******

[**WABS ACCESS STEM PBL Unit/Lesson Plan Template**](https://docs.google.com/document/u/1/d/1lzkUygoxlsEvaoczfdcXTIwzbba2y2ON/edit)

**UNIT OVERVIEW**

| **Title of PBL Unit: Duwamish River Project/Stormwater Treatment at KCIA**  **Target Grade Level(s): 10**  **Subject(s): Math (geometry) as well as Computer Aided Design (CAD) as it is taught in conjunction with geometry**  **Author(s): Michael Gudor** |
| --- |

| **Problem Statement: How can King County International Airport effectively steward stormwater runoff?** |
| --- |

| **Unit Overview and Table of Contents:**  **This unit is part of a multidisciplinary project working with KCIA in adapting their stormwater management system for severe rain events.**  **At our school, in geometry, we have embedded (or taught in conjunction) CAD. So every student taking geometry will also learn basic CAD (program is Autodesk Inventor). These two classes (geometry and CAD) are being taught during one period of a standard 6 period schedule (not geometry for one class and CAD for another). For many reasons, including time constraints, in order to teach CAD I try to have students utilize it as performance assessments for geometry.**  **Major topics covered prior to this unit:**   * **Geometry - Some of the fundamental laws that govern relationships between lines, angles, and two-dimensional shapes**   + **Basic geometry review**   + **Parallel lines & transversals**   + **Rigid transformations** * **CAD - basic introductory**   + **Students have learned how to make basic ‘parts.’ They have learned how to draw 2D ‘sketches,’ extrude those sketches to make 3D shapes. Then create more sketches on the different planes (of their 3D shapes) - followed by extruding those sketches to either cut away from or add onto their part. This took roughly 7-10 lessons (50 minute classes). Students would have had no experience with CAD prior to these 7-10 lessons.**   **Project requirements:**   * **Students will be required, as part of their solution, to include 3D CAD drawings for a model of their proposed system/solution as well as 2D site plans (top-down view of proposed solution).**   + **This lesson is the bulk (~75%) of the total CAD work to be done IN ORDER TO PREPARE them to have success on the project requirements**   **Unit lessons - this is part of what will be used to get them ready to tackle the project requirements above. These lessons took roughly 2 weeks of class time (8 - 10 days - 50 minutes classes)**   * **Working directly with the chemistry teacher (who all my geometry students have for science), we created a filtration lab, which included components for:**   + **Physical property filtration (gravity)...utilizing the filtered liquid..**     - **Chemical reaction to separate iron from liquid…followed by…**       * **Physically filter this liquid to separate iron from liquid** * **Geometry students were tasked with creating a container to utilize in their lab. Upon completion, I then 3D printed them so they had them to use during their lab. This will give them experience that will serve them for their project requirements. The lessons helped them create an example container to match mine, and then use that process/etc. to make their own unique container. Their unique containers had many constraints student design’s needed to satisfy** |
| --- |

