Logbook

Invention Logbook

Grades 3-5

Teaching Edition

ANDREWS UNIVERSITY
STEM
Science | Technology | Engineering | Math

Table of Contents

Teacher resources and videos available on our website:
www.andrews.edu/go/invent

Contact us at stemconnect@andrews.edu
with any questions, comments, or suggestions.

Introduction

STEM has become increasingly important in the world today, as companies expect applicants to understand basic science and math concepts and be able to think critically and solve problems in the workplace. Learning these skills starts in the classroom where you as a teacher are expected to instruct your students in STEM.

The goal of this project is to engage students with math and science through a hands-on learning opportunity. They are encouraged to work collaboratively, think for themselves, and solve real-world problems. The engineering design process will serve as the problem-solving method.

Traditional math and science classes are important for teaching the basic skills, but it is difficult for students to appreciate what they are learning without a practical application. This project lets them think and experiment and learn by doing. When students are able to use math and science as tools to solve problems, they develop a greater appreciation for what they are learning. Even beyond the STEM professions, the problem solving skills they learn from this project are useful for everyone.

Project Summary

Students will choose a problem and create an invention to solve that problem. They will collaborate in groups of 3-4 to solve the problem together. Each team of students will complete one Logbook together over the course of the project. The Logbook will keep their work organized and provide instructions for each step of the process. We have designed this as a workbook with prompts and space to write/draw.

When you start the project, print one copy of the Logbook for each group and put it in a 3-ring binder. This way you can add more pages as needed. Alternatively, you are welcome to use a notebook for each team instead of the workbook version. If you choose to do that, give each group one notebook to fill out together and use the digital version of the Logbook as an outline.

In addition to the Logbook, we recommend students journal what they did for that day or week. This helps them reflect on their progress and set goals for next time. This can be done in a notebook or using the Weekly Progress worksheet available online.

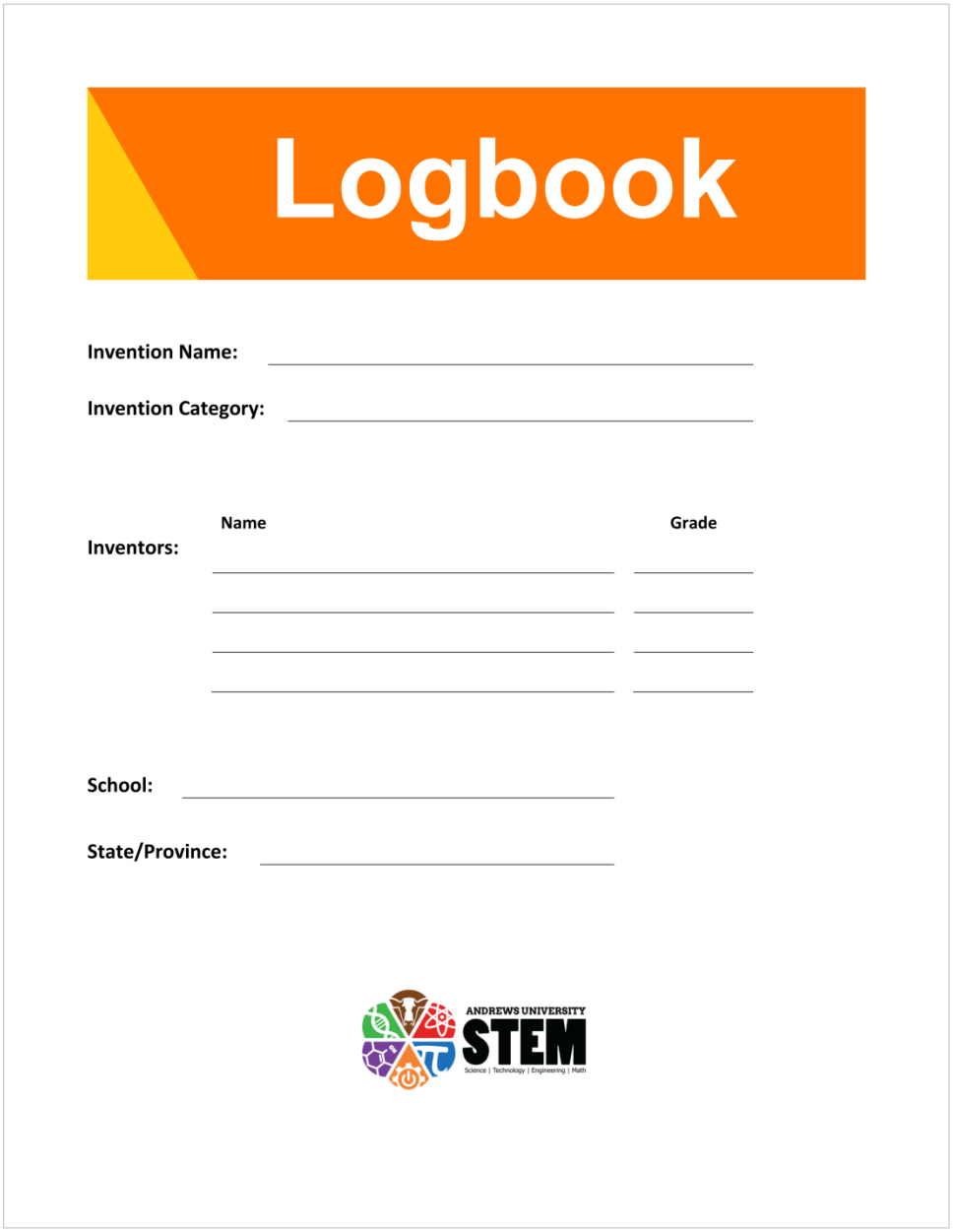
As Adventist educators, we are encouraged to integrate biblical principles throughout our curriculum. To meet this need, we have included a biblical connection with this project. Give examples throughout the project and let each group think of a favorite Bible story, character, or a verse that relates to their invention. It is easy to separate STEM from spirituality, but we hope this will help students see STEM as a God-given gift to bring Him glory.

Cover Page

Invention Name:
Let the students come up with a fun and creative name that describes their group's invention. They should write it here on the cover page and use it in their presentation.

While it might be tempting to name the invention early on, the students should wait until the end of the project when they know more about it.
We recommend naming the invention during the Communicate step.

Invention Category:
Help your students choose the invention category that best describes their invention and write it here on the cover page.
See the Invention Categories handout for more information.



If you decide to use composition notebooks or other blank notebooks instead of the provided Logbook, include the information from this page on the cover or first page of the notebook.

Logbook Introduction

Read this quick intro to your students or summarize it when you start the project.

Introduction

Sometimes math and science don't seem useful for everyday life. Maybe you've asked your teacher, "Why do I need to learn this?!" In fact, math and science are simply tools to help you solve problems. Everyday life is full of challenges, which means we all need to solve problems. The goal of this project is to teach you how. Whether or not you decide to become a mathematician, scientist, or engineer, the problem solving skills you will learn from this project can be used almost anywhere. So have fun, be creative, and enjoy this opportunity to learn about STEM by making inventions!

About the Logbook

Fun hands-on project? Cool! So why do I need this big document? The Logbook will be your record of how you create your invention. It will have all your ideas, your designs, and what you tried. Your team will fill it out together as you do the project, so it won't be too much all at once.

The finished Logbook will be the proof of what you did. It is important to take neat, careful notes for each step so that other people (or your future self) can read it easily. If you decide to patent the invention, this can also serve as the record of your work in case there are questions about your claim to the ideas.

At the end of the project, you will present on your invention. The Logbook will help you prepare for this so you know what to talk about. Then at the end, you will submit the Logbook for grading.

