Curriculum Units by Fellows of the Yale-New Haven Teachers Institute
2001 Volume V: Bridges: Human links and innovations

Bridge: A Hands-On Approach to Learning

Curriculum Unit 01.05.07
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Synopsis

The purpose of this study is to introduce and integrate architecture as a study subject in the regular math school curriculum at the 9th grade level in The Sound School, a public school in New Haven, CT. Students at the end of the program will create a small model of a bridge as the chief goal of their work and study. This curriculum unit consists of a series of lessons that will teach students the basics of architecture principles. The project presented in this unit describes my experiences in organizing, managing, supervising, and testing this program. To explain the development process of this project, I will present it in three phases as follows:

Phase 1: Background and Program Description

This phase describes the implementation of the project and how the students will be selected. It also describes the contents of the architecture program and how it integrated into the math curriculum.

Phase 2: Implementation

This phase will be a general overview and introduction to architecture principles. Students will be introduced basic principles of architecture and engineering, and an overview of the urban history and social issues of the building of some of the bridges of New York City. Some of these issues will be covered along the social studies teacher at The Sound School.

Phase 3: Execution of the Program

The third phase will explain how the project will be executed. The program will be introduce to the students in two parts. In the first part students will visit some of the bridges in New York City. This will be by bus or by boat, as budget permits. The second part will be dedicated to a hands-on approach. Students will collect all their data learned during the program and then, they will create and built a small scale model of a bridge.

Contents of Curriculum Unit

Introduction

One of the major purposes of this unit is to integrate architectural principles into the 9th grade math curriculum taught in one of the classes at The Sound School. The Sound School is an educational institution of the New Haven public school system. The school is designed to offer an alternative program to regular schooling. Our main focus is geared to teach aquaculture and agriculture technology. Our students at The Sound School come to this school because they love a small school environment where Staff has not only an specific certification to teach their subject matter, but also have many different backgrounds and skills. Most of them have had other trainings in other careers. This makes this program a very unique school, where staff and students interact with a multicultural engagement of several professions.

As an architect and educator, I have always geared to create hands-on approach projects that would combine architecture and education. Developing a unit of this nature will give me the opportunity not only to use my knowledge as an architect, but also to integrate this knowledge into a regular educational curriculum, in this particular situation with a freshman math class of 15 students.

Also, a very important issue within this unit is to contribute to the solution of some of the educational and social problems faced by the New Haven Public Schools and its communities by creating activities that would enable students to become deeply involved and engaged in their school learning. Activities will also improve their basic math skills and help them excel in their scores on the Connecticut Academic Performance Test (CAPT).

The unit is intended to be used during 3 phases broken down into several lessons during the last 3 months of the academic year. Also many of the activities in this unit will be project-based to create student involvement. The initial phase of this unit will introduce the principles of architecture, the second phase centers on a visit to a site, and the last phase of the unit will focus on building a small replica of the Brooklyn Bridge, located in New York City. The other 2 phases of the unit, the introduction and the visit to the Brooklyn Bridge, will be introduced to students and executed during the academic year.

Objectives of the Program

General

1. To enable students to acquire knowledge and skills in math that they can integrate into their day-to-day lives.
2. To familiarize students with their environment: To foster their sense of pride and preservation of New Haven.

Specific

1. To introduce students to architectural and urban concepts that would foster understanding and appreciation of our environment.
2. To integrate their architectural knowledge in the fiel of mathematics.
3. To identify different materials, tools, and textures used in the process of construction of different buildings and bridges in their community.
4. To initiate and implement hands-on activities.
5. To create an architectural/engineering model. To compare the model with elements seen in architectural/engineering projects around their environment.
6. To create and environment that fosters cooperative learning through groups work. The students are encouraged to be an active participant in the learning process, and to bring out their creative talent.
7. To initiate a healthy philosophy of life, creating morals, respect, and development of self-esteem.
8. To behave, become responsible, and to be interested and respectful of other persons.
9. To communicate and exchange ideas with each other and nurture the ability to work together.

