**AP CSP CodeX**

| **MISSION 14 Line Art** | | | | **Time: 2 class periods** | |
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| **Project Goal:** In this project students will use computer graphics to create beautiful string art.  **Learning Targets**   * I can use pixels to draw a line on my LCD screen. * I can use the bitmap function to get display width and height. * I can explain how to convert a number from a float to an integer. * I can use a loop to create a pixel grid on the LCD. * I can draw an envelope (webbing) using the **display.draw\_line()** function. | | | **Key Concepts**   * Display is a bitmap, and every bitmap has a width and height. * Using built-in line drawing functions are faster, simpler and support drawing diagonal lines. * One way to optimize code is to replace many lines of code that draw lines with a function instead. * Creating string art is easy by using an envelope, a loop and a constant. * Defining a custom function with line points that spin counterclockwise makes a web pattern. | | |
| **Assessment Opportunities**   * Mission 14 Assignment * Line\_Art program | | | **Success Criteria**   * Draw an x- and y- axis on the display screen * Draw a white grid of dots on the display screen * Draw a blue square as a border around the screen * Use built-in screen information for drawing lines (display.width and display.height) * Create a function for drawing a web * Call the web function at least 6 time | | |
| **AP CSP Framework**  **AAP-2.K** Write iteration statements.  **AAP-3.C** Develop procedural abstractions to manage complexity in a program by writing procedures.  **Computational Thinking Practice 1.B** Determine and design an appropriate method or approach to achieve the purpose. | | | **Materials**   * Mission 14 Assignment / Answers * [Mission 14 Obj. 1-5 Kahoot Review](https://create.kahoot.it/share/firia-labs-mission-14-obj-1-5/d03517f5-7bef-4be0-a945-2bfedac5cfd8) * [Mission 14 Obj. 6-9 Kahoot Review](https://create.kahoot.it/share/firia-labs-mission-14-obj-6-9-review/dc78e7f2-af3e-4761-b2b2-d24d8687eb67) * Solution code for three objectives, the final and some of the challenges | | |
| **Teacher Notes**   * This can be a one or two day assignment. Your students can probably finish the mission as-is in one day. However, if you want to take two days, you will have time for discussion. Also, students can add functionality to the program, like a remix, with the challenges. This will give them an opportunity to practice some of the programming concepts learned earlier to a new project. * The math for the envelopes can look complicated. Students don’t need to understand it. The main idea here is selecting a beginning and ending position for each line point. Experimentation is fine. The finished picture doesn’t have to look like anything in particular. * The assignment is best completed digitally. Prepare the assignment for distributing through your LMS. * Encourage the students to do as much code on their own as they can, and use the CodeTrek to check their work, or as a hint when needed. * The assignment adds an extra step to complete after Objective 9, and a challenge. * Another suggestion for assessment is for students to keep a daily journal, or use a reflection form for students to process information they learned and reflect on questions they may still have. * Refer to the Python with CodeX Curriculum Guide or Mission 14 Lesson Prep (found in the l[earning portal](https://learn.firialabs.com/curricula/python-with-codex/teachers-resources/codex-teacher-materials)) for more information. * The teaching guide (below) gives the narration for one way to present the lesson.   NOTE: If students are interested in creating their own bitmap images (like pixel art), you can find the lesson “CodeX and ASCII Art” in the “Working with Graphics” tab in the learning portal. | | | | | |

**Teaching Guide**

The actual coding part of this Mission can be accomplished in one class period. The recommendation is to use two days to complete the mission and have discussions and do the challenges.

**Warm-up (5 minutes)**

🧑‍🤝‍🧑 **Discuss** – Use a discussion strategy, like journaling, working at boards, selecting random students, or a form of think-pair-share.

* **Topic:** In previous missions and lessons, you learned to draw using lines, circles and rectangles. How do you thin you can use them in loops to create art?

**Activity – Objectives 1-5 (30 minutes)**

💻 Randomly group students into pairs for pair programming (or they can work individually).

For pair programming, students log in to one computer. Two computers can be used if they want to have the assignment open on one computer and CodeSpace on the other computer.

Students go to [make.firialabs.com](http://make.firialabs.com) and should be at the beginning of Mission 14.

💡 **Teaching tip – Objective 1:**

This objective introduces setting a single pixel on the screen. It reviews Bitmaps and the 240x240 screen. Then students will learn about getting information from the screen using a “get” command. You may want to practice or review “set” and “get”. The objective uses the Console to observe the results of a print().

❓ **Teaching tip – Quiz**:

Objective 1 sets them up for the quiz. Students should follow the instructions in their assignment so they are prepared.

💡 **Teaching tip – Objective 2:**

Students replace their code with a for loop. They will delete all prior code except the import statement. The number for the range is not given. They need to remember the width of the screen is 240 pixels, which will be the range.

