Module 1:
Glass Casting

Art in Mathematics (AiM)

GLASS CASTING AND MATHEMATICS

Time Frame: 6 days

ENDURING UNDERSTANDINGS:

The process of creating a small clay sculpture that will be open-face cast into glass involves the understanding and utilization of geometric formulas for perimeter, area and volume. The casting process involves work with algebraic formulas, graphs of linear functions and understanding and interpreting graphs of two variables.

TARGET AUDIENCE:

- Grades 9 – 12
- Students needing additional practice or review with:
  - using geometric formulas
  - geometric transformations (rotations, reflections, etc.)
  - linear functions: relationship between graphical, tabular and symbolic form
  - graphing in two dimension and analyzing graphs
- The art creation process provides students with a real world application and motivation for learning the connections between the art and mathematics

ESSENTIAL QUESTIONS:

1. How is algebra utilized in the process of glass casting?
2. How is geometry utilized in the process of glass casting?

WASHINGTON MATH STANDARDS:

A1.4
A1.6
G.5
G.6
M1.3
M1.4
M1.1B

CRMS

Number Sense: 4.3
Geometry: 5.2, 5.3
Algebra: 7.3
Functions: 8.2, 8.4

AT THE END OF THIS UNIT STUDENTS WILL KNOW AND BE ABLE TO:

1. Calculate volume and surface area of molds and determine the amount of material needed to create sculpture.
2. Create linear equations from tables.

PRE-REQUISITE KNOWLEDGE/SKILLS:

1. Knowledge of graphing in two dimension

ACTIVITIES:

1. **Transformations** Worksheet
2. **Kaleidoscope Name** Activity
3. **Pond Problem** Activity
4. **2-D Sketch and 3-D Clay Model** Activity
5. **Painter's Problem** Warm-up
6. **Geometry Gift** Warm-up
7. **Ice Cream Dilemma** Warm-up
8. **Volume and Surface Area Application Problems Worksheet1**
9. **Volume and Surface Area Application Problems Worksheet2**
10. **Graph Interpretation Problems** Worksheet
11. **Firing Graph** Worksheet
12. **Hot Tub Problem** Worksheet
13. **400 Meter Race News Story** & Worksheet
14. **Bus Trip** Worksheet

*Optional Activities:

1. **Department of Motor Vehicle Graph Interpretation** Worksheet
2. **Baseball Salary Analysis** Worksheet
3. **Changes in Area Investigation** Worksheet

POST-ASSESSMENT:

Student Reflection Survey

RESOURCES:

Video Clips illustrating use of Symmetry and Math in Art
YouTube examples of casting: lenses, headlights, bronze sculpture

DAILY PLAN

DAY 1

Art

- Video clips showing the use of symmetry and math in art, Chuck casting
- Art warm-up to review art/math vocabulary

Math

- Transformations worksheet (translations, rotations, slides, reflections,etc)
- Kaleidoscope Name Activity

DAY 2

Art

- Video clips of artist's bias-relief work
- Sketch of bias-relief plan

Math

- Pond Problem Activity
- Painter's Problem Worksheet

DAY 3

Art

- Create clay model for glass bias-relief

Math

- Geometry Gift Worksheet
- Ice Cream Dilemma Worksheet

DAY 4

Art

- Feedback and revision of clay model for bias-relief

Math

- Volume and Surface Area Applications Worksheet 1

DAY 5

Art & Math

- Determine Mixing Investment
- Determine Volume of flask to hold investment
- Determine amount of glass needed to charge mold for chuck casting
- Video clips of casting: lenses, headlights, bronze sculptures

Math

- Volume and Surface Area Applications Worksheet 2

DAY 6

Art

- Firing of glass casting
- Writing Assignment: self-reflection about what they learned about the math and art involved in this process

Math

- Firing Graph Worksheet
- Graph Interpretation Worksheet
- Hot Tub Problem Worksheet (interpreting the meaning of slope)
- 400 Meter Race Worksheet (describing change over time)
- Tour Bus Worksheet

Optional Projects:

a. Department of Motor Vehicle Graph Interpretation
b. Baseball Salary Analysis (graphs, data, central tendency)
c. Cylinder Problem

Module 2: The Art & Math of Video Games

Art in Mathematics (AiM)

THE ART & MATH OF VIDEO GAMES

TIME FRAME: 5 - 15 days

ENDURING UNDERSTANDINGS:

Mathematics is a critical component of animation in general and computer games in particular.