Project Guidelines

Requirements:

- The teacher must sign off on the project and design before the prototype is built.
- The final design and solution must be completely original or sufficiently different that it can be considered a true innovation and not a copy of existing inventions/products.
  See the Solution section of the Logbook for more information (pg. 14-15).
- All group members must sign the originality statement promising that the design ideas in the Logbook follow the originality requirements.
- The invention prototype does not need to be fully functional, but it should be able show how the final design would operate. If the group can create a functional or partially functional prototype, they should do so.
- If the invention cannot be demonstrated at the final presentation due to size constraints or other considerations, a video must be made demonstrating its use.
- For all presentations, each group will need a Tri-Fold board explaining the project, the signed and completed Logbook, and the prototype. Some or all of these items can be used in the verbal presentation but regardless, they need to be available to show people afterwards.
  See the Presentation Guidelines handout for more information.

Restrictions:

- Animals may not be brought to the final presentation at the invention event. If the design is for animals or uses animals in any way, you must find a way to demonstrate its function without the animal present.
- Inventions may not use wall outlet electricity (110V or higher) unless you are only using unmodified consumer products such as a fan or smartphone charger.
  Battery operated devices are acceptable as long as they use common low voltage batteries (i.e. no car batteries, etc.).
- Inventions may not use any flames or heat sources (lighters, matches, candles, fireworks, heating elements, etc.) or any combustible liquids.
- Inventions may not use biohazards or other dangerous materials.
- Inventions may not be or make use of any weapons such as guns, knives, explosives, stun guns, pepper spray, or blunt weapons.

If you have any questions about the project guidelines or feel that the project deserves an exception to the above Requirements & Restrictions, the teacher may contact us at stemconnect@andrews.edu.

Signatures

Statement of Originality:
Students are encouraged to identify original/unique invention ideas for their project. This statement helps students formalize this commitment.

Originality also pertains to the origin of students' ideas. Students should work together to develop their inventions, rather than relying on adults or copying an idea they've seen.

Each student in the group must sign the originality statement sometime before the project is over.

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Statement of Originality

We promise that the ideas and designs in this Logbook are our own.
(all team members must sign)

Name	Signature

Date:

Teacher's Signature

I approve of the invention that my students created/will create and agree that it meets the Project Guidelines for safe and acceptable projects.

Teacher's Name	Signature

Date:

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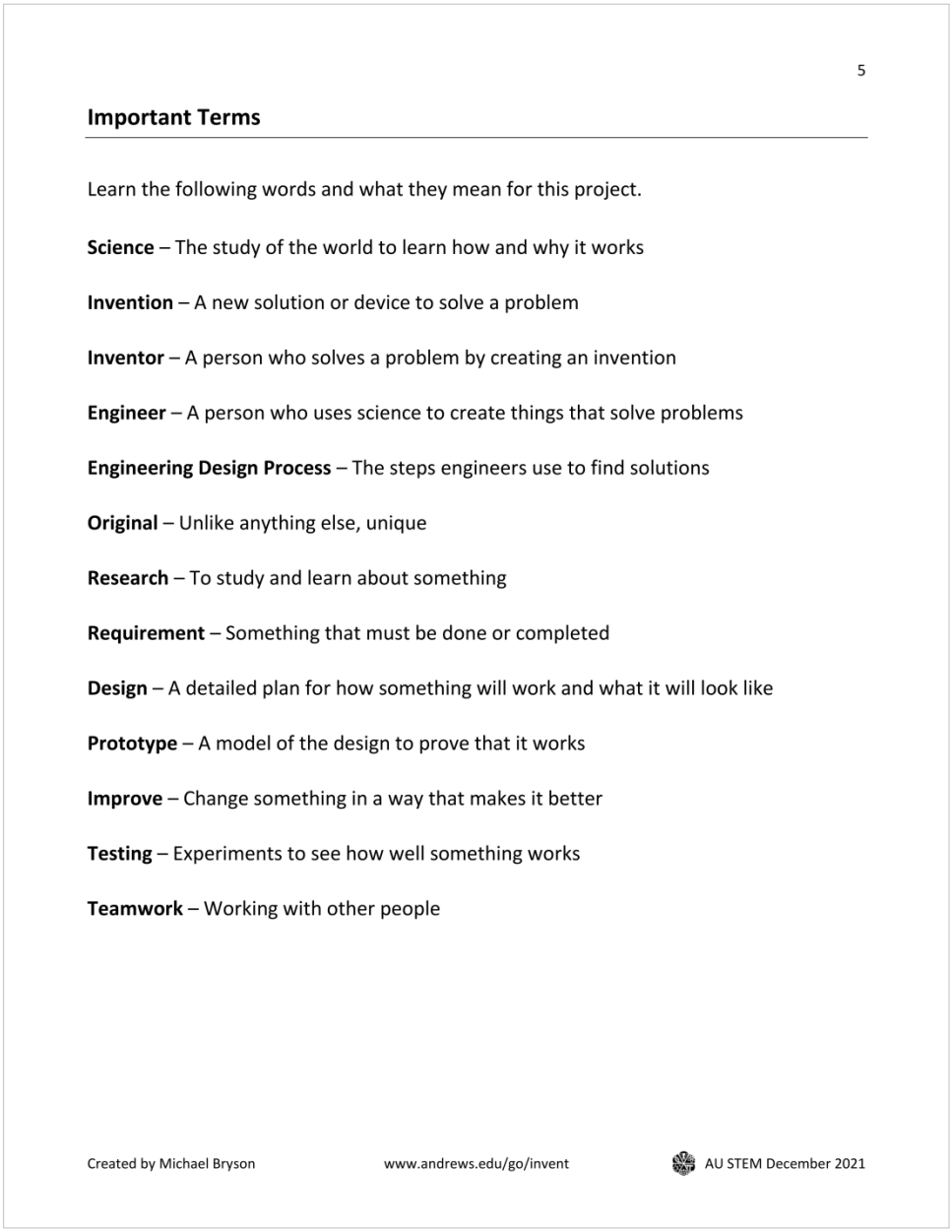
Teacher's Signature:
Once your students choose a solution to their problem, discuss it with them to make sure it meets the Project Guidelines (pg. 3). Once you are satisfied, sign off on the idea. You may need to check again after they build the prototype and whenever they revise the design.

Vocabulary

Introduce the following words to your students. The provided definitions are intended to help your students understand the vocabulary and concepts covered in this project.

Feel free to use and teach the words in the way that best helps your students.

This vocabulary list is also available as a separate document you can print or refer to in class.



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Important Terms

Learn the following words and what they mean for this project.

