Instructor's Guide

CITY X PROJECT

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Welcome

In a world dominated by exponential change, the next generation must be equipped with the tools to adapt, empathize, collaborate, and innovate. The City X Project workshop meets this need by helping youth learn the value of empathy, creative thinking, and problem solving, in the context of a society whose citizens face real-world challenges. The workshop will help you bring the "changemaker mindset" to your students, using the same process and tools as some of the world's foremost thinkers and inventors.

Thank you for choosing to take part in the City X Project. Let the inventing begin!

– IDEAco, The Coalition for Innovative Development, Education and Action

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Website: *www.cityxproject.com*
Twitter: *www.twitter.com/cityxproject*
Facebook: *www.facebook.com/cityxproject.*

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Workshop Overview

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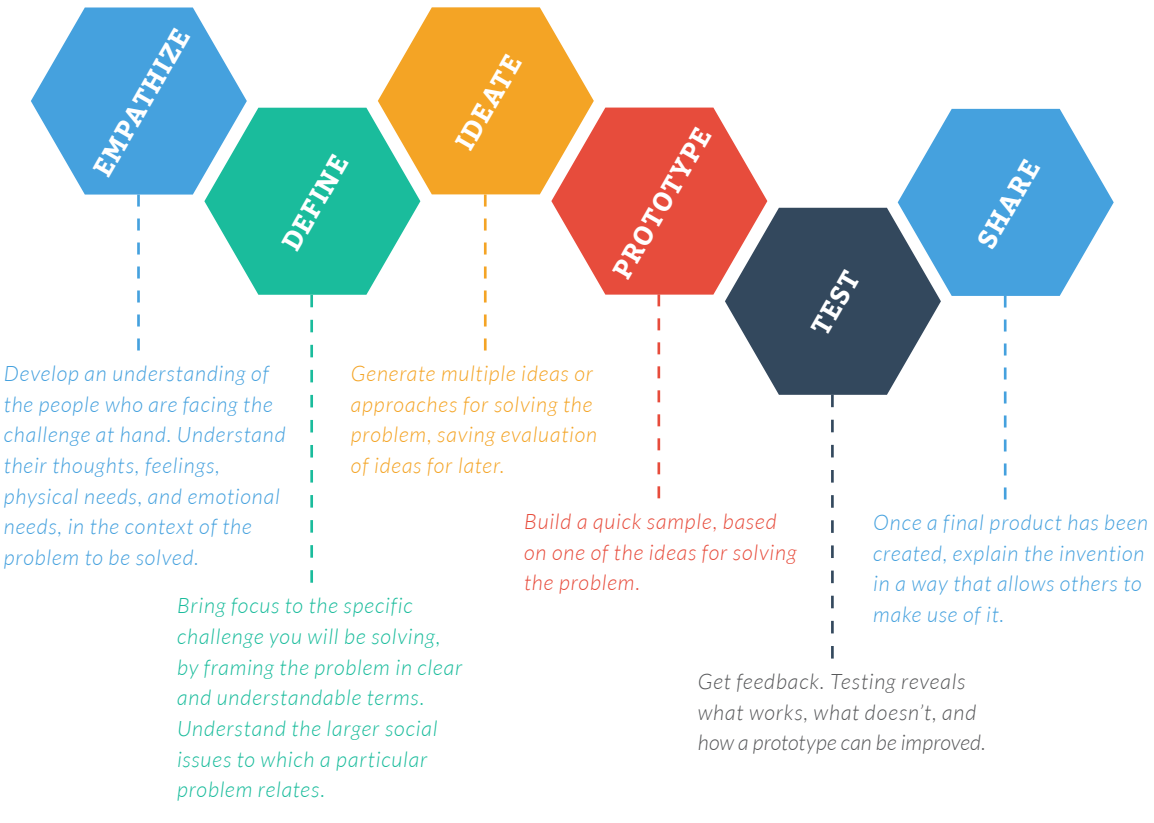
Workshop Overview

The City X Project is an international education workshop designed for students between the ages of 8 and 12. The workshop teaches creative problem solving using The Design Process and 3D technologies.

Instructional Model

The instructional model for the City X workshop is called The Design Process. This six-step method is an adaptation of the "Design Thinking" process used by the Stanford d.school. The process teaches students to understand a challenge and the people it affects, generate possible solutions, and develop a final product that not only solves the problem at hand, but can be shared with the world.

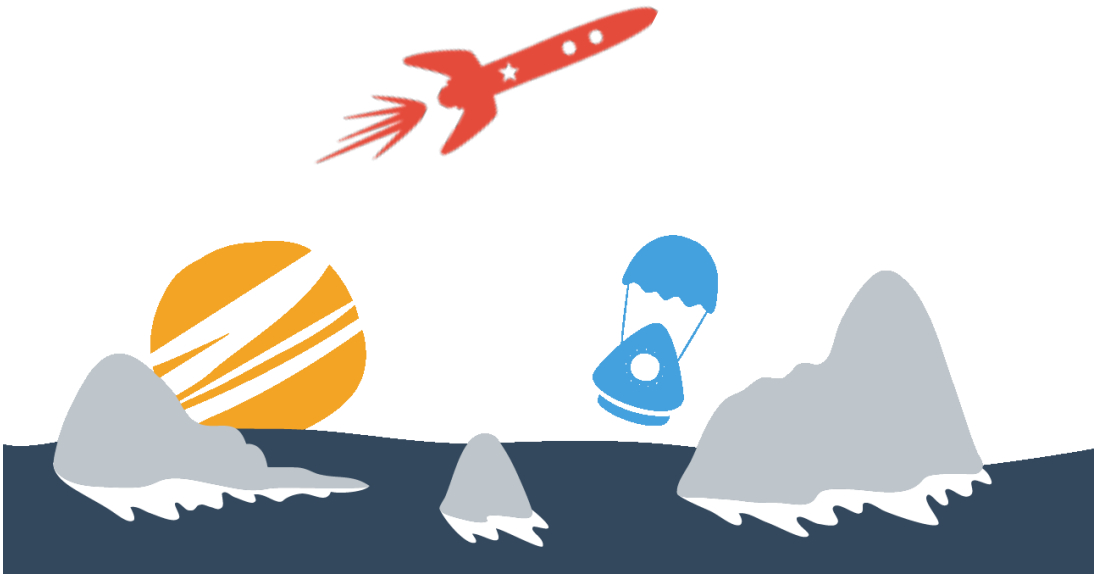


The City X Story — Introduction

To ensure a fun and engaging experience for your students, we have developed a story to give context to the workshop.