TARGET AUDIENCE:

- Grades 9 – 12
- Students needing motivation in Algebra and Geometry.
- Students needing additional real-life applications for Algebra II, Precalculus, and Trigonometry topics with a "wow" factor.
- See the Overview page for more detailed information about topics.

ESSENTIAL QUESTIONS:

1. What do computer game writers do and what mathematics do they use?
2. What are the essential elements of simulating motion and defining color in computer games?

WASHINGTON MATH STANDARDS:

M1.2
M1.3
M2.5
M2.6

CRMS:

PS/Reasoning: 1.2
Communication: 2.3
Probability/Stats: 6.2

AT THE END OF THE CHAPTER STUDENTS WILL KNOW AND BE ABLE TO:

1. Describe position of an object on a coordinate system.
2. Illustrate how a position of a point is denoted differently in a computer animation.
3. Convert numbers into different bases and understand how hexadecimal numbers are used to represent RGB colors in computer graphics.
4. Explain how ratios and proportions are used in computer simulation.
5. Adapt a piece of computer or calculator code to change direction, color or speed in an animation.

6. Use vectors to describe direction and movement in games.
7. Describe how matrices can move a figure to a new position.
8. Describe and illustrate the parallax effect.

PRE-REQUISITE KNOWLEDGE/SKILLS:

Graphing in two dimensions

PRE-ASSESSMENT ACTIVITY:

None

ACTIVITIES:

Introductory problem, **Racing Away**
Animation Worksheets #1, #2, #3
Computer activity: **Moving On**
Video 02 and Cornell Notes for Video 02
Hexadecimal Numbers and RGB color website
Video 03 and Cornell Notes for Video 03
Flip Book
Video 04 and Cornell Notes for Video 04
Video 06 and Cornell Notes for Video 06
Vector Website
Where in the World is Wally's Treasure
Vector Worksheet
Video 07 and Cornell Notes for Video 07
Matrix assignment

POST-ASSESSMENTS:

Students will modify a video game.
Team open note assessment on learning objectives

LITERACY STRATEGIES:

Cornell Notes

RESOURCES:

www.1728.com/colrchr3.htm
http://www.onlinemathlearning.com/vectors.html
http://staff.imsa.edu/math/journal/volume4/articles/GeomMatrices.pdf
http://en.wikipedia.org/wiki/Abacus

DAILY PLAN

Day 1:

- Computer clip of sample marquee (optional)
- Introductory problem: Racing Away
- Start worksheet 1 in class

HW: Finish worksheet 1 at home.

Day 2:

- Go over homework
- Work in class on worksheet 2 and 3. Correct.

HW: Students write a process paper describing how matrices are added together and how matrices and rates (pixels per second) would help simulate movement in a video game.

Day 3:

- Activity: Moving On
- Download Calculator Program: Moving On

HW: Modify the program Moving On so that the program moves each student's letter from the bottom left diagonally up towards the top right hand corner.

Day 4:

- Have students check each other's program.
- Start DigiPen Unit 1 Activities.
- Students watch video 02 and complete the Cornell Notes for Video 02 (This video is so packed with information, students might have to watch it twice, which will mean that some of the game playing may run over to day 5)
- Students play Space Shooter Game, try invincibility code and boss level.

HW: Students review notes and complete summary at bottom of the Cornell Notes.

Days 5-6:

- Entry tasks (see Teacher Resource for DigiPen Unit 2 and 3)
- Students read handout of Purple math article on base 2 and base 8 and 16. Students can look at this material online at: http://www.purplemath.com/modules/numbbase.htm
- Students go to www.1728.com/colrchr3.htm to work with colors given their hexadecimal code. Spend about 10 minutes with this.
- Students watch video 03 and complete the Cornell notes for video 03.
- Students change the color of sprites in game.

Day 7:

- Entry task (See Teacher Resource for DigiPen Unit 4)
- Students watch the Video 04 and complete the Cornell Notes for video 04.
- Work with the game changing the frames per second and the animation speed.

Day 8:

- Entry task (See Teacher Resource for DigiPen Unit 4)
- Students watch the Video 06 and complete the Cornell Notes for video 06.
- Students work on game to activate the scrolling effect in the game and to change the scrolling speeds of the Star fields.