💡 **Teaching tip – Objective 3:**

Students will add another loop to draw a vertical line. They must use variables for the range, not a literal value.

🗝️ **NOTE:** Students will answer the question “what can you do to avoid magic numbers?” The answer can be straight from the textbook – get the display width and height straight from the source, or they can be more general and say something like using variables and constants to represent the numbers. The goal in the objective says to eliminate magic numbers by using the functions rather than literal numbers. You can remind students that a literal number IS a magic number.

🗝️ **NOTE:** Running the code WILL cause an ERROR. Students may realize it is because of the type of division.

💡 **Teaching tip – Objective 4:**

Students fix a bug by converting the division into integers. Using the integer division method will work nicely, but the validator will check that the int() function is used.

💡 **Teaching tip – Objective 5:**

Students will use nested for loops to create a grid. They will use the “step” parameter in the for loop. During the objective, have students experiment with the step parameter so they can make a mental model of what it is doing before going to the nested for loops.

Solution code for this objective is provided.

❓ **Teaching tip – Quiz**:

The quiz gives a code segment and asks questions about it. You may want to type it in and run the code on a screen for the class, or have them try the code on their computers, to see what it does. You could do this either before or after they answer the questions.

**Activity – Objectives 6-9 and challenges (30 minutes)**

💻 Continue either in pairs or individually. Students go to [make.firialabs.com](http://make.firialabs.com) and should be on Objective 6 of Mission 14.

💡 **Teaching tip – Objective 6:**

This objective introduces display.draw\_line() and reviews display.draw\_rect(). It should be review for most of your students. Go over any of this material as needed.

🗝️ **NOTE:** Students are asked to do a “Save As” and give the file a new name. This will keep the original file and start a new file with code already there. They will delete some code from the new file before adding more. If they don’t do the “Save As”, it is okay. They just won’t keep their original code.

💡 **Teaching tip – Objective 7:**

A lot of information here about creating string art with envelopes. A link to wikipedia is included. This is really advanced math!! Don’t worry about the math. Students can understand the concept without knowing the details. You can even skip the part about the envelope if you think it will be frustrating, and just use the term.

Solution code for this objective is provided.

💡 **Teaching tip – Objective 8:**

This objective helps students understand the math by using their fingers to “trace” the lines and see the movement. You might want to try this yourself first and demonstrate for the students. They can use their own CodeX, or you can print the webbing on paper and have them “trace” on the paper.

This objective shows students how to use a for loop to draw the lines to create the web. After they create the for loop, run the program. Then they will need to change the value of WEB\_SPACING and run again to meet all the goals. The CodeTrek uses literal numbers for 120 and 239. After Objective 9 students are asked to use the variables to replace the magic numbers.

💡 **Teaching tip – Objective 9:**

This is a fairly long objective. It starts with adding another for loop to the code. Then students learn about creating a function that will do all the work for them. There is a lot of math! Don’t stress about it. Just teach the math at their level, and they don’t have to understand all of it, just that it changes the values so the lines create a curve.

Then students create the function and replace the for loops with function calls. Four function calls are provided. Students must call the function two more times. They can try to complete the webs that are drawn, but they don’t have to. Any two function calls will meet the goal. The solution provided shows the completed webbings as a possible solution.

Solution code for this objective is provided.

💡 **Teaching tip – After Objective 9:**

Students add functionality to the code by using programming concepts learned in earlier missions. They will create two functions and use variables instead of magic numbers.

Solution code for the final program is provided.

💡 **Teaching tip – Challenge:**

If students have time, have them try at least one challenge. This gives them an opportunity to apply their knowledge in a new situation. This is like a remix of the mission, without starting from scratch. Several ideas are given, but students can use their own creativity to add to the project.

Solution code for some of the challenges is provided.

✅ Assignment is complete and ready to turn in.

**Wrap-Up (5 minutes – optional)**

The post-mission reflection asks students to think about using their creativity and working through frustration. You can change the questions if there is something else you want to emphasize with your students.

* You have learned a lot about pixel art! How did you use your creativity to complete the program?
* This program can be frustrating. How did you manage your frustrations and work through problems?

Students complete the wrap-up questions on the assignment. You can have a short discussion on their answers.

You can use a formative assessment for the wrap-up.

✅ **IMPORTANT!!**

* Remind students to clear their CodeX.

Formative Assessment:

* Daily reflection journal
* [Mission 14 Obj. 1-5 Kahoot Review](https://create.kahoot.it/share/firia-labs-mission-14-obj-1-5/d03517f5-7bef-4be0-a945-2bfedac5cfd8)
* [Mission 14 Obj. 6-9 Kahoot Review](https://create.kahoot.it/share/firia-labs-mission-14-obj-6-9-review/dc78e7f2-af3e-4761-b2b2-d24d8687eb67) (in class or individual)
* Exit ticket on display functions
* Exit ticket on for loops and the step parameter