Humans have just landed on an alien planet, and they've staked out an area for their first city, City X. But building a new city is difficult work, and they're beginning to identify some challenges relating to health, safety, communication, transportation, and more—problems that they need help to solve.

Now the Citizens of City X are sending transmissions back to Earth, describing the challenges they're facing. It's up to the young designers and innovators of Earth to invent solutions to these problems and help create a thriving City X.



Structure

Ideally, the City X workshop should be divided into three two-hour sessions on three separate days. Modifications can be made depending on your particular needs and circumstances.

Day One — Empathize, Define, and Ideate

Students are introduced to the challenges in City X. Each student is assigned a Citizen with a problem to solve. The students will take part in brainstorming to begin to develop ideas of how to solve the problem.

Day Two — Prototyping and Testing

Using basic tools like clay, paper, and markers, your student designers will create prototypes of their inventions. They will present their ideas to testing groups of peers and instructors for feedback. The students will improve their inventions based on the feedback they receive.

Day Three — Share

Students will use simple 3D modeling software to create 3D models of their inventions. The inventions can then be printed using a 3D printer in the classroom, and can be instantly shared with anyone in the world (and beyond).

If you do not have access to a 3D printer, the workshop can be adapted to function without it. Students will still learn the basics of 3D modeling and its uses, but will not be able to print physical examples of their completed inventions.

What Students Will Learn

Throughout the workshop, your students will learn literacy, problem solving, creativity, critical thinking, 3D technology and STEM (science, technology, engineering, and math) skill sets. The City X workshop aligns with Common Core State Standards for Math and Literacy for grades 4–6 (see Appendix 4, “Common Core State Standards Alignment” on page 55).

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Preparing *for the* Workshop

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Preparing *for the* Workshop

In order to be as well equipped to lead the workshop as possible, please read this Instructor's Guide thoroughly in advance. If you have any questions, please feel free to contact us.

Email: *info@cityxproject.com*

Twitter: *@cityxproject*

Required Materials

In order to lead the City X workshop you will need the following components:

- ☐ City X Project Toolkit, which includes:
  - ☐ Instructor's Guide
  - ☐ Designer Workbook for **each student**
  - ☐ Deck of 40 Citizen Cards
  - ☐ City X presentation and videos (available online at *www.cityxproject.com/resources*)
    - ☐ City X Presentation
    - ☐ Video A: "3D Printer"
    - ☐ Video B: "3D Printing in Space"
    - ☐ Video C: "Intro from the Mayor"
    - ☐ Video D: "Robohand"
    - ☐ Video E: "Thanks from the Mayor"
- ☐ A computer or iPad for **each student** (for 3D modeling, see requirements below)
- ☐ Internet access for **all computers and iPads**
- ☐ Half stick of clay or play dough for **each student**
- ☐ Pens and markers

Recommended Materials

We also recommend using the following materials:

- ☐ 3D printer
- ☐ Projector and speakers to play City X presentation and videos (or a television if a projector is not available)
- ☐ 10–20 sticky notes for **each student**
- ☐ A timer with an alarm for keeping track of individual activities
- ☐ 3D printing samples
- ☐ 3D printed "City X Medallions" for **each student** (printable 3D model is available online at *www.cityxproject.com/resources*)
- ☐ Wireless internet access

Workshop Support

Technology

The City X Project workshop relies on computers or iPads with 3D modeling software to fully teach the Design Process. Please be sure to review the ***3D Modeling Guide*** (Appendix 1, page 45), for software recommendations and system requirements. You may want to share the system requirements with an IT professional who can ensure that you will be equipped to complete the workshop.

Take some time to get comfortable with the 3D modeling software and test its functionality on each computer or iPad you will be using for the workshop. Detailed setup instructions and links to learning resources can be found in the ***3D Modeling Guide***.

If you will be using a 3D printer, take some time to become familiar with it and test its functionality. Try several test prints to ensure that the printer is working properly. This will also help you gauge how much time you will need to produce a 3D print during the workshop.

Because 3D printing can take quite a long time to complete, it's likely you will only be able to print 1–3 models during the third day of the workshop. If time allows, you may want to print everyone's models over several weeks after the conclusion of the project. However, it will be important to let your students know from the beginning that not everyone's model may be able to be printed during the workshop.

If you do not have access to a 3D printer but would like to use one in your workshop, consider reaching out to a local makerspace, library, or university for assistance. These organizations have increasing access to 3D printers. Specifically, try searching for a nearby "makerspace," "hackerspace," or "fablab." You can share a link to the City X Project Video (available on our homepage at *www.cityxproject.com*) to explain the project to potential collaborators.

Volunteers

It can be very helpful to recruit some adult volunteers to assist with the workshop. Depending on the size of your class, 2–3 volunteers can be a valuable asset—especially for Days Two and Three.

Leading *the* Workshop

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Leading *the* Workshop

The City X Story

The story of City X is one of adventure, possibility, and invention. In the not-so-distant future, Earth has sent a group of travelers to create a colony on a distant planet. Upon their arrival these Citizens began to build their inaugural city, City X. But as time has gone on, they've started to identify common challenges—social problems that affect all of the Citizens, and stand in the way of building a thriving city.