Science – The study of the world to learn how and why it works

Invention – A new solution or device to solve a problem

Inventor – A person who solves a problem by creating an invention

Engineer – A person who uses science to create things that solve problems

Engineering Design Process – The steps engineers use to find solutions

Original – Unlike anything else, unique

Research – To study and learn about something

Requirement – Something that must be done or completed

Design – A detailed plan for how something will work and what it will look like

Prototype – A model of the design to prove that it works

Improve – Change something in a way that makes it better

Testing – Experiments to see how well something works

Teamwork – Working with other people

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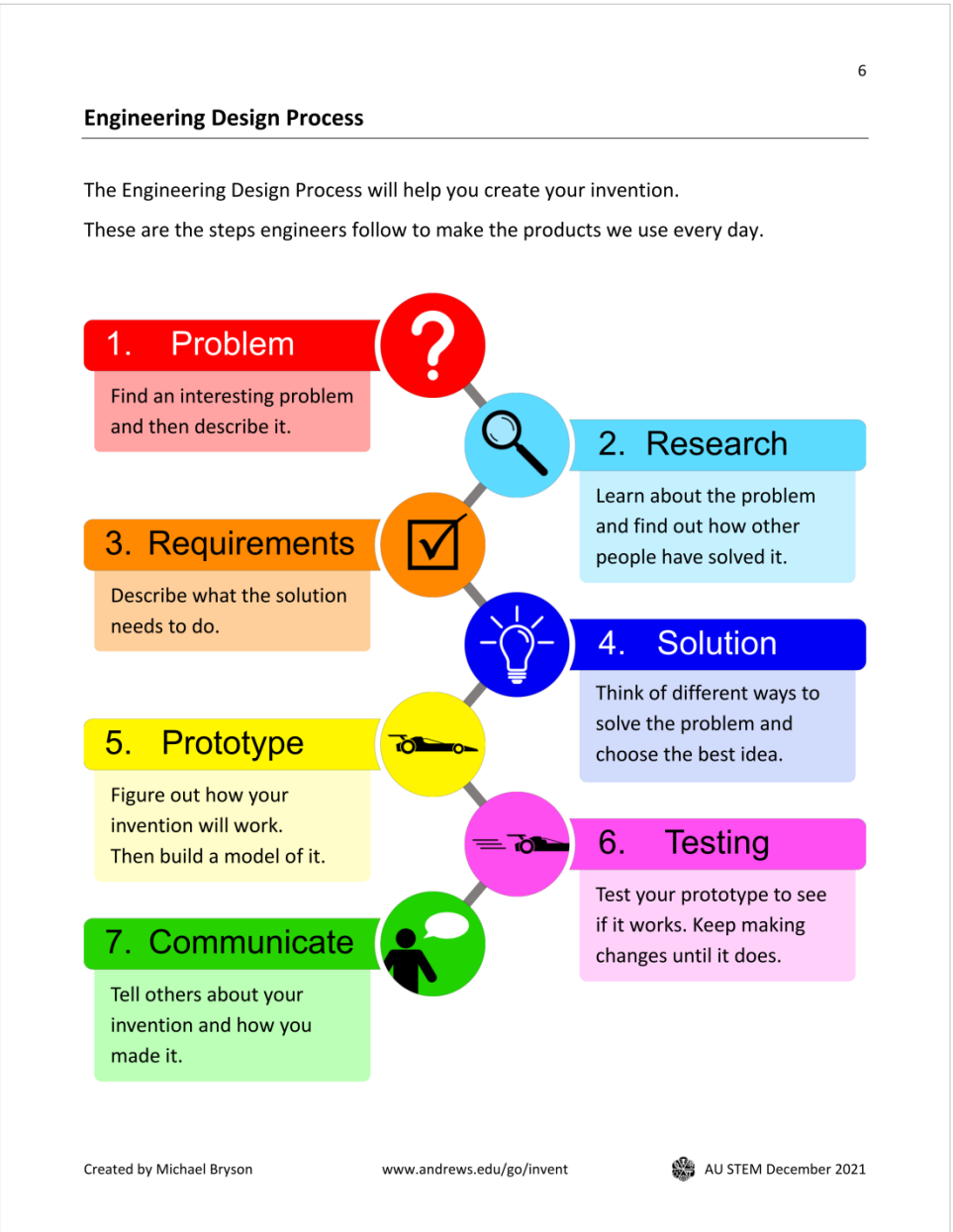
Engineering Design Process

The engineering design process is how engineers solve problems and develop the products we use every day. Many inventors throughout history were engineers, so it makes sense to use this process when creating a new invention.

Beyond engineering and inventing, the engineering design process can also serve as a pattern for solving all kinds of problems. The steps in this process will help your students identify and develop good ideas and focus their efforts to produce tangible and fulfilling results.

Learn More:
To learn more about engineers and the engineering design process, check out the engineering videos and examples on our website.



This diagram provides an overview of the engineering design process and the following pages will expand on this, providing concrete steps for your students to follow as they develop their inventions.

This engineering design process diagram is also available as a separate document you can print or refer to in class. We also have a printable quick reference version (without descriptions).

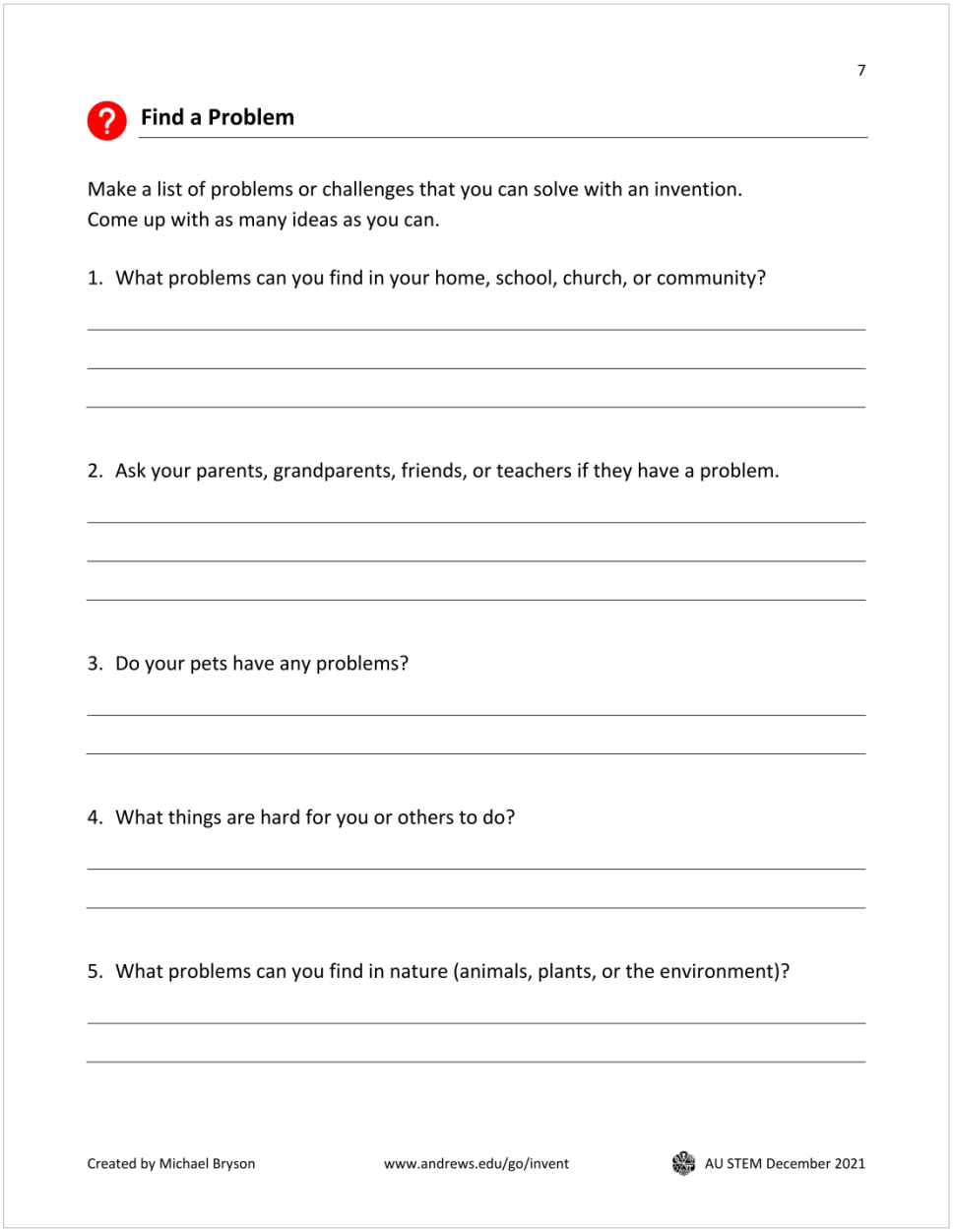
Problem

Find a Problem:
Divide the class into groups of 3-4. The groups will stay the same for the entire project. Each group needs to choose a different problem and create an invention to solve it.

Finding a problem is often the hardest step so you may need to try different things to help the students find good problems. The Invention Categories handout suggests many areas where problems may be found.