Integration of the Architectural Program into Math

This unit will focus on hands-on activities. The architecture portion of this unit will focus on using technical tools, drawing perspectives, sections, elevations, mapping, measuring, calculating, solving math problems to help students understand architecture. The math portion of this unit will concentrate in studying concepts learned in the 9th grade curriculum during the technical drawing and making of a bridge. This component will provide service to help prepare students for the mathematics sections of the Connecticut Academic Performance Test (CAPT). This set of lessons will include problem solving and reasoning, communicating, computing and estimating as follows: exploring congruent polygons, triangles and quadrilaterals, symmetry, estimating measures, angle relationship, proportions, and the use of scale.

Also, this unit will be team taught with a social studies teacher who will teach the social studies and urban aspects of the Industrial America at the end of the 19th Century by understanding the environment and community of the people living in New York City, as well as the transportation links during the building of the Brooklyn Bridge during the late 1800's.

PHASE 1: Background and Program Description

The Built Environment

One of the most important issues in the unit is to give students a sense of identity, both individually and as a group. During their teenage years students constantly wonder, who they are, where they fit in , the makeup of their community, and what their role is in their society. To study the built environment, students are encouraged to think about the following statements:

1. As a society changes from an agrarian to an industrial way of life, its needs and activities become more complex.
2. As the population increases, the cities grow and the society needs space to move around. A bridge, that connects two isolated cities, would become a significant conduit of communication.
3. Creating basic systems and structures must satisfy individual as well as social needs. When any one of these needs vary (such as climate, ideas, technology, resources, construction, general needs and systems so will the characteristics of structure. This is also true of transportation systems.
4. Engineers have to consider several factors in building bridges such as the costs of the bridge, the suitability of the riverbed for supporting structures, the weather conditions of the area, and type of materials. Some concerns are that the bridges must be strong enough to support the mass of people and vehicles trafficking across them. It's also correct to use appropriate building materials, and tools. Another issue is finding skilled labor able to handle the complex operation of bridge construction.
5. Discovering the special qualities of bridges, streets and neighborhoods, and highlighting the value of community landmarks can lead to proposing alternatives that enhance the community's environment.

6. As cities go through a process of expansion, many historic landmarks are destroyed. Students need to understand the importance of preserving those remaining elements that serve as part of our cultural memory.
7. Understanding what makes for a good environment, how do environmental changes occur, how can ordinary citizens actively constitute changes toward improving the quality of their surroundings, all are some of the topics which environmental education aims to address.

Lesson Plan One: Principles of Architecture and Engineering

Grade: 9th grade Math.

Number of students: 15

Length of lesson: 2 hrs. per activity.

Objective

To acquaint with the basic terms and technology of architecture and engineering.

Development

Students will learn what architects and engineers do. Students will focus on particular ideas, as follows:

1. Students will learn about architecture and engineering with an emphasis on bridges.
2. Students will investigate what a bridge is and what is its function.

1. Students will get handout sheets that will introduced them to the subject. They will be given a map of The Brooklyn Bridge's location and learn how to read it effectively. Students will be given work sheets for follow up activities related to map reading.
2. Students will learn why cities need bridges. They will be able to distinguish and name the different types of bridges. They will also learn what purpose the individual parts play in the overall structure of a bridge.
3. Once students understand the general nature and function of a bridge. They will use The Brooklyn Bridge as our case study. The choice is made because of the impact it made on the socioeconomic history of the United States of America.
4. I will hand out sketches and maps showing the site where they will visit. A slide show will be given showing some other major bridges built in New York City.
5. A videotape about the Brooklyn Bridge will be presented (see information about this videotape in the teachers bibliography.) To expand students' knowledge, I will give the collaborating social studies teacher will get a copy of the materials I had presented for follow-up activities in the classroom.

Vocabulary:

- arch bridges
- beam bridges
- covered bridges
- maps
- moving bridges
- suspension bridges
- truss bridges
- suspension bridges

Follow up activities:

- Walking Tour to the Brooking Bridge

The History of the Building of the Brooklyn Bridge

When the first settlers arrived in the New York City area they found a variety of landscapes. In Brooklyn, the settlers built small houses similar to those that they had left in Europe. In Manhattan, commerce was the main economic activity at the time.