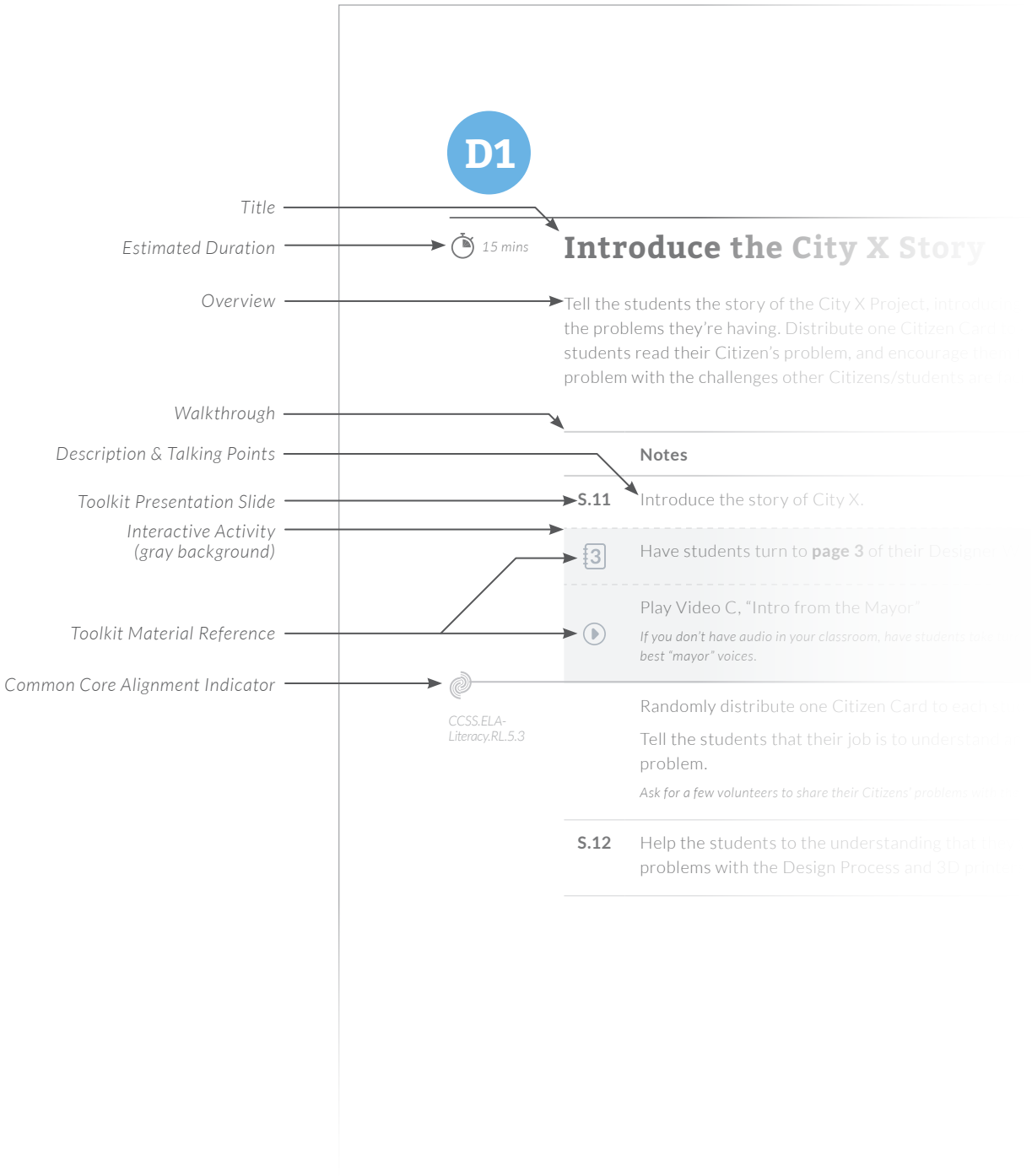
To help them solve these problems, they are enlisting the help of Earth's young inventors. Forty Citizens of City X have sent home transmissions detailing the problems they are facing in their new city. Their problems relate to health, safety, communication, transportation, and more. It's up to your students to help solve these problems, by learning about the Citizens, getting to know their challenges, brainstorming solutions, and ultimately designing inventions that the Citizens of City X can build using the 3D printers they've brought with them.

Step-by-Step Walkthrough

What follows is a detailed walkthrough of the City X Project workshop. Each portion of the workshop is divided into distinct topics, and is presented with an anticipated duration, overview and objective, as well as detailed guidance for each component. The labeled diagram on the opposite page is a prototypical example of the step-by-step walkthrough pages.

This walkthrough will be a valuable resource both during your preparation and especially when leading the workshop. As you prepare, take some time to read it thoroughly and become acquainted with the content. When leading the workshop, open to this walkthrough and use it as your step-by-step guide.

Throughout the City X workshop, continue to ask questions to lead your students to the correct answers and understanding of each concept (for instance, when explaining the steps of the Design Process, always start by asking students what they think the word means). This workshop is intended to be hands-on, interactive learning—keep it fun by keeping the students active.


D1
Title
Estimated Duration
15 mins
Introduce the City X Story
Overview
Tell the students the story of the City X Project, introduce
the problems they're having. Distribute one Citizen Card
students read their Citizen's problem, and encourage the
problem with the challenges other Citizens/students are
Walkthrough
Description & Talking Points
Notes
Toolkit Presentation Slide
S.11
Introduce the story of City X.
Interactive Activity
(gray background)
Have students turn to page 3 of their Design
Play Video C, "Intro from the Mayor"
If you don't have audio in your classroom, have students
best "mayor" voices.
Toolkit Material Reference
Common Core Alignment Indicator
CCSS.ELA-
Literacy.RL.5.3
Randomly distribute one Citizen Card to each
Tell the students that their job is to understand
problem.
Ask for a few volunteers to share their Citizens' problems
S.12
Help the students to the understanding that
problems with the Design Process and 3D

D1

30 mins

Introducing the City X Workshop

Distribute student workbooks. Ask the students to write their names on the cover, but have them keep their workbooks closed. Launch the City X Project presentation, available at *www.cityxproject.com/resources* or use the PDF presentation included in your toolkit download package.

You will begin by introducing the students to the basics of the City X Project. Then introduce the Design Process (briefly explaining the terms if necessary—your students will learn these concepts more clearly through the exercises associated with each step) and the concept of 3D printing.