Let the students use the problem worksheet to look for problems on their own. Have them check around their house, talk to people they know, and pay attention to challenges throughout their day. Start this as soon as you begin the project.

Next, they can share with their group or the whole class. Small-group discussion introduces ideas much faster than simply working alone. Have them answer the questions/write their ideas in the Logbook.



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Find a Problem

Make a list of problems or challenges that you can solve with an invention.
Come up with as many ideas as you can.

1. What problems can you find in your home, school, church, or community?

2. Ask your parents, grandparents, friends, or teachers if they have a problem.

3. Do your pets have any problems?

4. What things are hard for you or others to do?

5. What problems can you find in nature (animals, plants, or the environment)?

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Choose a Problem:
Each group needs to choose a problem they can solve with an invention (something they can build). Give them a deadline and remind them to choose quickly so they have enough time to make the invention. If they still can't decide, you might need to discuss with them or suggest a problem. Compiling a list of problems from the whole class might help with this. Let them do as much as they can on their own, but don't spend more than 1-2 weeks on this step.

Problem (continued)

After the students choose a problem, they need to write down everything they know about it.

Read the example together as a class and answer the questions about the example on the board.

1. The brother falls off his bike
2. Outside
3. Prevent him from falling and/or prevent him from getting hurt
4. Getting hurt is bad

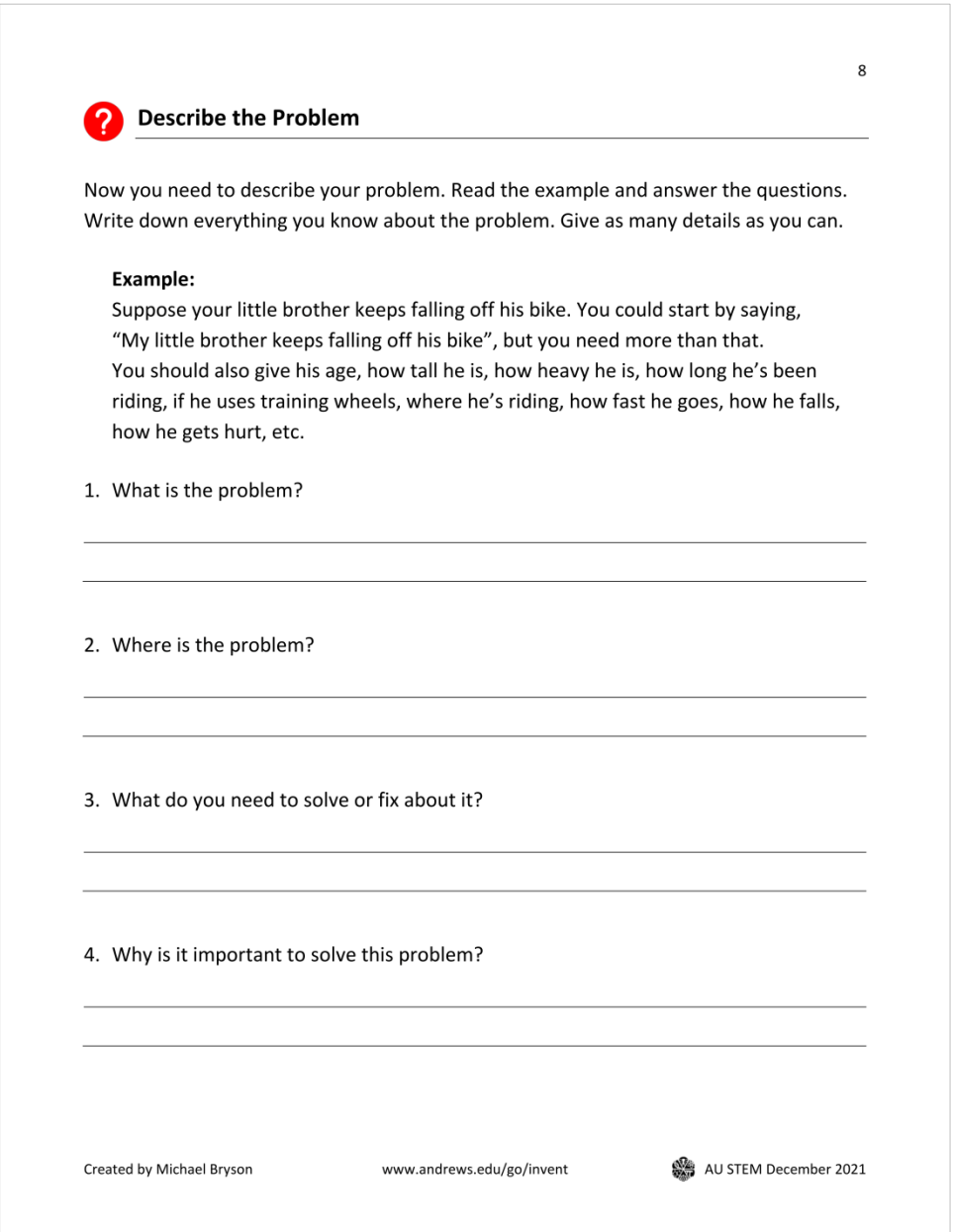
After completing the example, let the students discuss their problem in their groups and answer the questions in the Logbook.

Question 1: Write the previously chosen problem.

Questions 2-4: These apply generally to any problem.

Question 5: Describe things that are specific to the problem.

Question 6: Draw a picture to further clarify.



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Describe the Problem

Now you need to describe your problem. Read the example and answer the questions. Write down everything you know about the problem. Give as many details as you can.

Example:
Suppose your little brother keeps falling off his bike. You could start by saying, "My little brother keeps falling off his bike", but you need more than that. You should also give his age, how tall he is, how heavy he is, how long he's been riding, if he uses training wheels, where he's riding, how fast he goes, how he falls, how he gets hurt, etc.

1. What is the problem?

2. Where is the problem?

3. What do you need to solve or fix about it?

4. Why is it important to solve this problem?

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Notice that this step is different from the upcoming Requirements step. The requirements describe the *solution*, while this step describes the *problem*.