Brooklyn remained a farming area with a predominantly rural character, at least until the early nineteenth century. However, at about this time, New York city began to expand dramatically. People began to look for new building sites across the river from lower Manhattan. With the initiation of the Fulton Ferry in l8l4, they moved into the Brooklyn area. With time, the area turned into neighborhoods with an urban lifestyle very different from the way people lived when Brooklyn was an agricultural area.

After the Civil War, New York City grew even faster than it had at the beginning of the century. More people sought the open spaces that Brooklyn had to offer. The number of people traveling between Manhattan and Brooklyn increased considerably The need for improved systems of communication and transportation became critical. The building of the Brooklyn Bridge responded to this problem. As the first bridge to span the wide expanse of the East River, its construction posed a tremendous challenge to John Roebling, the designer and builder of the bridge aided by his family. A graceful structure, the bridge is comprised of two main towers working in compression. Steel cables working in tension hold up the roadway span.

The Brooklyn Bridge remains to this day one of the major transportation links and historical landmarks in the lower Manhattan-Brooklyn area in New York City. (St. George)

PHASE 2: Implementation

Field Trip to The Brooklyn Bridge

The purpose of this trip is to show the students realistically what the bridge looks like and to give them a clear idea of what they would need to know when they build their small replica of the bridge.

Lesson Plan Two: What is a Bridge

Grade: 9th grade Math.

Number of students: 15

Length of lesson: 2 hrs. per activity.

Objective

Before students visit the site, students will familiarize themselves with the history and different styles of bridges in the New York city area.

Development

They will also gain a clearer understanding of architecture, engineering, questions as they research in cooperative learning about different topics concerning bridges.

Activities

Students will find the answers of the architectural and engineering questions as follows:

1. What is a bridge.

2. What are the different styles of bridges?

3. Why do we build bridges?

4. What are the specific materials used in the construction of bridges?

5. What is the meaning of the following terms?

- beams
- columns
- compression
- joints
- loads
- stone
- arches
- span
- structures
- tension
- walls
- triangular structural systems

Vocabulary

- columns
- compression
- joints
- load
- span
- structures
- tension

Follow up activity

Visit to The Brooklyn Bridge.

Lesson Plan Three: Field Trip The Brooklyn Bridge

Grade: 9th grade Math.

Number of students: 15

Length of lesson: ½ hr. per activity.

Objective

Students will performed a "design" exercise (sketching different views and sections of the Brooklyn Bridge.

Development

The students at Sound School will have a walking tour abroad a schooner to visit The Brooklyn Bridge. Students will be asked to identify and sketch some details of the structure of the bridge that they might use later in the classroom to build a small bridge. During the field trip the students will look closely at the bridge by walking along its entire lenghth. They will be able to recognize and identify parts of the bridge studied during previous classes.

Activities

Students will be involved in the following activities:

1. Students will take pictures of different parts of the bridge to use in the classroom as a reference to aid in their construction of the bridge model.
2. Students will explore the Brooklyn Bridge and will draw perspectives of the suspension bridge from different points of view.
3. Students also will draw different details of the bridge as they walk along its entire length.
4. Students will measure the following: the thickness of the steel, the length and thickness of the bricks and concrete, the size of the cables, and the size of a connecting bolt.

Vocabulary:

- anchorage
- archways
- cables
- platform
- stays
- suspenders
- towers

Lesson Plan Four: Drawing sketches and creating the Replica of The Brooklyn Bridge

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Grade: 9th grade Math.

Number of students: 15

Length of lesson: 2 hrs. per activity

Objective:

The pre-and-post activities will be designed to help students understand the built environment and to begin looking at their city as a resource of history. My ultimate goal, however, is to have them draw the actual Brooklyn Bridge to scale, and build a small replica of the suspension bridge.

Development:

This unit will introduce students to style and structures pertaining to building-construction issues. After the field trip, the students will have a clearer idea of what they are going to build. Students will gather all the written information from the beginning of the semester and the field trip and proposed ways to make a scale model of the bridge using all their drawings and sketches. The brainstorming will help them use their knowledge of structure, engineering & architecture to create a small-scale model of the Brooklyn Bridge.

