



Curriculum Units by Fellows of the Yale-New Haven Teachers Institute
2006 Volume IV: Math in the Beauty and Realization of Architecture

Math, Music, and Architecture: Kindergarten Geometry and Aesthetics in Music and Architecture

Curriculum Unit 06.04.02
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Introduction

The class "Math in the Beauty and Realization of Architecture" through the Yale-New Haven Teachers Institute was a wonderful opportunity to learn and grow as a teacher and learner. As a preK-8 music teacher at King/Robinson with a dual endorsement in elementary education, teachers around me value life-long learning as well as the integration and cross-pollination of different disciplines as a means to which we can present curricular material in a more interesting and authentic way. To develop a unit that incorporates mathematics, music, and architecture reflects the world in which our students live-- a world of connections and meaningful engagement that does not operate within tight confines of disciplinary boundaries. Utilizing the five senses: playing or performing instruments that are analogous to mathematical principles in architecture (tactile, auditory), and presenting images that elicit writing, musical composition (visual), and possibly even having experiences that involve smells and tastes, elicits critical thinking and dialogue in our explorations within the unit. In other words, this curriculum will enable students to engage their senses, our vision in the aesthetics of architecture, and hearing in musical listening and composition especially, to be a springboard for writing, reading, mathematics, composition, and conversation.

Our school, like all schools within New Haven Public School District, is currently involved in a high emphasis on testing and academic proficiency. This affects the music classroom as essentially supporting literacy and mathematics growth even in a music classroom. Thus, mathematical skills placed within the context of architecture and music will be an invaluable and authentic way to support my school's initiatives and academic focus. Emphasis will be on the connections between mathematics, architecture, and music in a Kindergarten music curricular unit called "Music, Math, and Architecture." By making the interdisciplinary connections between music, math, and architecture, students will be exposed to the highest quality examples of architecture, and not only share historical facts about music and architecture (students will read, view, and listen to information), but guided with the music, architecture, and mathematics by reading, writing, discussing, and doing computations. This curricular unit includes a field trip to Yale to look at different architectural examples, counting shapes and colors in rose windows, listening to and counting the number of cymbal crashes in a musical piece of the same time period as the architecture we observe, and then create architecture pieces ourselves. The closure of the unit would be that students could work on group projects and ultimately make collage presentations demonstrative of their studies with architecture, mathematical

principles, and selecting appropriate music for the background. Each student can pick one letter of the alphabet or one number in which to focus their project. Finding these interdisciplinary connections within a culture and/or time period will be an authentic way to explore the relationships that history, art, architecture, mathematics, and music have with each other.

Previous living experiences in Chicago, IL, Portland, OR, and New Haven, CT, have enriched the author's personal appreciation and awareness of architecture, not only the aesthetic beauty of architecture, but the structural, mathematical principles that allow such artifices to exist. Looking at architecture and making connections to other disciplines has much historical, aesthetic, and personal value. Being able to have the opportunity to look at, read about, listen to, and talk about these connections within architecture, mathematics, and music through New Haven Public School District's partnership with Yale was an opportunity for personal learning and for my exposure to then more broadly help create an important and engaging interdisciplinary unit for students who participate in this experience.

Goals for Enduring Understanding

- We can make connections in our lives, between math, music, architecture, art, writing, and other disciplines.
- By using our senses, we are constantly learning and connecting with the world around us.
- Sound and Sight are two senses that can be tools to deepen our mathematical skills and understanding.
- Looking at the world through a scientific and mathematical lens allows us to see the many academic principles and knowledge that help to create the world around us, i.e. in music and architecture.

Objectives

- Students will be able to count from 1-20
- Students will be able to identify the following shapes: circle, semicircle, square, rectangle, triangle, diamond/rhombus, oval, star
- Students will identify odd and even numbers
- Students will order shapes by the number of sides and corners
- Students will estimate and count to check the number of a given item, lengths, and weights

- Students will measure items using personal referents (i.e. fingers, arm spans, etc.)
- Students will describe, model, draw, and classify shapes
- Students will use real-life experiences, concrete objects, and technology to explore and understand properties of 2- and 3-dimensional shapes
- Students will create and then solve each others' story problems involving music and architecture from the unit.

Context

The initial ideas and concepts of this unit were piloted with preK-8th grade music students at King/Robinson Interdistrict Magnet School. Teaching students from individual classes one to three times a week, music standards were incorporated as well as math and literacy standards within the instruction. Through exposure to architecture and music, students can develop a deeper and richer appreciation and connection to the world around them. This Kindergarten curricular unit exposes students to the beauty of math, music and architecture in "Math, Music, and Architecture: Kindergarten Geometry and Aesthetics in Music and Architecture."