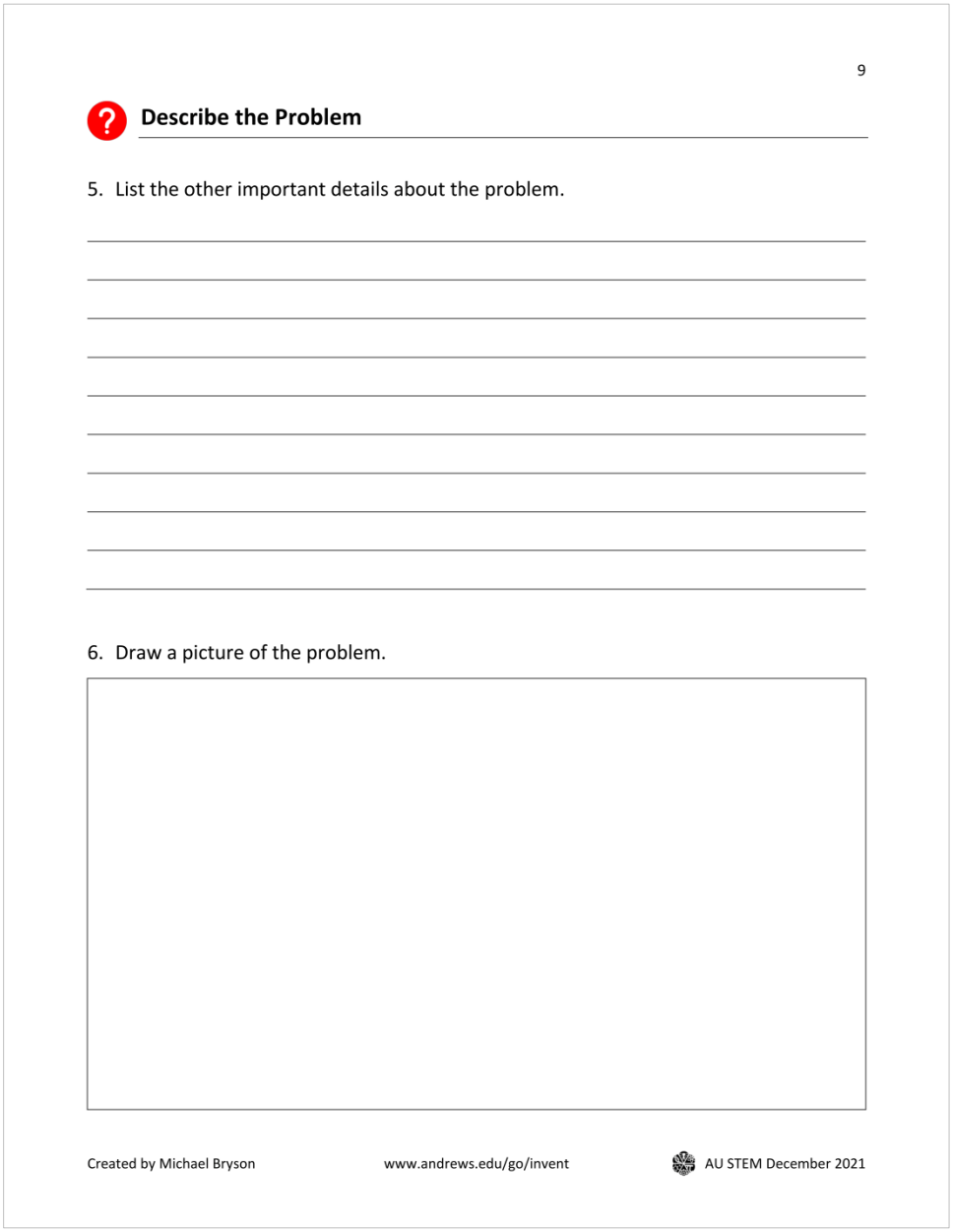
It is important to understand the problem before considering solutions. This will make the following steps easier.

Problem (continued)

5. He is 7 years old
   He is 4 ft tall
   He weighs 50 lbs
   Riding for 1 year
   No training wheels
   Riding on gravel
   Rides too fast
   Tips over to the right
   Scrapes his knee and hits his head

Question 5 is open-ended to allow students to write the details about their problem that don't fit under the other questions. This is where most of their problem description will be.

Have the students draw a picture to further clarify and illustrate their problem.



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Describe the Problem

5. List the other important details about the problem.

6. Draw a picture of the problem.

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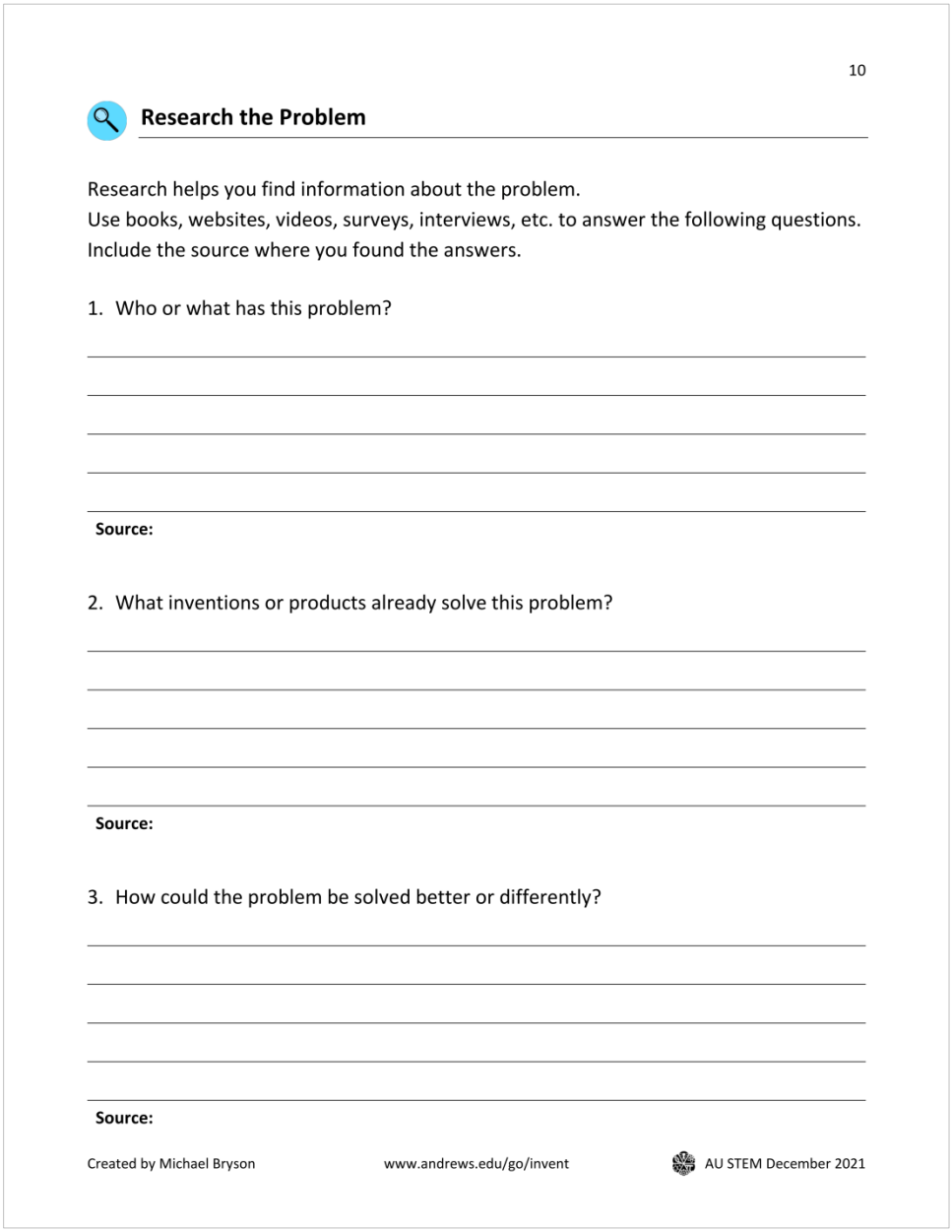
Research

Let students work in their groups to research the problem. The provided questions will guide their search but they are welcome to look beyond the prompts to learn more.

Ask them to use books, websites, videos, surveys, interviews, etc. to find the relevant information.
If they are not already familiar with this type of research, you may need to give additional instructions.

They should also cite where they found the information. Each question will be followed by a brief citation and will correspond to a detailed citation at the end of the Logbook. You can choose how they format these and what details to include. Print additional source pages as needed.



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Research the Problem

Research helps you find information about the problem.
Use books, websites, videos, surveys, interviews, etc. to answer the following questions.
Include the source where you found the answers.