Try not to give away too many details in advance. Introduce each aspect in turn, building the excitement as you go.

If you are using a 3D printer, get a sample print started about 10–30 minutes before beginning the workshop.

	Notes
S.1	Explain that over the next three days, your students will become designers and inventors in a project that has been completed by students all over the world. You can refer to the map at *www.cityxproject.com* to see where the City X Project has gone. Get your students excited about joining others around the world as they invent solutions to the problems of City X. Ask, "Who are some inventors, and what did they invent?"
S.2	One invention everyone knows is the telephone. Describe the evolution of the phone from its invention by Alexander Graham Bell until today, when a single smartphone is more powerful than all of the computers NASA needed to land people on the moon. Come back to this example throughout the workshop to illustrate the importance of each stage of the Design Process.
2	Have students turn to **page 2** in their workbooks.
S.3	Give a brief overview of the Design Process. *See page 9 of this guide for reference.* Explain it as a process inventors use to turn ideas into real life inventions.

	Notes
	Have your students write a sentence or two in the space provided, describing what the Design Process is and what people use it for.
S.4	Transition into an introduction to 3D printing. Now that your students have a process for inventing (Design Process), next they need a tool. Ask if they have heard of 3D printing.
	If using a 3D printer, have your students gather around it so they can see how it prints.
	If you don't have a 3D printer in the classroom, play Video A, "3D Printer"
	Ask your students if they can guess how the 3D printer works. After they have given any guesses, give a full definition: • A coil of plastic called a "filament" feeds into the printer. • The printer heats up the filament and lays down one layer at a time, slowly building an object from the bottom to the top. Engage the students to keep up the excitement. Encourage questions as you introduce the innovative nature of 3D printing technology. *A list of commonly asked questions and corresponding answers is available in Appendix 2, page 43*
	If you have any sample 3D prints, pass them around the room.
S.5	Explain "non-manufacturable objects" using the knot as an example. There is no way to create an object like this with traditional manufacturing. 3D printing opens up possibilities for complicated design and engineering that was never before possible. Ask your students to come up with ideas of the kinds of objects a 3D printer could make. Encourage them to think big.

D1

Introducing the City X Workshop, *continued*

	Notes
S.6-9	Advance through the examples of amazing 3D printed objects. If you have other or better examples you'd like to share with your students, share them along with (or instead of) the following examples. • 3D printed house expected to be built in the Netherlands • 3D printed model car used for action scenes in the James Bond ***Skyfall*** movie to avoid damaging the priceless real car • 3D printed ear made with real cartilage cells; the ear has a radio frequency antenna implanted that would allow it to hear things a human ear cannot. It can't yet transmit a signal to the brain or be connected to a person, but it's part of a growing field of medical research for 3D printing. • 3D pizza printer schematic being developed by NASA to provide customized nutrients for astronauts in space
S.10	Play Video B, "3D Printing in Space"
	Ask the students again what kinds of things they think 3D printers can make. Guide them to the answer, "Anything." Use the idea of 3D printing in space to transition into the City X story..

D1

Introduce the City X Story

15 mins

Tell the students the story of the City X Project, introducing the setting, characters, and the problems they're having. Distribute one Citizen Card to each student. Have your students read their Citizen's problem, and encourage them to share and compare the problem with the challenges other Citizens/students are facing.

	Notes
S.11	Introduce the story of City X.
	Have students turn to **page 3** of their Designer Workbook.
	Play Video C, "Intro from the Mayor" *If you don't have audio in your classroom, have students take turns reading the transmission in their best "mayor" voices.*
	Randomly distribute one Citizen Card to each student. Tell the students that their job is to understand and solve their Citizen's problem. Ask a few students to share their Citizen's problems with the class.
S.12	Help the students understand that they will be solving these problems with the Design Process and 3D printers.

CCSS.ELA-Literacy.RL.5.3

D1

15 mins

The Design Process: *Empathize*

Introduce your students to the concept of empathy. In their workbooks, have them circle the feeling words that relate to their Citizen's problem. Help them make the connection between understanding how a person feels about their problem and designing an effective solution.

	Notes
2	Have students turn to **page 2** in their workbooks.
S.13	Introduce the first step of the Design Process, "Empathize." Talk about the definition of "empathy."
2	On **page 2** of their workbooks, have the students write the definition of the "Empathize" step of the Design Process in their own words.
	Explain how, in order to make a great invention, you have to start by understanding the person you're trying to help.

CCSS.ELA-Literacy.RL.5.3

4	On **page 4** in their workbooks, have the students circle the feelings they believe their Citizens are experiencing. *Try to use real world examples to help the students think of types of feelings.*

D1

The Design Process: *Define*

15 mins

Introduce the concept of defining a problem. Help your students develop an understanding of the larger community-wide issues to which their Citizen's particular problem relates.

	Notes
2	Have students turn to **page 2** in their workbooks.
S.14	Explain the second step of the Design Process, "Define." Explain the difference between personal problems and social problems: • Personal problems affect one person. • Social problems affect a group of people or community. *Use examples to help students understand personal vs. social problems (e.g., "I'm hungry." = personal problem; "How do we find food for our city?" = social problem)*
2	On **page 2** of their workbooks, have the students write the definition of the "Define" step of the Design Process in their own words.
	Review the eight types of social problems in the Designer Workbook and have students give examples for each.
4	On **page 4** of their workbooks, have your students circle the social problems to which their Citizen's personal problem best relates.

CCSS.ELA-Literacy.CCRA.W.7

D1

45 mins

The Design Process: *Ideate*

Introduce the concept of ideation. Have your students brainstorm individually or break them into brainstorming groups of 3–5. Get them started listing or sketching some of their ideas in their workbooks or have them sketch their ideas on sticky notes (one idea per sticky note).

Tell your students the City X brainstorming guidelines:

- Don't judge. (no idea is a bad idea in brainstorming)
- Go for quantity. (come up with as many ideas as you can)
- Build on the ideas of others.
- Encourage wild ideas. (sometimes the craziest ideas are the best)

Encourage originality by following these three additional guidelines:

- No ideas from adults.
- No robots.
- No inventions that already exist. (even if they only exist in a movie or TV show)

At the end of the day, review what you've covered so far. Encourage your students to keep thinking about their Citizen's problem and which of their invention ideas they like the best.