Activities:

1. Back in the classroom students will start to refine their sketches of the structures, much like architects and engineers do, in an effort to better understand the scope of their project. Some drawings will be done from memory, others by utilizing reference photos taken by the students at the site. Other drawings will utilize books and photocopies of the bridge collected from different books (See students bibliography).
2. Students will sketch their bridge to decide on the type and amount of materials to be use to represent the small-scale model of the Brooklyn Bridge. Once the model is finished, students will present them to other classmates or classes. This will allow them to have some experience in building, displaying the bridge, and making presentations for their final project and evaluate their achievements.
3. Students then will proceed to draw on paper a 2D and 3D small scale model of The Brooklyn Bridge.

Vocabulary

- 2D and 3D figures
- congruency
- data displays
- polygons
- rotations
- similarity
- translation

Follow up activity

Model Making of the Brooklyn Bridge

PHASE 3: Execution of the Program

For this purpose, students will be asked to analyze the different materials and patterns of the bridge, and choose the model's materials that represent the actual materials used on The Brooklyn Bridge. Students will be aware of the importance of model making. The students will experience the process of thinking about a project along with the complexities of the design process the bridge had to go through in the late nineteenth century. The processes included planning, designing, organizing tasks, and, finally, building the bridge.

The Brooklyn Bridge is a suspension bridge. A suspension bridge uses a series of strong cables and stays to suspend the roadway. The model has cables similar in shape to those of the actual bridge and demonstrates the principle of suspension.

The towers students will build could stand on a simple base. In the actual bridge, the towers had be sunk many feet into the riverbed. This was a very dangerous job. The reason for doing this was to provide a sturdy foundation to carry the tremendous weight of the bridge's stone, steel, and cables. The cables of the Brooklyn Bridge were threaded above the main archways. The cables of the Brooklyn Bridge are fastened to massive bases called anchorages located at each end of the bridge. In the student's replica, students will use thick cardboard to form the anchorage.

Lesson Plan Five: Model Making of The Brooklyn Bridge

Grade: 9th grade Math.

Number of students: 15

Length of lesson: 4 hrs. per activity

Objective

The main reason for making the model is to allow the students to solve a design task: build a small scale model of The Brooklyn Bridge.

Development

The model of The Brooklyn Bridge that students will build will be in proportion to the actual bridge. However it will be assembled differently from the way the actual bridge was constructed since the students will use other type of light weight materials such as balsa, cardboard, fishing line, and ropes.

Activity

1. Students will be divided into small groups to make tasks easier. First, all groups concentrate in measuring using their scale all the different parts of the bridge they have created.
2. Students will cut the different parts of the bridge,
3. Students will assemble all the parts together.
4. Students will decide and will work on the surrounding environment of the bridge.

Vocabulary

- diagonal stays
- caisson foundation
- river span
- roadway span
- land span
- suspenders
- towers and archways

Follow up activity

Presentation of the bridge to friends, parents, teachers, and fellow classmates.

Evaluation of the Unit

In this unit students will be able to experience all the processes involved with the bridge construction and thereby simulating the processes used in the construction during the late nineteenth century. Also important were those approaches in managing and supervising human resources, planning, re-planning, scheduling, and delegating tasks.

At this point students will be able to use in a regular basis some architecture vocabulary; they will be able to

integrate basic knowledge of architecture and some of the engineering principles with the regular 9th grade math curriculum as follows:

1. Integrate in a hands-on approach some elements and vocabulary used in their 9th math curriculum such as proportion, geometric figures, symmetry, use of areas, space, volume, patterns, angles, and scale.
2. Students will be able to visualize and sketch the way the actual model bridge is going to look.

Conclusion

The unit was structured with a focus on the urban and architectural development of the bridge. Students will be able to present architecture in its historical and cultural context. Also, this unit will help to tie the program to the 9th grade curriculum by providing issues related to math.

In conclusion, students will be able to formulate and create solutions to small design problems. Also, very important is the process of creating a bond among students and teacher while building this scale model of the Brooklyn Bridge.

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