1. Who or what has this problem?

Source:

2. What inventions or products already solve this problem?

Source:

3. How could the problem be solved better or differently?

Source:

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Requirements

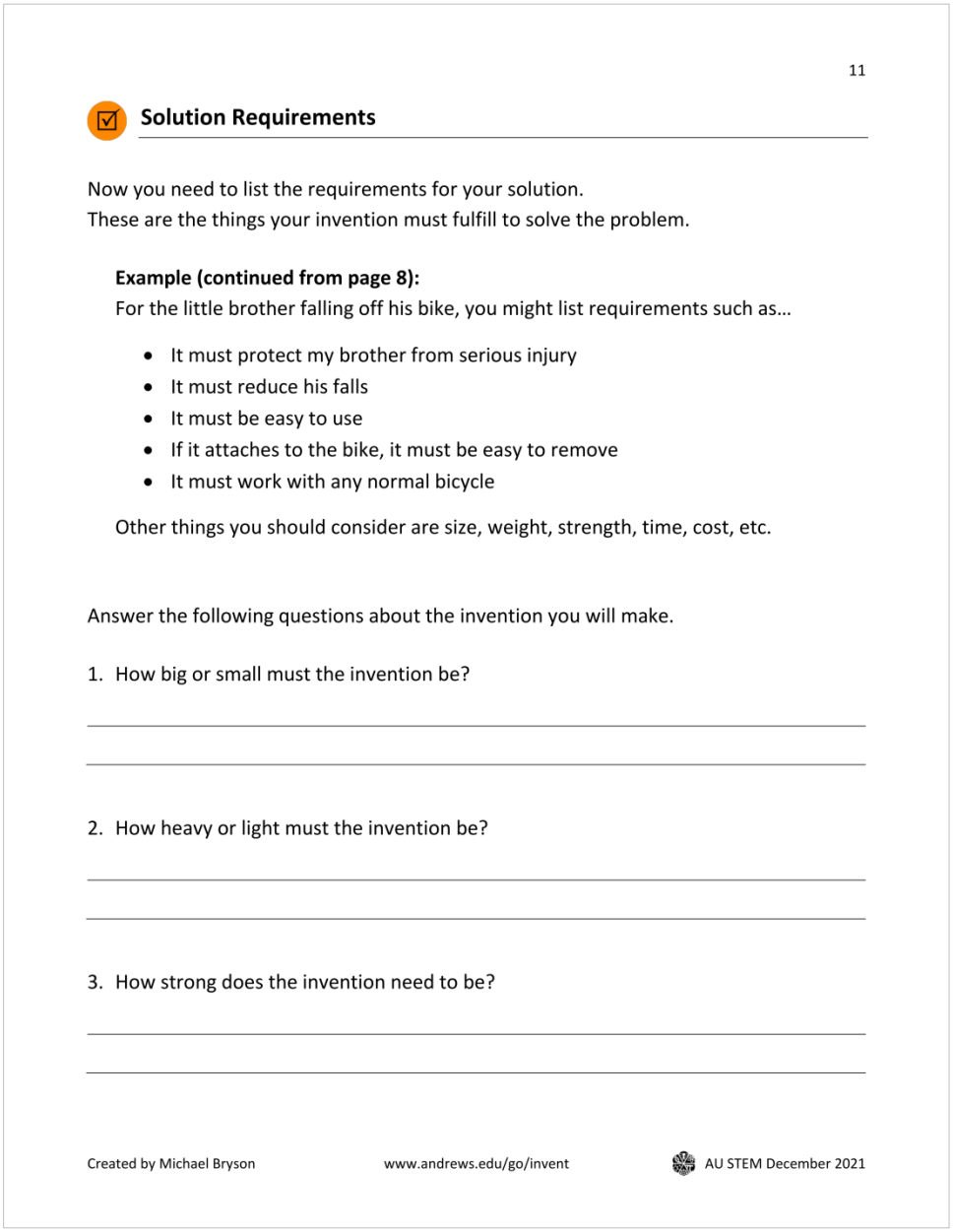
What are Requirements?
Listing the requirements is an important step in the process because they help you know what the solution will need to do or fulfill, without deciding exactly how to do it.

Later, when it is time to choose a solution, the requirements will help compare ideas and choose the one with the best chance of success (meets all the requirements).

After the students have built their prototype, the requirements will serve as a checklist to evaluate its success.

List the Requirements:
Read the example together and let the students answer the questions in their Logbook.

Questions 1-5:
These apply to most inventions.



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Solution Requirements

Now you need to list the requirements for your solution.
These are the things your invention must fulfill to solve the problem.

Example (continued from page 8):
For the little brother falling off his bike, you might list requirements such as…

- It must protect my brother from serious injury
- It must reduce his falls
- It must be easy to use
- If it attaches to the bike, it must be easy to remove
- It must work with any normal bicycle

Other things you should consider are size, weight, strength, time, cost, etc.

Answer the following questions about the invention you will make.

1. How big or small must the invention be?

2. How heavy or light must the invention be?

3. How strong does the invention need to be?

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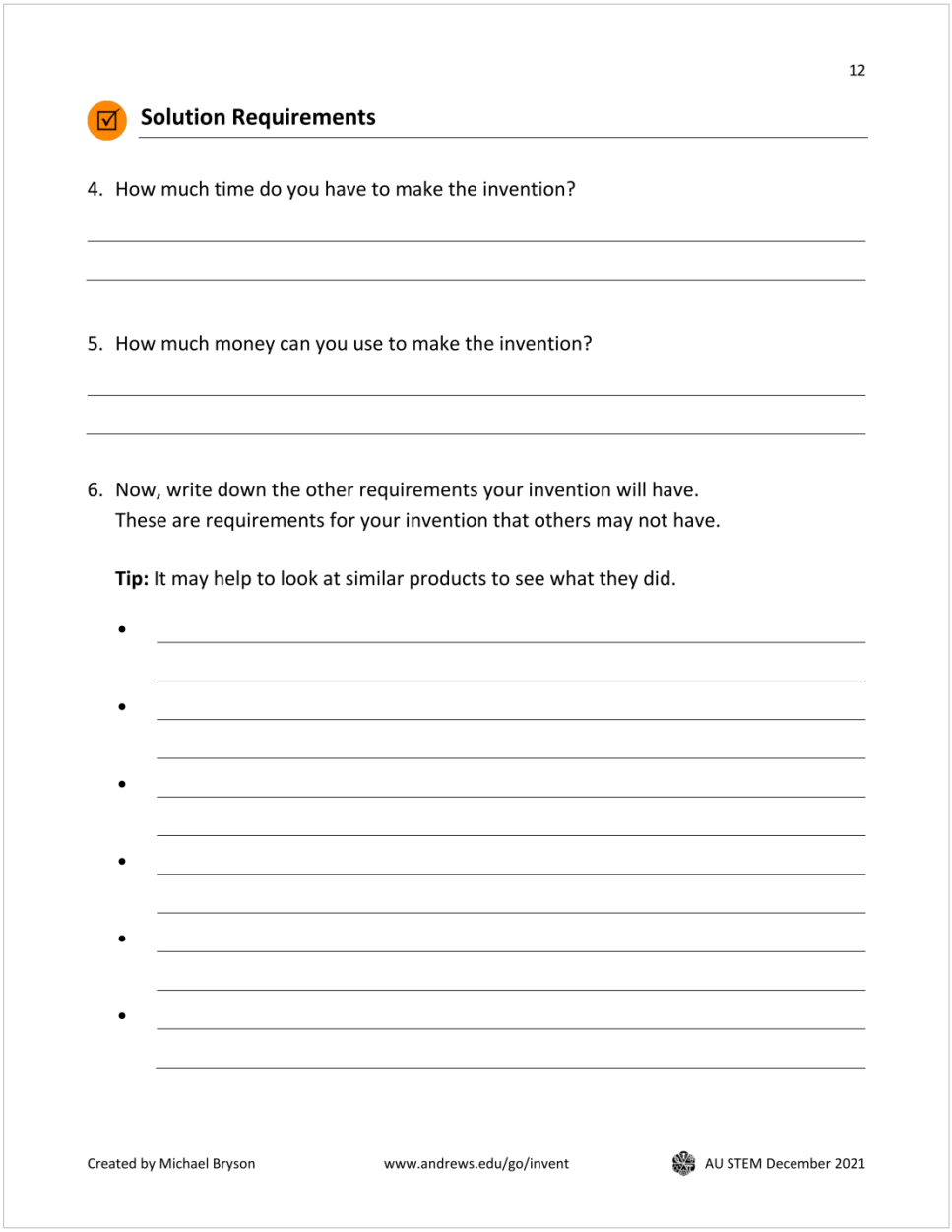
Requirements (continued)

Questions 4-5:
Students may not know how to answer these questions but you can help them find answers based on your class schedule and project budget. Money shouldn't be much of an issue since most materials will be free, but it is still good for students to think about.

