to two of the diseases plaguing the town. Understanding the effect of mountains on water runoff is important.

Life Science Strand:

- *Classification of Organisms: Be familiar with organisms from each kingdom. (p. 46)*
 - This project focuses on the interactions of organisms from the Monera and Protista Kingdom with humans.
- *Structure and Function of Cells: Recognize that all organisms are composed of cells, and that many organisms are single-celled (unicellular), e.g., bacteria, yeast. In these single-celled organisms, one cell must carry out all of the basic functions of life. (p. 46)*
 - Students will investigate water samples and discover single-celled organisms infecting it. They will learn that different infectious organisms have different effects on humans, look different, and are transmitted differently.

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- *Changes in Ecosystems Over Time: Identify ways in which ecosystems have changed throughout geologic time in response to... the actions of humans (p. 48)*
 - Students investigate the situation in River City over a virtual period of several years. They discover that the actions of the city residents have changed the environment in ways causing disease.

Physical Sciences Strand:

- *Properties of Matter: Define density (p. 60)*
 - Students discover information on population size and acreage and are guided to calculate population density.

Historical and Social Context

Finally, this project emphasizes the historical and social context of science, as outlined in Appendix V of the frameworks in several ways.

- *History of Science (p. 119):*
 - The city is placed in the 19th century with 3-D representations of Smithsonian artifacts for accuracy.
 - Students learn how scientists of the time investigate problems and discover the tools of the time.
 - They will experience a period of time when microbiology was born.
 - In addition, the researcher built into the program is a real 19th century female scientist. In a field where most role models are male, this gives a unique opportunity for female students.
- *The nature of science (p. 119):*
 - The immersive nature of this project helps motivate students to learn science.
 - Students learn that scientific discoveries follow inventions of better tools.
- *Benefits of science and technology/engineering:*
 - Students learn about the benefits of the development of the car, indirectly, by understanding the pollution effects of horses.
- *Unintended negative effects from uses of science and technology/engineering:*
 - The installation of newly invented 'flush toilets' is a crucial source of pollution in River City.