Day 9:

- Entry Task: Given right triangle ABC where angle B is a right angle. Sketch the triangle. If side AB is 5 cm long and side BC is 8 units long, what is the area of the triangle and what is the length of side AC. Share answers, have a student review Pythagorean Theorem.
- Open website www.onlinemathlearning.com/vectors.html
- Have students take Cornell Notes on the following sections. If students have access to their own computer they could go through these as teams of two and take notes. Then the class could come together for sharing.
  What is a vector?
  Vector Magnitude (no need to show video clip with this section)
  Negative vectors
  Vector Addition (show video with this section)
  Position Vectors
  After the notes are finished, have volunteers give an example of each of the main points above.
- In-class Assignment: **Where in the World is Wally's Treasure.**

HW: Vector Worksheet

Day 10:

- Go over homework from the day before.
- Watch Video 7 and take Cornell Notes. Have students make the appropriate changes to the game. After making changes, students might have time to play the complete game.
- There is another video (Video 10) that deals with vectors also, but also some physics. It might be something that advanced students could watch and change.

If there is time, review how to enter matrices into the graphing calculator. Also review some general information about size of matrices, such as a 2X3 is a matrix that has 2 rows and 3 columns.

Day 11:

- Entry task: have students add two 2 by 3 matrices together. This should be a review from the beginning of the course. Move from here into doing this work on a graphing calculator.
- Students may or may not have multiplied matrices together, as needed show the rule for multiplying, but the rest of the assignment will be done on the calculator, so the rule is just for background.
- In-class assignment, **Matrix Assignment**. Share out discoveries.
- Hand out information sheet, **Geometric Transformations with Matrices**. Have students read silently, then review information on the first page. Students should have discovered most of this material from the assignment.
- Watch Video 12. It is short and talks about how matrices are used. No notes needed and no changes to game from this video.

Day 12:

On this day students work in pairs to write a paper that shows their knowledge and understanding of the following objectives.

At the end of the chapter students will know and be able to:

1. Describe position of an object on a coordinate system.
2. Illustrate how a position of a point is denoted differently in a computer animation.
3. Convert numbers into different bases and understand how hexadecimal numbers are used to represent RGB colors in computer graphics.
4. Explain how ratios and proportions are used in computer simulation.
5. Adapt a piece of computer or calculator code to change direction, color or speed in an animation.
6. Use vectors to describe direction and movement in games.
7. Describe how matrices can move a figure to a new position.
8. Describe and illustrate the parallax effect.

Module 3:
Ceramic Vase Building

Art in Mathematics (AiM)

VASE BUILDING AND MATHEMATICS

TIME FRAME: 6 days

ENDURING UNDERSTANDINGS:

The project involves integrating the creation of ceramic vases with geometric concepts from mathematics. The mathematics concepts include measurement skills in length, area, volume, shrinkage and absorption calculations, scaling, and tessellation patterns with symmetry, and transformational geometry. The art components include designing, measuring, dimensioning and building a vessel from a template guideline or a designated extrusion form. The process of creating the vase, drying the clay, firing the vase in a kiln ("bisque") and doing a final glaze firing, will demonstrate real world mathematics concepts.

TARGET AUDIENCE:

- Grades 9 – 12
- Students needing additional practice or review with:
  - using geometric formulas
  - geometric transformations (rotations, reflections, etc.)
- The art creation process provides students with a real world application and motivation for learning the connections between the art and mathematics.

ESSENTIAL QUESTIONS:

1. How is geometry utilized in the process of vase building?

WASHINGTON ART STANDARDS:

1.1.1 Understands arts Concepts and Vocabulary
1.1.2 Understands arts Concepts and Vocabulary
1.2 Develops art Skills and Techniques
2.1 Applies a Creative process in the Arts
3.2 Uses the arts to Communicate for a specific purpose
3.3 Develops personal aesthetic criteria to communicate artistic choices
4.2 Demonstrates and analyzes the connections between the arts and other content areas
4.3 Understands how the arts impact lifelong choices

WASHINGTON MATH STANDARDS:

M1.3
M1.4
M1.1B

CRMS:

Number Sense: 4.3
Geometry: 5.2, 5.3

AT THE END OF THIS UNIT STUDENTS WILL KNOW AND BE ABLE TO:

1. Design and construct a vase which follows the cutout guideline the student pre-measured and designed earlier or the extrusion selected
2. Calculate volume and surface area of the vase and determine the amount of material needed to create vase.
3. Determine the volume and surface area of vase
4. Determine the percent of shrinkage in the four stages of the vase (wet, dry, bisque firing and glaze firing)
5. Describe the patterns on the vase in terms of tessellations, symmetry, and transformational geometry using terms like “rotation” “reflection” “translation” “glide reflection” “rotational symmetry” “reflective symmetry”.
6. Utilize scaling to draw a two-dimensional image of the three-dimensional object (or alternately; given a two-dimensional drawing, create a scaled three-dimensional vase)
7. Reflect on process of designing Measuring, Dimensioning, and Building Process.

PRE-REQUISITE KNOWLEDGE/SKILLS:

1. Basic knowledge coil pot building

ACTIVITIES:

1. Clay Stages (PowerPoint Presentation)
2. Hand-building Techniques (PowerPoint Presentation)
3. Geometric Analysis Worksheet
4. Reflection Paper

POST-ASSESSMENT:

Student Reflection Survey

CONTENT/PRODUCT/PERFORMANCE BASED ASSESSMENT:

4.0 Exceeds Standards
Work at this level:

- Shows an imaginative, inventive, and confident use of the Elements and Principles of Art & Design
- Shows high quality composition- you organized the piece nicely
- Is consistently of high quality, although not all pieces will necessarily be at the same level of skill
- Demonstrates evidence of confidence with the use of skills and techniques (energy)
- Addresses evidence of fairly complex visual and/or concepts (rigor & relevance)
- May show successful engagement with experimentation and/or risk-taking (going beyond the requirements)

3.0 Meets Standards
Work at this level:

- Is generally strong, although there may be inconsistencies in overall quality
- Demonstrates a strong grasp of the elements and principles of art & design
- Shows generally strong composition – organization of piece is strong
- Shows obvious evidence of thinking and problem solving skills
- Successfully engages with most aspects of skills/techniques and materials

2.0 Approaching Standards
Work at this level:

- Demonstrates a good understanding of the elements and principles of art & design
- Shows generally purposeful composition
- Demonstrates some degree of success and shows some changing of main ideas (make it your own)
- Has some technical aspects or ideas that are handled well but the two don't always mesh or work together
- Thinking and problem solving skills are evident

1.0 Little or No Evidence of Standards
Work at this level:

- Shows little or no evidence of thinking/artistic decision-making
- Reveals a misunderstanding of skills and technique
- Shows little or no awareness of tools/media
- Uses simple solutions to complex visual problems
- Is insufficiently put together, with minimal consideration given to elements and principles of art & design

FOR GEOMETRIC ACTIVITY ASSESSMENT, SEE GRADING RUBRIC AFTER THE ACTIVITY

RESOURCES:

- Examples of templates
- Examples of student work

DAILY PLAN

DAY 1

- Clay Stages PowerPoint Presentation
- Hand-building Techniques PowerPoint Presentation
- Students learn how to create a coil pot template by using a ruler and choose their own dimensions for the pot, or choose an extruder shape

DAY 2

- Students will create base out of a flat wedged piece of clay
- Students will begin to construct the coil pot

DAY 3

- Students continue building pots, scoring and slipping

DAY 4

- Student complete pots adding the geometric designs
- Students set pot on drying rack to green ware stage before the pot is fired

DAY 5

- Students work on Math Analysis Worksheet while pots are dried and fired

DAY 6

- Students glaze and re-fire pots
- Students complete Math Analysis Worksheet

HW: Self Reflection Survey

Module 4:
Music & Math

Art in Mathematics (AiM)

MUSIC & MATH

TIME FRAME: 12 days

ENDURING UNDERSTANDINGS:

Music can be modeled and refined/changed with mathematics.

ESSENTIAL QUESTIONS:

1. How do translations affect the sound or melody of a tune?
2. How can sine functions help us analyze sound or tones?

TARGET AUDIENCE:

Students needing additional real-life music applications for Algebra II, Precalculus, and Trigonometry topics with a "wow" factor that includes: function notation, translation of functions, application/translation of sine functions.