Question 6:
There will be other requirements that have not been covered by the previous questions. This is left open-ended to allow for problem-specific requirements. If students are struggling with this question, they may need additional prompting.

It might help to consider an extreme case. For example, the bike problem could be solved by wrapping the brother in tons of bubble wrap, but obviously that isn't very practical! Instead, you might specify that it should be easy to use.



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Solution Requirements

4. How much time do you have to make the invention?

5. How much money can you use to make the invention?

6. Now, write down the other requirements your invention will have.
   These are requirements for your invention that others may not have.

   Tip: It may help to look at similar products to see what they did.

-
-
-
-
-
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Look at Similar Products:
It may be useful to look at similar products. Product images and descriptions can help you guess the requirements for those products and determine the requirements for your invention.

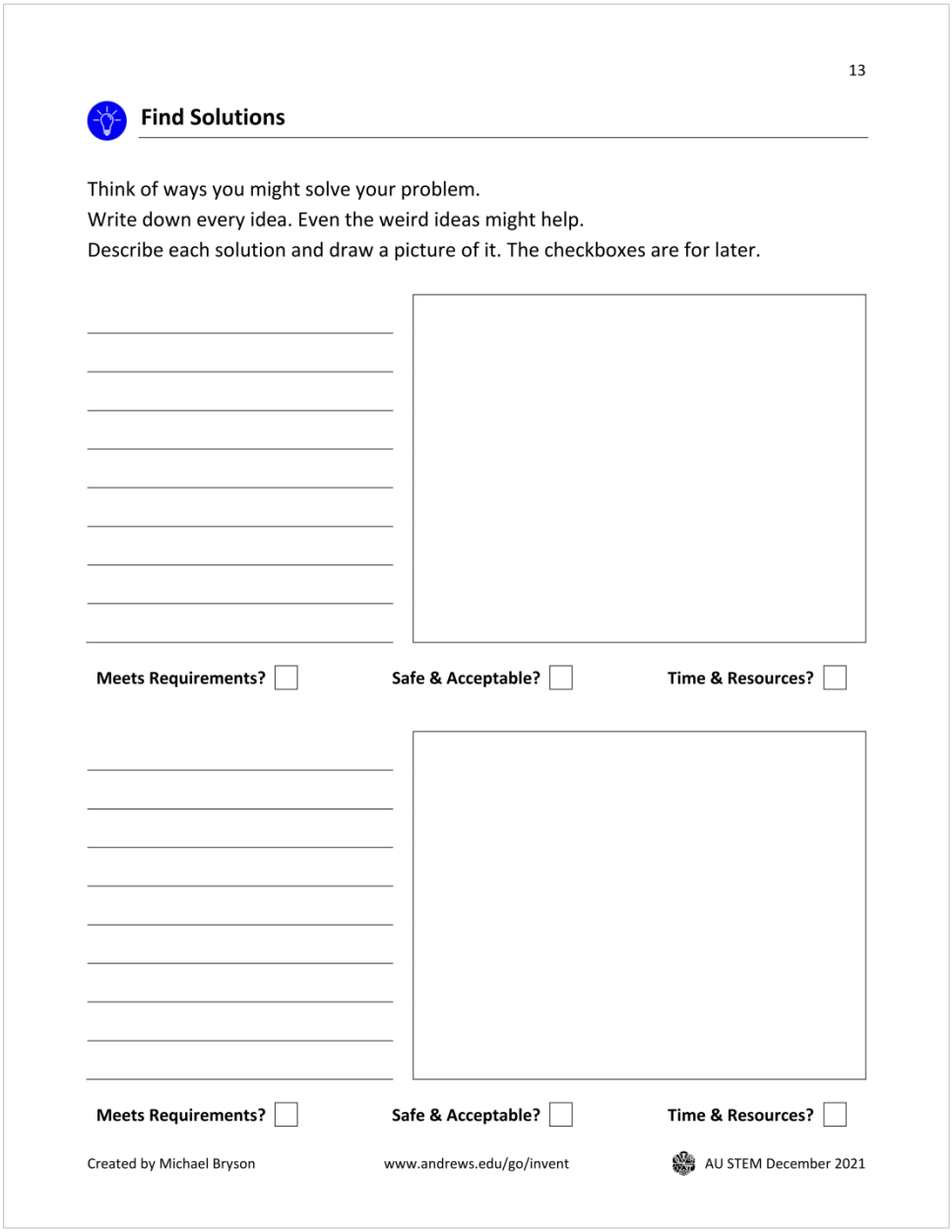
Solution

Find Solutions:
Brainstorming solutions is a fun activity. You can really let your imagination go and think of any and every solution that comes to mind. There are no bad ideas at this point, because even a weird idea might inspire something great.

Let the students talk in their groups and think up as many solutions as they can. These should be things they can build and ideally they should be new (original) ideas.

Have them draw the ideas in their Logbook and write a brief description for each. The 3 checkboxes are for later.

The Logbook provides space for two solutions, but students should think of more than that. Print extra solution pages for each group and add them to the Logbook as needed.



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Find Solutions

Think of ways you might solve your problem.
Write down every idea. Even the weird ideas might help.
Describe each solution and draw a picture of it. The checkboxes are for later.

Meets Requirements? ☐ Safe & Acceptable? ☐ Time & Resources? ☐

Meets Requirements? ☐ Safe & Acceptable? ☐ Time & Resources? ☐

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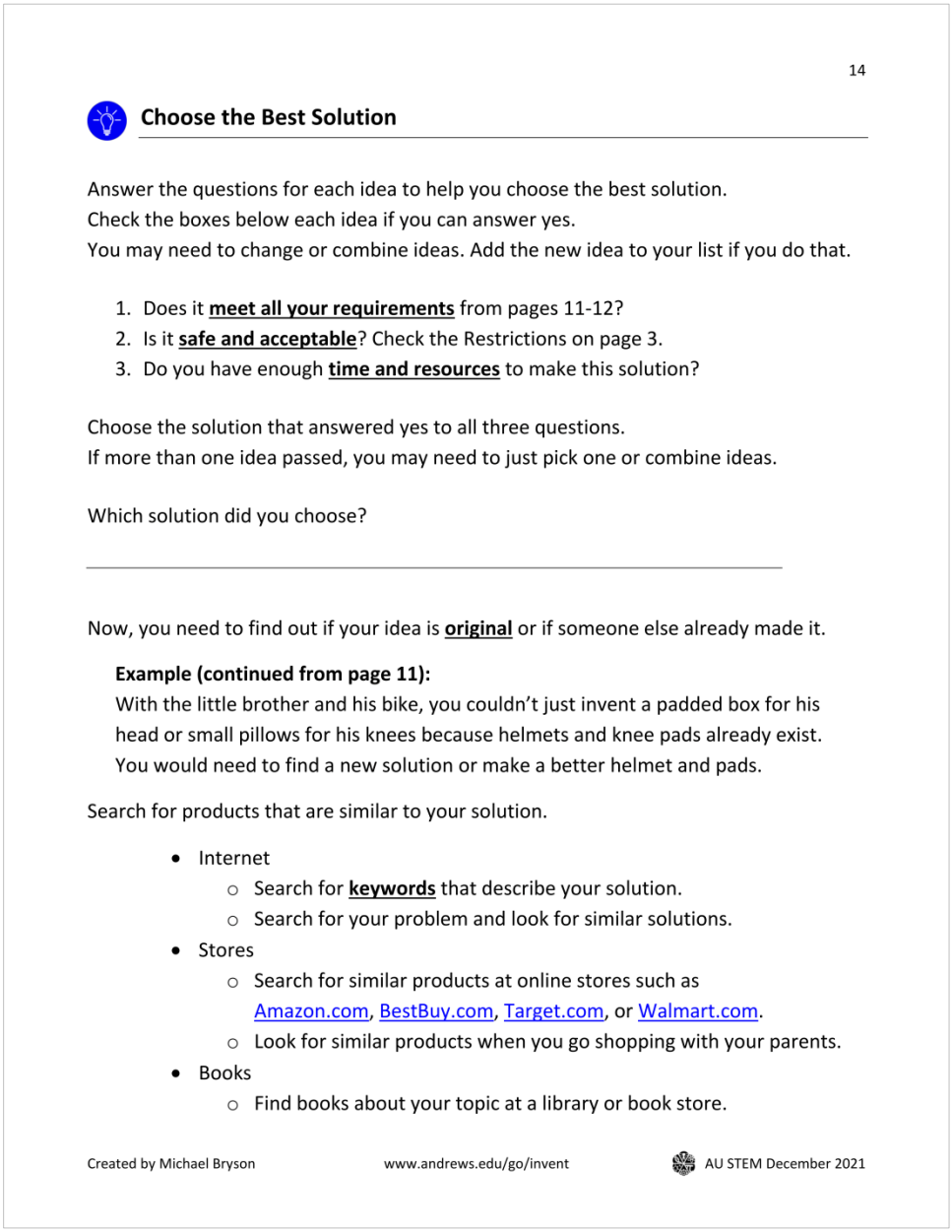
Solution (continued)