Rationale

The best learning in schools reflects the learning and living in the world around us. Thus, as the world we live in is full of interconnectedness, cross disciplinary connections, and ongoing interactions between subject matters, this unit presents ideas and attempts to fluidly connect different topics and subjects to each other in an authentic way. Students will be exposed to mathematics and language arts while learning about architecture and music. These disciplines will not be taught with confines of rigid boundaries, but rather intersect with each other through various learning exercises and experiences. We will grow as mathematicians, musicians, architects, aesthetics, and learners by engaging the senses and practicing skills.

The instructional strategies in the unit are all designed to be effective for all levels of students, from proficient mathematicians to students just beginning to gain basic number sense, ELLs (English Language Learners) to fluent English speakers, from students whose parents are architects to students who have never heard the

word "architecture," from proficient musicians to students never having sung or played a musical instrument before, from low-literacy levels to highly literate students. There is currently an increase in inclusive educative practices, allowing English Language Learners, students with Individual Education Plans, and Talented and Gifted students to all learn together within the context of one elementary classroom. Thus, teachers must be all the more sensitive to differentiated instruction. Teachers should accommodate to different ability levels, as well as multi-modal learning: address of learning styles such as visual, kinesthetic, tactile, and auditory. Another way would be to address multiple intelligences: interpersonal, linguistic, physical, natural, intrapersonal, mathematic, visual/spatial, and musical intelligences. This unit incorporates both homogeneous and heterogeneous groupings for instruction and practice. The use of homogeneous grouping for certain activities allows for students to be challenged at their levels (e.g., guided reading groups). The use of heterogeneous grouping allows for students to mix with other students of different ability levels, which allows for struggling students to participate in activities they would not be able to do independently, while higher level students can engage in deeper thinking skills by assisting the struggling students in their learning (e.g. through explaining, summarizing, teaching, etc.)

Oral language development will be emphasized and ongoing within instruction, as per developmental needs of kindergartners; therefore, many of the instructional strategies in the unit are centered around oral language. One of the most important strategies which is referred to throughout the unit is the 10-2, in which the teacher stops talking after ten minutes to allow students to talk for two minutes. This allows students to orally reprocess newly learned information by discussing with a partner or small group. Students can simply restate vocabulary, discuss a concept, or formulate questions. It is a time for "target talk"- for students to develop their oral language skills in a constructive, academic setting. I also highly utilize structured oral language development through poems and chants. Throughout the year, my students become familiar with the frames used for these poems and chants, so that when new content is introduced in the familiar frame, struggling readers have greater opportunities for success and can quickly comprehend. Students are given opportunities to repeat/echo, restate, and retell frequently. This allows students to practice the new language in a safe, choral setting before they are asked to read or write it.

Teaching this unit to a group of kindergartners, some of whom may never have been to school before, requires that this unit has focused, intentional vocabulary and concepts that they will use readily. This unit is designed thematically to incorporate math, architecture, music, and literacy. Brain research shows that students are more likely to retain newly learned information when it is connected to something previously known (schema). Thematic units that integrate the subject areas are powerful instructional tools because by connecting the content across the curricular areas, students can develop their skills in each area while they are learning the content. Research also shows that the more exposure the brain has to new information in a variety of contexts, the more likely it is that the information will be retained. This is true not only for content, but also for language learning. For this reason, the instructional activities in this unit are designed to use the same repeated key vocabulary and concepts in a variety of contexts. Students will have repeated exposure to increase their learning opportunities.

Developmentally, kindergartners need a fast pacing of teaching and activities, as well as engagement of the senses as much as possible. Demonstrations are hands-on so that students can develop understanding at a concrete level before being expected to think abstractly. Visuals and "realia" (actual objects*) will be utilized whenever possible to allow students greater access to the content. A field trip to Yale will be also be employed so students can have first-hand knowledge, visual, and tactile learning, and to create more opportunities for student engagement in the content. Where visual aides are not enough, graphic organizers are used to help students organize information. Basically, every effort was made to ensure that all students have access to the

curriculum and are able to learn, regardless of their mathematical, musical, or architectural previous abilities and predispositions.

* "Realia" is a term describing actual objects brought into the classroom for educational purposes. G.L.A.D. (guided language acquisition and development)-related research shows that student are able to make connections and strengthen learning by seeing, touching, experiencing objects that relate to the curriculum.

Target Vocabulary

-Numbers 1-20

-circle

-semicircle

-square

-rectangle

-triangle

-diamond/rhombus

-oval

-star

-odd

-even

-sides

-corners

-estimate

-length

-weight

Classroom set-up

Students will be seated in clusters, or groups. There will be individual tasks as well as "team-tasks" so that work and learning is done alone as well as in groups. There are ongoing visuals created (posters, chants, etc.) which are kept up around the room for reference and review of concepts. An easel and/or whiteboard will be used regularly and should be placed where all students can see easily, and where the teacher can visually manage the students. Easel paper for chants and visuals will be used regularly and space should be created for the easel paper to be displayed around the room.