| **Standards:**  **CCSS.MATH.CONTENT.HSG.CO.A.1**  **Know precise definitions of angle, circle, perpendicular line, parallel line, and line segment, based on the undefined notions of point, line, distance along a line, and distance around a circular arc.**  **CCSS.MATH.CONTENT.HSG.CO.B.7**  **Use the definition of congruence in terms of rigid motions to show that two triangles are congruent if and only if corresponding pairs of sides and corresponding pairs of angles are congruent.**  **CCSS.MATH.CONTENT.HSG.CO.C.9**  **Prove theorems about lines and angles. Theorems include: vertical angles are congruent; when a transversal crosses parallel lines, alternate interior angles are congruent and corresponding angles are congruent; points on a perpendicular bisector of a line segment are exactly those equidistant from the segment's endpoints.**  **CCSS.MATH.CONTENT.HSG.CO.C.11**  **Prove theorems about parallelograms. Theorems include: opposite sides are congruent, opposite angles are congruent, the diagonals of a parallelogram bisect each other, and conversely, rectangles are parallelograms with congruent diagonals.**  **CCSS.MATH.CONTENT.HSG.GMD.A.3**  **Use volume formulas for cylinders, pyramids, cones, and spheres to solve problems.**  **CCSS.MATH.CONTENT.HSG.GMD.B.4**  **Identify the shapes of two-dimensional cross-sections of three-dimensional objects, and identify three-dimensional objects generated by rotations of two-dimensional objects.**  **CCSS.MATH.CONTENT.HSG.MG.A.1**  **Use geometric shapes, their measures, and their properties to describe objects (e.g., modeling a tree trunk or a human torso as a cylinder).**  **CCSS.MATH.CONTENT.HSG.MG.A.3**  **Apply geometric methods to solve design problems (e.g., designing an object or structure to satisfy physical constraints or minimize cost; working with typographic grid systems based on ratios).** CCSS.MATH.PRACTICE.MP1 Make sense of problems and persevere in solving them.CCSS.MATH.PRACTICE.MP2 Reason abstractly and quantitatively.CCSS.MATH.PRACTICE.MP3 Construct viable arguments and critique the reasoning of others.CCSS.MATH.PRACTICE.MP4 Model with mathematics.CCSS.MATH.PRACTICE.MP5 Use appropriate tools strategically.CCSS.MATH.PRACTICE.MP6 Attend to precision. |
| --- |

| **21st-Century Skills:**  **These are common between all subjects for this project**  **21st-Century Skills: 1-3**  **Learning & Innovation**  **1- Creativity and Innovation**  **1.A.1**  **Use a wide range of idea creation techniques (brainstorming etc.)**  **1.A.2**  **Creates new and worthwhile ideas using both incremental and radical concepts**  **1.A.3**  **Elaborates, refines, analyzes and evaluates their own ideas in order to improve and maximize creative efforts**  **1.B.1**  **Develop, implement and communicate new ideas to others effectively**  **1.B.2**  **Be open and responsive to new and diverse perspectives; incorporate group input and feedback into the work**  **1.B.3**  **Demonstrate originality and inventiveness in work and understand the real world limits to adopting new ideas**  **1.B.4**  **View failure as an opportunity to learn; understand that creativity and innovation is a long-term, cyclical process of small successes and frequent mistakes**  **1.C.1**  **Act on creative ideas to make a tangible and useful contribution to the field in which the innovation will occur**  **2-Critical Thinking and Problem Solving**  **2.A.1**  **Use various types of reasoning as appropriate to the situation**  **2.B.1**  **Analyze how parts of a whole interact with each other to produce overall outcomes in complex systems**  **2.C.1**  **Effectively analyze and evaluate evidence, arguments, claims and beliefs**  **2.C.2**  **Effectively analyze and evaluate major alternative points of view**  **2.C.3**  **Effectively synthesizes and makes connections between information and arguments**  **2.C.4**  **Effectively interpret information and draw conclusions based on the best analysis**  **2.C.5**  **Reflect critically on learning experiences and processes**  **2.D.1**  **Effectively solve different kinds of non-familiar problems in both conventional and innovative ways**  **2.D.2**  **Effectively identify and ask significant questions that clarify various points of view and lead to better solutions**  **3-Communication and Collaboration**  **3.A.1**  **Articulate thoughts and ideas effectively using oral, written and nonverbal communication skills in a variety of forms and contexts**  **3.A.2**  **Listen effectively to decipher meaning, including knowledge, values, attitudes and intentions**  **3.A.3**  **Use communication for a range of purposes (e.g. to inform, instruct, motivate and persuade)**  **3.A.4**  **Utilize multiple media and technologies, and know how to judge their effectiveness as well as assess their impact**  **3.A.5**  **Communicate effectively in diverse environments (including multi-lingual)**  **3.B.1**  **Demonstrate ability to work effectively and respectfully with diverse teams**  **3.B.2**  **Exercise flexibility and willingness to be helpful in making necessary compromises to accomplish a common goal**  **3.B.3**  **Assume shared responsibility for collaborative work, and value the individual contributions made by each team member** |
| --- |