	Notes
2	Have students turn to **page 2** in their workbooks.
S.15	Explain the third step of the Design Process, "Ideate." • Talk about the root word, "idea." • Use other terms the students may have heard of, like "brainstorming," to help them understand the concept.
2	On **page 2** of their workbooks, have the students write the definition of the "Ideate" step of the Design Process in their own words.

Notes

Have your students turn to **page 5** in their workbooks.

Tell your students the City X brainstorming guidelines:

- Don't judge. (no idea is a bad idea in brainstorming)
- Go for quantity. (come up with as many ideas as you can)
- Build on the ideas of others.
- Encourage wild ideas. (sometimes the craziest ideas are the best)

Tell your students the additional City X guidelines:

- No ideas from adults.
- No robots.
- No inventions that already exist. (even if they only exist in a movie or TV show)

CCSS.Math. Practice.MP1

Have them spend the rest of the first day listing or sketching their ideas in their workbooks or on sticky notes.

Remind the students that their ideas need to be inventions that can be made by the Citizens of City X with their 3D printers.

Encourage students to talk to each other and help each other come up with lots of ideas.

At the end of the day, review the three steps of the Design Process covered so far. Have students explain the definitions of each step and why each is important.

END OF DAY 1

D2

15 mins

Review: *Empathize, Define, Ideate*

Begin Day Two by reviewing the Empathize, Define, and Ideate steps of the Design Process. Continue the City X Presentation on **Slide 15**. Have your students open their workbooks to **page 5** and spend about **10 minutes** on additional brainstorming or sketching, if they need it. Sometimes great ideas happen when you step away and come back to a problem.

	Notes
S.16	Review the Empathize, Define, and Ideate steps of the Design Process
5	Have your students open to **page 5** in their workbooks, and allow them **10 minutes** for additional brainstorming or sketching, if they need it.

D2

The Design Process: *Prototype*

20 mins

Introduce the concept of prototyping and why it's important for making good inventions. Have your students choose the invention idea they like the best and circle it in their workbook (or pick out the sticky note with their favorite invention on it). Have your students create a prototype of their favorite invention with modeling clay or play dough.

	Notes
2	Have students turn to **page 2** in their workbooks.
S.17	Explain the fourth step of the Design Process, "Prototype," and why it's important for inventors. • A prototype is a model of one of your ideas. • Prototypes give you the opportunity to test your ideas and improve on them, to make sure you have the best invention possible.
2	On **page 2** of their workbooks, have the students write the definition of the "Prototype" step of the Design Process in their own words.
	Have your students choose which one of their ideas they like best.
	Hand out a half stick of modeling clay or half container of play dough to each student. Give your students **10 minutes** to create the first prototype of their invention—we will refer to this as "version 1.0." *Explain that prototypes aren't meant to be perfect.* *Set a timer for prototyping and ask your students to put their hands in the air when time is up, or have fun with countowns.*
6	Have your students turn to **page 6** in their workbooks. Give your students **2 minutes** to sketch their version 1.0 prototypes in the box labeled "v1.0." *Have your students start to think about what they want to name their invention.*

D2

20 mins

The Design Process: *Test*

Divide your students into pairs. Have them take turns presenting their ideas and giving feedback to each other. Explain to your students the three types of good feedback:

- Good things (things you like about an invention)
- Questions (things you don't understand about an invention)
- Things to change (ideas for making an invention better)

	Notes
	Have students turn to **page 2** in their workbooks.
S.18	Explain the fifth step of the Design Process, "Test," and why it's important. • We want to let the people who will be using our inventions look at them and try them out. • We want them to tell us what they like, what they're confused about, and what they think could make it better.
	On **page 2** of their workbooks, have the students write the definition of the "Test" step of the Design Process in their own words.
	Divide your students into small groups and have them take turns presenting their inventions and giving feedback on each other's prototype. *If you have adult volunteers helping out, have them assist the students in generating feedback.*
	On **page 6** of their workbooks, have each student write down **at least one change** they can make to their prototype based on the feedback they received.

D2

Prototype and Test: *Iterations*

30 mins

Explain the importance of using feedback to improve an invention. Explain why "iterations," or continuing to test and make changes, helps find the best way to solve a Citizen's problem. Have your students take the feedback they noted in the previous step and use it to create version 2.0 of their prototypes. Repeat the testing and modifying steps to arrive at a final version (v3.0) of their invention prototype.

	Notes
S.19	Introduce the concept of "iterations." • Iterations are repeating cycles of prototyping, testing, and making changes to create a new prototype. • Iterations continue until an invention is as helpful as possible for the people who will use it.
	Give your students **5 minutes** to modify their clay/play dough prototypes based on the changes they wrote down during testing.
	Give your students **2 minutes** to sketch their version 2.0 prototypes in the box labeled "v2.0" on **page 6** in their workbooks.
	Divide your students into new small groups and have them take turns presenting their inventions and giving feedback on each other's prototypes.
	On **page 6** of their workbooks, have your students write down **at least one change** they can make based on the feedback they received.
	Give your students **5 minutes** to make their final modifications to their clay/play dough prototypes based on the changes they wrote down during testing.
	Give your students **2 minutes** to sketch the final version of their prototypes in the box labeled "v3.0" on **page 6** in their workbooks. Have your students write the name of their invention and a sentence or two describing how their Citizens will use it.

D2

40 mins

The Design Process: *Share*

Engage the students in an exercise that will illustrate the difficulty of transferring ideas, by having one student describe their invention to another, who will attempt to build it out of modeling clay or play dough without seeing the original.

Explain the idea of sharing their inventions. Introduce the concept of 3D modeling. Have your students produce a blueprint of their inventions using basic three-dimensional shapes.

At the end of the day, review the whole Design Process, especially the Prototype, Test, and Share steps.