CRMS:

Functions 8.2b, 8.2c, 8.3a, 8.6d, and 8.6e

AT THE END OF THE CHAPTER STUDENTS WILL KNOW AND BE ABLE TO:

1. Write a tune on Finale Notepad.
2. Use translations to change a melody.
3. Analyze how a particular translation will affect a tune or a function.
4. Use logger pro to tune a musical instrument.

PRE-REQUISITE KNOWLEDGE/SKILLS:

Graphing

PRE-ASSESSMENT ACTIVITY:

None

ACTIVITIES:

Introductory problem, **Twinkle Twinkle**
Tubular Glockenspiel
Making Music with Wine Glasses

POST-ASSESSMENTS:

Project: Write a melody and play it on wind chimes.
Cornell Notes on Transformations of Sine Curves
Portfolio of Work (including above mentioned notes)

LITERACY STRATEGIES:

Group Work
Cornell Notes

RESOURCES:

YouTube Videos at:
http://www.youtube.com/watch?v=VEiEBEadZFI
http://www.youtube.com/watch?v=rJSu12sWPFY

Physics Applet at:
http://www-personal.umich.edu/~yxl/486/ggb/sine_curve_transformations.html

Finale Notepad Software Program at**:**
http://www.finalemusic.com/notepad/

Music files at:
http://www.instruction.greenriver.edu/projecttime/Music/Music_home.htm

DAILY PLAN

Day 1:

- Introductory activity: **Twinkle, Twinkle**.
- **Graphing Calculator Activity** – review how to enter lists of data on calculator, enter Twinkle, Twinkle notes into graphing calculator.
- Concept Map Review (Teachers might hand out Final Project Requirements at this time also).
- Finale Notepad if time.

HW: Work on melody at home if possible, otherwise no homework.

Day 2:

- Introduce function notations with Entry task of: If $y = 2x + 1$, what is y if $x = 3$, what is y if $x = 6$. How does this relate to $f(x) = 2x + 1$ and $f(3)$ and $f(6)$? Students should be familiar with this notation.
- Work with students to complete **Worksheet 1: Functions**. Students use their graphing calculators if they want to help complete the worksheet. Make sure students get a good start on this worksheet.
- Work on melody and Finale Notepad at least 20 minutes (start work on **My Personal Song**).

HW: Continue work on melody. Finish **Worksheet 1**.

Days 3-4:

- Go over Worksheet 1. Have students work in pairs to correct work. Send students to board to answer any questions that might come up about the worksheet. Students enter the tables from worksheet on graphing calculator to compare graphs.
- Students take Cornell Notes on Function Translations.
- 20 minutes on Finale Notepad Day 3
- Hour on Finale Notepad Day 4, Correct homework

HW: Worksheet 2: Transformations of Twinkle, Twinkle

Day 5:

- Input information from worksheets into Finale Notepad ($f(x - 4)$, $f(x) + 2$) Divide class into teams. Assign different transformations to different teams.
- Students finish Individual Tune and write table of notes
- Share out tunes.

HW: Students work on translating their melodies, Start **Worksheet 3, My Personal Song.**

Day 6:

- Watch YouTube Clips at:
  http://www.youtube.com/watch?v=VEiEBEadZFI
  http://www.youtube.com/watch?v=rJSu12sWPFY
- Worksheet 4: Sine Curve Activity (Physics Applet on Sound on computer) at:
  http://www-personal.umich.edu/~yxl/486/ggb/sine_curve_transformations.html
- Students take Cornell Notes on their own about effects of a, b, c, and d on sine waves. Students use Sine Waves Cornell Notes Worksheet.

HW: Continue work on **Worksheet 3: My Personal Song**.

Day 7:

- Worksheet 5, Tuning Forks Activity using LoggerPro

HW: Continue **Worksheet 5**

Days 8-10:

- Groups tune wind chimes, wine glasses, or other objects.
- Activity: **Tubular Glockenspiel**
- Activity: **Making Music with Wine Glasses**
- Each group tunes objects for one note, and then whole class can use tuned instruments to play their Personal Song.

Days 11-12:

- Groups play one of melodies on wind chimes or other class instruments.
- Project: Personal Tune and Translations.
- Students Turn in Portfolio, Music Unit: **Final Project/Portfolio**.