Instructional Design and Strategies

Through the disciplines and experiences of architecture, music, mathematics, and language arts are integrated wherever possible. (See math standards in Appendix. Kindergarten math standards that are addressed have an asterisk (*) before the standard.) The unit will be taught in second quarter of the year, after students have acclimated themselves with school and classroom procedures and routines. As they will be building upon home and other life experiences, we will explore mathematics through the lens of architecture and music. The unit will last approximately 3 weeks.

The introduction to the unit open with Lesson #1, called a "gallery walk." In this activity, many photographs acquired during the Yale seminars pertaining to the topic (architectural images, musical images) and a variety of objects and materials (instruments, architectural materials) will be posted at different stations throughout the room. Students will rotate around the room in small groups, study the photographs/objects, and write their observations and questions on a paper next to the photograph that has a specific prompt, such as "I observe," "I wonder," or "I predict." These objects and cards will be posted in the room for the duration of the unit, and the teacher will guide a discussion about the images as guided by the student observations and questions. Lesson #2 will again activate students' schema (prior knowledge) as well as give the teacher a sense of how students feel about their baseline knowledge of topics within the unit. Students will also place a sticker along three line continuums labeled "Architecture," "Music," and "Math." On the left side of the line continuum, it will be labeled with a question mark: "I don't know anything about this." On the right side, it will be labeled with a smiley face: "I'm an expert at this." Students will place their sticker dots along the continuum to mark where they perceive their understanding is of that subject. Students will also be offered the optional activity of writing a vocabulary word or drawing a picture related to the subject on the sticker dot. At the end of the unit, students can go back and do both activities again, this time writing what they have learned about each object/picture, as well as placing different colored dots to show their growth and learning for each of the three subject matters.

Lesson #3 involves a "KWL (what we Know, what we Want to know, and what we've Learned) inquiry chart." In this activity, which is detailed below, students' schema/prior knowledge, which has already been activated during the gallery walk and line continuums, is recorded on a chart with student initials by each statement. Student questions are also generated which can be added to throughout the unit and researched by the students to create greater enthusiasm for learning. The L column of the KWL will be revisited at the end of the unit to answer the questions from the initial activity as well as share other facts and concepts that were

learned.

Students will do another gallery walk after observing an example using all five senses with a material or instrument. Answers will be written out to the following prompts:

What do I see (picture of an eye)?

What do I smell (picture of a nose)?

What do I taste (picture of a mouth and tongue)?

What do I feel/touch (picture of a finger)?

What do I hear (picture of an ear) (material or instrument to be struck or played)?

Gradual release of responsibility, in which the teacher models an activity, then students and teacher practice it together, and students eventually engage in independent practice (I-We-You), will be a format for instruction throughout the unit. At this point in time, students will go around the room with the teacher and fill out answers to those same five prompts for different architectural materials and musical instruments. After completing all five senses for all the materials, teacher and students will then be architecture and music detectives, where the teacher will read off cards saying something like: I look brown and black, with four strings. I smell like wood. I taste like wood. I feel smooth and have curves and thin strings. I sound like singing. I am... (Students guess) a violin! Then students point to which instrument is a violin. We continue the five senses architecture and music detectives game until all the items in the room have been played/utilized.

Students will also, at this point, become exposed to some chants and poems which will reinforce the target vocabulary (lesson 5). In these poems, the parts of speech will be color-coded. The poems follow a specific frame, and are highly contextualized with pictures and photographs to support struggling readers.

The next lesson will be a time line of architecture and musical history, noting shapes and lines as images are shown from each time period. After this lesson, we will read the book *Architecture Shapes* and take a field trip to Yale to see some of the images previously viewed in the introductory lessons, as well as have students go on a "shape hunt." Each pair of students will be assigned to a specific shape on the top of separate sheets. As students find examples in the buildings, of certain shapes, students will tally the number of shapes they have found as they will be given individual sheets to mark on. At this point, there will be a transition into specific math skill practice sheets with architectural and musical themes--counting the numbers of sides, ordering numbers, finding shapes, etc. in music and architecture images.

Other lessons that can be included are noting sound differences with materials that are struck in different rooms, making instruments with different architectural materials, and going through the process of designing and creating a raised garden bed in the spring to plant flowers and vegetables. Collaboration with other teachers within the school, and Martin Gehner, Yale Architecture professor emeritus at Yale can allow the unit to expand and evolve to suit the particular teacher or school's needs and interests.