	Notes
CCSS.Math. Practice. MP6	Select two volunteers who have not seen each other's prototypes. Ask them to come to the front of the class, leaving their prototypes at their workstations.
	Give one student a half stick of modeling clay or half container of play dough. Allow **3 minutes** for the other student to describe his or her invention, while the student with the clay attempts to create a replica of it. *It can be fun to have the other students gather around and cheer on their classmates. If you can, use a timer and get the whole class involved in a final countdown as time runs out.*
	Ask all the students to compare the first student's original model with the new model from this exercise. Ask the two volunteers to describe how easy or hard it was to explain and understand the invention in this exercise. Ask the students how they think this exercise would go if the two students didn't speak the same language.
	Have students turn to **page 2** in their workbooks.
S.20	Explain the final step of the Design Process, "Share," and why it's important. • Sharing is communicating your invention idea to others. • Sharing is important because we created our inventions for other people to use to solve specific problems.

	Notes
	On **page 2** of their workbooks, have the students write the definition of the "Test" step of the Design Process in their own words.
	Ask your students how they think they could share their inventions with the Citizens of City X on a distant planet. *Use examples to illustrate what* **doesn't work**. *For example, mailing a prototype or emailing pictures won't give enough detail.*
S.21	Introduce 3D modeling. • 3D modeling is a way to share every detail of an invention with anyone. • Anyone with a 3D printer can use a computer-generated 3D model to create an exact copy of your invention. Explain that the students will be using computers and 3D modeling software to create digital versions of their prototypes to share with the Citizens of City X.
	Have your students turn to **page 7** in their workbooks.
	Explain the concept of creating a blueprint using "primitives" (basic shapes like spheres, cubes, or pyramids). Creating blueprints with basic shapes will help your students identify which shapes to use when they begin 3D modeling.
	Give students **10 minutes** to create a blueprint of the front, side, and top views of their invention. *Students can find it frustrating to get into the 3D mindset. If you have adult volunteers, have them help students who are struggling.*
	At the end of the day, review all the steps of the design process. Have students explain the definitions of each step and why it is important.

END OF DAY 2

D3

90 mins

3D Modeling

Review the Design Process, encouraging your students to supply definitions for each step. Review the importance of 3D modeling for sharing their inventions with the Citizens of City X.

Demonstrate the 3D modeling application for your students. Have your students use the 3D modeling application to create 3D models of their inventions.

When your students begin 3D modeling, have them name their files using the following format:

Title of Invention by **Student's First Name** in **Location** #cityx #cityx**citizen**

For example, Meteor-Powered Tooth Puller by Johnny in San Francisco #cityx #cityxadam

Print one of the models (or as many as time allows) using the 3D printer.

	Notes
	Review the Design Process. Ask your students to explain the steps and why they're important. Review why 3D modeling is important for sharing their inventions with the Citizens of City X.

	Log in to the 3D modeling application and demonstrate how it works.
	• Use the teddy bear blueprint on **page 7** of the workbook to demonstrate basic 3D modeling.
	• Explain the primary tools and shapes, how to change the perspective, and how to save their 3D models.
	• Make sure your students know at least five things:
	  o How to save
	  o How to pan their view in all directions
	  o How to add objects
	  o How to delete objects
	  o How to "undo"
	Students usually catch on quickly once they start using the 3D modeling application. Encourage them to help each other if they are having trouble.

Notes

Distribute login information to each student, or write it on the board, if you have one (refer to Appendix 1, page 45 for details).

Have your students log in to the 3D modeling application.

Have your students save their 3D models using the City X Project file-naming convention (***Title of Invention by Student's First Name in Location #cityx #cityxcitizen***)

Give students as much time as they need to create a 3D model of their invention.

CCSS.Math. Practice.MP4

Keep reminding the students to use the "primitives," or basic shapes, to build their 3D models.

Encourage your students to save their projects often.

As students begin to complete their 3D models, choose at least one invention and start it printing on the 3D printer.

When the print is completed, have your students compare the final printed invention to the clay or play dough prototype.

If any students finish early, they can continue modeling using another invention, or you can engage them in one of the Add-On Activities in Appendix 3.

D3

30 mins

Conclusion

Review the Design Process, 3D modeling, and 3D printing. Discuss with your students how they can make a positive impact in their own lives using what they learned in the City X workshop. Conclude with a "thank you" from the Mayor and Citizens of City X.

	Notes
	Have your students close the 3D modeling application and shut down their computers or set aside their iPads. Ask your students to define the six steps of the Design Process and explain why each is important in creating an invention. Ask your students what they learned about 3D modeling and 3D printing, and why they're important.
S.22	Play Video D, "Robohand."
	Have your students point out similarities between the video and what they did in the workshop. Have your students come up with some ideas of how they could use what they've learned to make a positive impact in their own lives and communities.
S.23	Play Video E, "Thanks from the Mayor"
	If you have printed out City X Medallions, present them to your students at the conclusion of the workshop.

END OF DAY 3

Support & Attribution

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Support & Attribution

Support

Presentation and video files are available to view online or download at *www.cityxproject.com/resources*.

CITY X FORUM

The City X Forum, *www.cityxproject.com/forum*, is a great resource for answers to common questions, tips and tricks for 3D modeling, related educational resources, continuing curriculum, and much more.

For other support and questions regarding the City X Project not covered in the forum, please email *info@cityxproject.com* or follow *@cityxproject* on Twitter.

Thanks & Attribution

The City X Project is an initiative of IDEAco, The Coalition for Innovative Development, Education and Action (IDEAco.org). IDEAco is a 501(c)3 nonprofit on a mission to build and empower communities of Changemakers.

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Appendices

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3D Modeling Guide

A1

Refer to this 3D Modeling Guide for details of recommended software, system requirements, instructions for setting up user accounts, and other suggestions for preparation.

A1

Technology

The City X Project workshop relies on student access to 3D modeling software. There are several freely-available 3D modeling applications that are well suited for beginners, including Tinkercad (*www.tinkercad.com*) and 123D Design (*www.123dapp.com/design*).