| **Locally and/or Personally Relevant for Students:**  **For this unit: Students want to be able to design and produce their ideas - CAD allows them one tool to do that.**  **For the project: The Duwamish River is Seattle’s only river. Most students live in or near Seattle. The school site is actually on the Duwamish, directly between KCIA and the river.** |
| --- |

| **Connections to Career and Educational Pathways:**  **For this unit: CAD is a widely used tool for nearly all forms of engineering. With the increase in and availability of computers/programs, many more fields are utilizing it to help in design.**  **For the project: In our work with KCIA, students will have the opportunity to speak with professionals, particularly a variety of engineering professionals as well as have the opportunity to propose ways to address an authentic issue, creating a process to treat and manage stormwater overflow. Additionally, students will receive and interpret the problem using a RFP document almost identical to the document the county uses when seeking contracts.** |
| --- |

**LESSON OVERVIEW**

**This section should be repeated for each individual lesson that makes up the unit.**

| **Lesson Number and Title: #1 - Using CAD to create a container for a lab in chemistry** |
| --- |

| **Problem Statement: How do we design useful things based on constraints?** |
| --- |

| **Lesson Objectives: Design a container with specific constraints, how to export files for 3D printing, How to design things for more successful 3D prints** |
| --- |

| **Lesson Standards: See standards above** |
| --- |

| **Materials: individual computer for each student, CAD software, 3D printer (for production only)** |
| --- |

**LESSON PREPARATION**

| **Time Required: 8 - 10 50 minute period** |
| --- |

| **Grouping of Students for Instruction: Individually with computer/program** |
| --- |

| **What is the instruction? (Consider the PBL procedure that is being addressed here): students learn how to design with CAD with respect to constraints and purpose** |
| --- |

| **Possible Accommodations: NA** |
| --- |

| **Possible Extensions: students can use CAD to design things of their own desire** |
| --- |

| **Possible Assessment: students make a unique container at the end** |
| --- |

| **References and Resources:**  **Because these lessons were much more individually paced for each student, there isn’t a ‘set’ lesson for each day. I will include the lesson flow for the entire 7 - 10 days it took my students. Also, there is very little taught synchronously - it is much more self-paced by students so it is intended to be ‘asynchronous.’ Therefore, I am not putting it in a table of teacher vs student actions. The teacher is constantly walking the room and helping students in their individual places. Each of the embedded pictures below is actually a link to a video (youtube).**   * **Flow of lessons (instructions to students)...over the 7-10 lessons...teacher helps individual students:**   + **Watch the first video and create a container as I have**   + **Watch the 2nd video and create a top for the container and then make a hole in your container**     - **I did some extra things like an assembly you do not need to do (but you can if you are ready, like CAD 2 students should be). This is something we all want to be able to do by the end of the year, but CAD 1 students should NOT feel like this is something they should be able to do already.**   + **Now that you have created (or re-created) the container I made in the last lesson (did you turn that assignment in???), it is now time for you to create your own. Please watch this quick video for some guidance.**     - **Your container needs to:**       * **Be unique - you may work with someone else for help, but you need to create different containers (it doesn't help you to use someone else's work)**       * **Have a hole (diameter = .688 inches) to accept the barbed fitting**       * **Have a window opening**       * **Have a volume of approximately 1.25 liter (~75 cubic inches)**     - **Unique Container #1**     - **Unique Container #2 (Window opening)**     - **Unique Container #3 (getting your container ready for 3D printing #1)**     - **Unique Container #3 (getting your container ready for 3D printing #2)**     - **Optional video - this an a different way to create your container...it can make things really fast and easy:**     - **How to calculate volume**     - **Correct file type for 3D printing** |
| --- |