Homework

Homework allows students to independently practice and reinforce skills learned in the classroom. It allows families to be truly involved in the learning process, and review what they have learned together. Homework not only has the academic purposes of reviewing instruction, but socially strengthens the family involvement to the child's education, the home-school connection. The following three prompts are examples of homework that gives students a chance to strengthen oral and written literacy skills while reinforcing content knowledge.

*Talk to your parent about what architecture is. Draw and write a picture of a building or other piece of architecture in your neighborhood or home. (Parent signature required)

*Share some of what you already know and what you want to know about music. Write or draw some things your parent knows or wants to know about music. (Parent signature required)

*Share some of what you already know and what you want to know about architecture. Write or draw some things your parent knows or wants to know about architecture. (Parent signature required)

*See also websites, in References/Resources section

Three Sample Lesson Plans

Introductory Lesson Plans

Lesson Plan 1: Activating Schema, gallery walk

Lesson Plan 2: Activating Schema, KWL

Lesson Plan 3: Activating Schema, continuum

(Introductory lessons to be enlarged onto an overhead or chart paper, see lesson examples below, as well as "Instructional Design and Strategies" re: presentation and context.)

[Lesson 4: 5 senses (music and architecture materials)]

Lesson 5: Chants and Poems

Lesson 6: Field trip to Yale (counting colors in stained glass windows, counting sides, corners, shapes of and in buildings, visiting Yale University Collection of Musical Instruments, 15 Hillhouse Avenue, New Haven, Connecticut 06511.

Lesson 7: Musical counting and story problems (i.e. Count number of cymbal crashes in 1812 Overture and write a story problem with architectural examples from the same time period.)

Lesson 8: Making and measuring musical instruments

Lesson 9: Group projects (collages of architecture, music, with number and shape emphases)

Lesson 10+: Design and create raised lasagna garden bed and plant seeds.], etc.

Gallery Walk

(image)

"I observe..." (picture of magnifying glass)

"I wonder..." (picture of question mark above child's head)

"I predict..." (picture of crystal ball)

Continuums

*Architecture

I don't know anything about this./ ? | I'm an expert at this./ :)

*Music

I don't know anything about this./ ? | I'm an expert at this./ :)

*Math

I don't know anything about this./ ? | I'm an expert at this./ :)

K.W.L.

What we KNOW | What we WANT to know | What we have LEARNED

Assessment

Individual behavioral rubric (incl. work habits)

(table available in print form)

Group work, team tasks rubric

(table available in print form)

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References and Resources (incl. teachers' bibliography, electronic resources)

Ames, Lee L., *Draw 50 Buildings and Other Structures*, Broadway Books, New York, 1980

Chanan, Steven, *The Geometer's Sketchpad: Dynamic Geometry Software for Exploring Mathematics*, Key Curriculum Press, Emeryville, CA, 2001, version 4.0

Gordon, J.E., *Structures: or Why Things Don't Fall Down*, Penguin Books, Ltd, London, 1978

Gordon, J.E., *The New Science of Strong Materials, or, Why You Don't Fall Through the Floor*, Princeton University Press, Princeton, NJ, 1984

Kapraff, Jay, *Connections: The Geometric Bridge Between Art and Science*, McGraw-Hill, New York, 1991

Pothorn, Herbert, *Architectural Styles: A Historic Guide to World Design*, Facts On File, New York, 1979

Stevens, Garry, *The Reasoning Architect: Mathematics and Science in Design*, McGraw-Hill, NY 1990

Teaching architecture for kids:

www.loggia.com/designarts/architecture/kids.html

archnet.org/forum/view.tcl?message_id=94135

architecture .about.com/od/teachersaids/

architecture .about.com/ od/teachersaids/tp/lessonplans.htm

www.kinderart.com/teachers/artlinks.shtml

Teaching "music and math" for kids

(**Music and Math** : How Do We Make the Connection for Preschoolers?): www.childcareexchange.com/resources/view_article.php?article_id=5015846

(Music and math worksheets):

www.lessonplanspage.com/MusicTextureMath.htm

homeschooling.gomilpitas.com/explore/music.htm

Student Bibliography

Crosbie, Michael J. and Rosenthal, Steve, *Arches to Zigzags: an Architecture ABC*, John Wiley and Sons, New York, 1993

Crosbie, Michael J. and Rosenthal, Steve, *Architecture Animals*, John Wiley and Sons, New York, 1993

Crosbie, Michael J. and Rosenthal, Steve, *Architecture Colors*, John Wiley and Sons, New York, 1993

Crosbie, Michael J. and Rosenthal, Steve, *Architecture Counts*, John Wiley and Sons, New York, 1993

Crosbie, Michael J. and Rosenthal, Steve, *Architecture Shapes*, John Wiley and Sons, New York, 1993

Appendix: "Implementing District Standards" (Standards that are covered by this unit have an asterisk () before it. See attached document in landscape formatting, page set-up)

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