Recommended 3D Modeling Software

Our recommended software for the City X Project workshop is Tinkercad. This free, online application is the best entry-level 3D modeling tool for children. It's well-designed, fun, and easy to learn. Tinkercad is a browser-only application that requires:

- consistent, fast internet access
- the latest version of Google Chrome or Firefox (WebGL must be enabled).

Alternate 3D Modeling Software

If Tinkercad won't work on your computers, our alternate software recommendation is 123D Design, also available for free online. 123D Design is slightly more advanced than Tinkercad, and the interface is not quite as child-friendly, but students still learn to model with it very quickly.

Visit *www.123dapp.com/design* to learn which of the three free versions of 123D Design will work best for your class:

- a desktop application that can be installed on Mac or PC
- an online version that can be run in-browser
- an iPad app for iPad 2 or later

Whichever method you choose, work with your IT department prior to starting the workshop to ensure that your chosen 3D modeling software will run on each of the devices to be used by the students.

Setup

Both Tinkercad and 123D require user accounts in order to create and save 3D models. **(Important note: both applications have "demo modes" that don't require accounts. If your students use this mode they will not be able to save anything they make.)**

To set up the 3D modeling application for use with the workshop, first register several new accounts for your students to use. You can name these accounts anything that makes sense to you. Assign each account a simple password. Your students will use these accounts to log in, create, and save models in the workshop. You can usually have up to five students using one account at the same time without slowing down the software's servers. If more than five students use the same login at the same time, this could cause the application to crash. Also note that students using the same account must be careful to only edit their own models (you might consider a "no deleting" rule so nothing accidentally goes missing).

As an alternate to generic accounts, you can also walk your students through the process of creating individual accounts (if time and regulations allow). This method would allow the students to continue to use their accounts after the workshop. If you choose this option, plan for an additional 15 minutes during the "Share" portion of the workshop.

Preparation

As you prepare for the workshop, you should also create an account for yourself, so you can log in and spend some time becoming familiar with the application. Make sure you learn the basics of how to add and delete shapes, adjust the perspective, save, and undo.

Tutorials for the recommended 3D modeling applications can be found at *www.tinkercad.com/video* and *www.123dapp.com/howto/design*.

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3D Printing FAQs

A2

This section contains answers to a few common questions about 3D printing.

A2

Frequently Asked Questions

How does a 3D printer work?

Next to the printer is a coil of plastic called “filament.” This filament is fed into the “print head” where it gets heated up and laid down in layers to slowly build an object from the bottom up. The whole thing works kind of like a tiny hot glue gun!

How much does a 3D printer usually cost?

Usually between $500 and $2000 USD.

How large of an object can a desktop 3D printer print?

Commercial printers can normally print about 5^3 in. but bigger printers can do much larger and more complex prints.

What can a 3D printer print with?

Commercial printers usually print in plastic, but other printers can use all kinds of materials including metal, ceramic, wood and more (more than 170 materials).

What special things can you make with a 3D printer?

One of the exciting things about 3D printing is that you can make objects that are impossible to make any other way. These are called “non-manufacturable objects.”

Example: In the 3D printed castle tower (if available), you’ll see a tiny staircase winding up the middle of the model. There is no way to make this other than using a 3D printer.

Add-On Activities

A3

These Add-On Activities provide additional exercises for your students. You can engage students in these activities if they complete their projects early, or you can use them as standalone exercises to extend the City X experience beyond the workshop.

A3

20 mins

Create Your Own Citizen Card

Have students sketch a new City X Citizen and invent a problem that the Citizen is experiencing. Review the difference between personal problems and social problems. Encourage them to think about problems that may exist in their own communities and how they could also affect the Citizens of City X.

MATERIALS NEEDED

- Paper
- Crayons or Markers

Flexible

City X Around *the* World

Attach a large world map to the wall. Have your students explore the public model galleries from 123D (*www.123dapp.com/gallery*) and Tinkercad (*www.tinkercad.com/things*) for inventions other students have made for the Citizens of City X, using "cityx" as a search query. Many of these inventions are tagged with the cities of the students who made them—locations ranging from Singapore to Beirut to Alaska! Have your students place pins in the map to mark where other students across the globe have taken part in the City X Project.

If you are using a 3D printer for the workshop, you can also print inventions from other students around the world to further illustrate the "Share" step of the Design Process—demonstrating firsthand how 3D technologies enable instantaneous sharing of physical objects.

Discuss with your students how this is different from the ways things have been manufactured and shared in the past.

MATERIALS NEEDED

- Large world map
- Pins
- Devices with internet access

Learn More About Made in Space

20 mins

Have your students visit the Made in Space website (*www.madeinspace.us*). Discuss with your students how they think 3D printing in space could help change or improve space exploration.

MATERIALS NEEDED

- Devices with internet access

Lessons *from* Failure Writing Exercise

25 mins

When something doesn't work, we learn a lot about what to change to make it better. Explain this relationship between failure and the overall success of an invention. Have students write a short essay that draws a parallel between an invention that has improved over time, such as the telephone, and how their invention improved throughout the prototyping and testing processes.

MATERIALS NEEDED

- Paper
- Writing utensils

Define *the* Problem Writing Exercise

15 mins

Have students write a paragraph or two explaining how their City X Citizen's problem relates to a larger social issue. Have them identify similar problems they face in their communities and explain why it's important to help solve them.

MATERIALS NEEDED

- Paper
- Writing utensils

A3

25 mins

Learn About 3D Scanning

If your students have iPads (or if you have volunteers with a few iPads or iPhones) help the students experiment with 123D Catch, a free app for turning real objects into digital 3D models. Have students try out the application and compare the pros and cons of 3D scanning versus 3D modeling. You can learn how to use 123D catch at *http://www.123dapp.com/catch*.

MATERIALS NEEDED

- iPads or iPhones with iOS 7.0. (Alternatively, you may use any digital camera (including iPhones and iPads) to take photos, and upload them to the 123D Catch web app using Google Chrome or Firefox.)

Flexible

Learn About 3D Printing Services

Have your students explore *www.shapeways.com*, a service that allows users to upload 3D models and have them printed. Have your students discuss how a service like Shapeways can help people create things even if they don't have access to their own 3D printer. Encourage the students to look at the different materials Shapeways can print with (there are many) and explore models other users have uploaded to the site.

MATERIALS NEEDED

- Devices with internet access

15 mins

Build a Spaceship *for* Mission to Mars

Have students visit the Mission to Mars page on Cubify.com (*http://cubify.com/en/Store/MissionToMars*) to build simple 3D models of spaceships. Just like with Tinkercad and 123D Design, these models can be downloaded and 3D printed. Review with your students how 3D printing could improve space exploration

MATERIALS NEEDED

- PC or Mac computers with internet access

Common Core State Standards Alignment

A4

The City X Project has been designed to align with several Common Core State Standards. This section contains detailed descriptions of alignment.

Day One	Day Two	Day Three
CCSS.ELA-Literacy.RL.5.3	*CCSS.Math.Practice.MP4*	*CCSS.ELA-Literacy.CCRA.W.7*
CCSS.ELA-Literacy.CCRA.W.7	*CCSS.Math.Practice.MP6*	*CCSS.ELA-Literacy.CCRA.SL.4*
CCSS.ELA-Literacy.CCRA.W.10	*CCSS.Math.Content.6.G.A.4*	
CCSS.Math.Practice.MP1		

A4

Language Arts

CCSS.ELA-Literacy.RL.5.3

Compare and contrast two or more characters, settings, or events in a story or drama, drawing on specific details in the text (e.g., how characters interact).

The City X Citizens are central to the project. Students spend time empathizing with these characters and constructing design statements that address the problems they are experiencing. One quick and simple extension activity could be to have students do a quick pair share about each of their Citizens and to compare/contrast their feelings, problems, and possible solutions in the context of the City X scenario.

CCSS.ELA-Literacy.CCRA.W.7

Conduct short as well as more sustained research projects based on focused questions, demonstrating understanding of the subject under investigation.

At a key point in the project, students connect their Citizen's problem to a real world issue. This can be a launching point for a deeper investigation of that social problem. Once they engage in this short research project, they will have a better understanding of the issue and, hence, be able to address it more effectively.

CCSS.ELA-Literacy.CCRA.W.8

Gather relevant information from multiple print and digital sources, assess the credibility and accuracy of each source, and integrate the information while avoiding plagiarism.

In order for students to have an effective brainstorming session, it could be helpful for them to have an opportunity to conduct research the social issue or problem that their Citizen is facing. Students can then integrate this research into their process of developing design solutions that address their Citizen's problem.

CCSS.ELA-Literacy.CCRA.SL.4

Present information, findings, and supporting evidence such that listeners can follow the line of reasoning and the organization, development, and style are appropriate to task, purpose, and audience.

Presenting and sharing their ideas is an integral part of the City X Project. Students must present their initial ideas during the Prototyping and Testing phases. They must be able to articulate themselves clearly and concisely so that others can understand the what and why of their models. Students must also share their final models with a wider audience at the culmination of the project. They must be able to not only present their models effectively but to reflect on their process clearly so that others get a sense of what they learned.

CCSS.ELA-Literacy.CCRA.W.10

Write routinely over extended time frames (time for research, reflection, and revision) and shorter time frames (a single sitting or a day or two) for a range of tasks, purposes, and audiences..

Opportunities for writing are embedded in the City X Project. From the empathy-building exercises to the prototyping activities, students need to document their process and their formative learning moments. Additional writing activities can be provided. For example, teachers may ask students to write a short narrative or monologue based on their Citizen. Students could also create a research log that documents the different sources and information they are finding about their social issue or problem.

A4

Math

CCSS.Math.Practice.MP1

Make sense of problems and persevere in solving them.

The foundation of the City X Project is problem solving. Using their Citizen card as the initiating learning resource, students are asked to understand and analyze the problem and then to develop a solution that addresses that problem. The whole project is structured around the design process so that students develop a solution pathway to the problem; they do not just jump in with a solution without trying to understand it from multiple perspectives.

CCSS.Math.Practice.MP4

Model with mathematics.

Creating a model is one of the central activities in the City X Project. This gives students an opportunity to apply the problem solving skills. They also have an opportunity to apply their understanding of geometry, ratios & proportional relationships, and measurement & data so that they actually produce an invention that adequately responds to their Citizen's problem.

CCSS.Math.Practice.MP6

Attend to precision.

Precision plays a very important role once students transition from blueprinting to producing their invention. If students do not tend to their measurements with accuracy and efficiency, their final product will not reflect their vision.

A4

CCSS.Math.Content.6.G.A.4

Represent three-dimensional figures using nets made up of rectangles and triangles, and use the nets to find the surface area of these figures. Apply these techniques in the context of solving real-world and mathematical problems.

Students will inevitably have to apply geometric methods in order to create their solution to their Citizen's City X dilemma. During the blueprinting activity, students will have to apply their understanding of polygons, whether they are rectangles, triangles, or hexagons, so that they create an initial model of their invention using these simple shapes. Once they complete their blueprint, students will have to apply similar concepts to ensure that their actual invention matches the blueprint.

A4

Integration with Other Subjects

History

Students in the City X Project develop inventions that address social issues. Once they identify the issue that is connected to their Citizen's problem, students can conduct further research on it. For example, before students begin to brainstorm their design solutions, they could do a short research project that addresses:

- What is the role of the issue in the past and present
- How have people been affected by the issue
- What solutions have people developed to address the issue, if any?

Language Arts

Characterization is a very important aspect of understanding the parts of a story. Students can help make the City X Citizens come alive by creating a short sketch that offers more detail about who their Citizen is, where they come from, and what they need in City X. This can give students more opportunity to develop and apply their empathy-building and narrative-writing skills.

Science

Students can apply their understanding of the parts of an ecosystem to the City X Project. Students can create a map of City X or the planet on which it was built, showing its distinct features. Students can include information about the living and nonliving things on the planet. Students can then use this information to further develop their ideas for their design solutions.

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