Compare Ideas:
The students will narrow their list by answering questions for each idea. If they answer yes to a question, they should check the corresponding box.

For example, if one of the solutions meets all their requirements, they will check the box for "Meets Requirements".

Choose the Best Solution:
After answering the questions for each solution, the group should choose the idea that answered yes to all 3 questions, or if multiple solutions passed, they may need to just pick one or combine ideas.

If they came up with new solutions during this process, provide them with additional solution pages.



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Choose the Best Solution

Answer the questions for each idea to help you choose the best solution.
Check the boxes below each idea if you can answer yes.
You may need to change or combine ideas. Add the new idea to your list if you do that.

1. Does it **meet all your requirements** from pages 11-12?
2. Is it **safe and acceptable**? Check the Restrictions on page 3.
3. Do you have enough **time and resources** to make this solution?

Choose the solution that answered yes to all three questions.
If more than one idea passed, you may need to just pick one or combine ideas.

Which solution did you choose?

Now, you need to find out if your idea is **original** or if someone else already made it.

Example (continued from page 11):
With the little brother and his bike, you couldn't just invent a padded box for his head or small pillows for his knees because helmets and knee pads already exist. You would need to find a new solution or make a better helmet and pads.

Search for products that are similar to your solution.

- Internet
  - Search for **keywords** that describe your solution.
  - Search for your problem and look for similar solutions.
- Stores
  - Search for similar products at online stores such as Amazon.com, BestBuy.com, Target.com, or Walmart.com.
  - Look for similar products when you go shopping with your parents.
- Books
  - Find books about your topic at a library or book store.

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Is it Original?
After choosing a solution, the students need to check if their idea is original or if someone else already made it. Often there will be similarities with existing products, but by identifying these, students can find ways to do it differently or better (innovation).

Read the example with the class and have them search for products that are similar to their idea. Answer the questions on the next page.

Similar Products

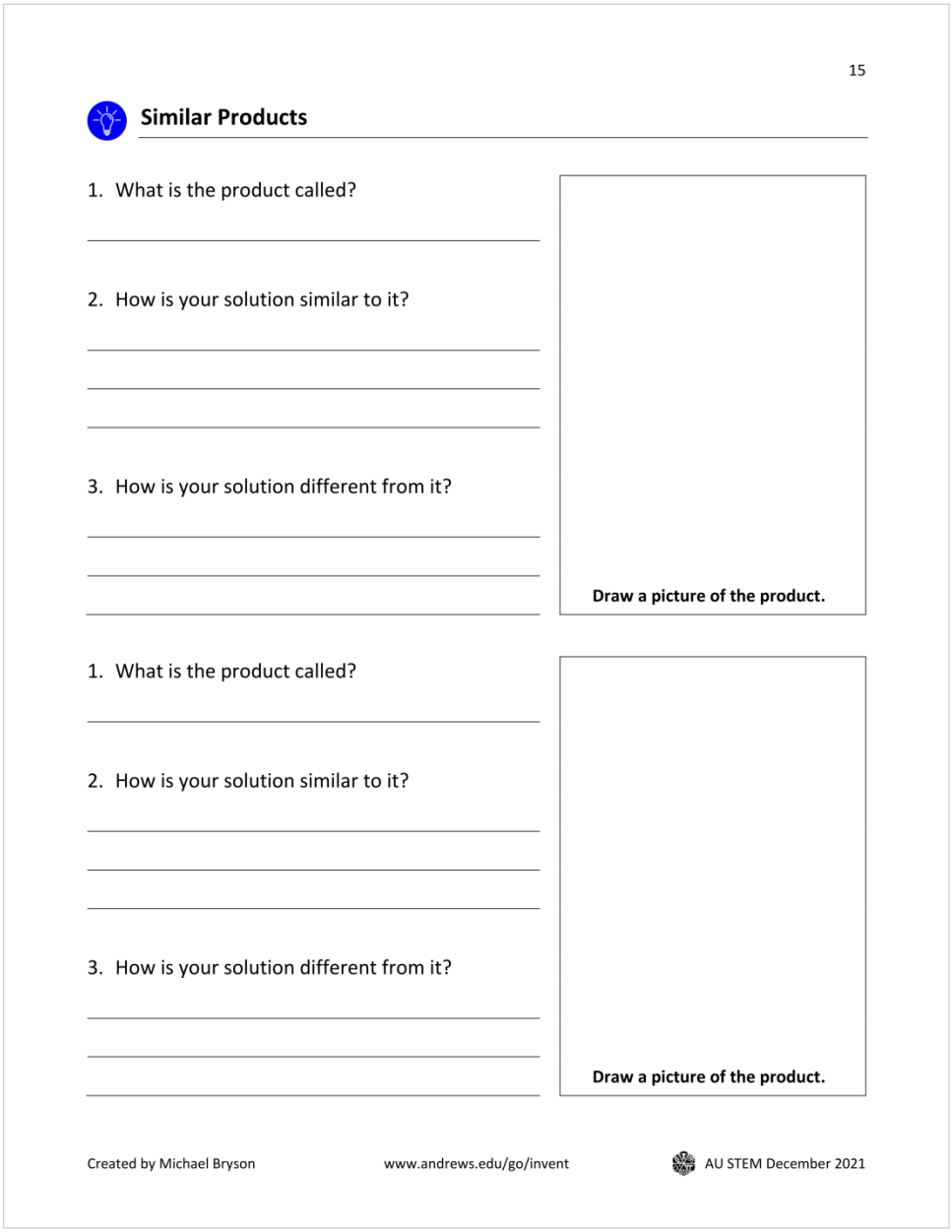
Students will search for existing products that are similar to their chosen idea.

Checking for products on store websites or search engines will likely yield the best results.

Encourage students to find at least 2 similar products. Print additional pages if they find more than 2.

For each product they find, the students will answer the questions and draw a picture of it.

This will help them to avoid copying existing inventions and find new and creative ways to solve their problem.



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Similar Products

1. What is the product called?

2. How is your solution similar to it?

3. How is your solution different from it?

Draw a picture of the product.

1. What is the product called?

2. How is your solution similar to it?

3. How is your solution different from it?

Draw a picture of the product.

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Approve the Invention Idea:

Compare each group's idea with the Project Guidelines (pg. 3) and sign on page 4 if you feel it is appropriate. You may need to check again when they revise their design or if they choose a new solution.

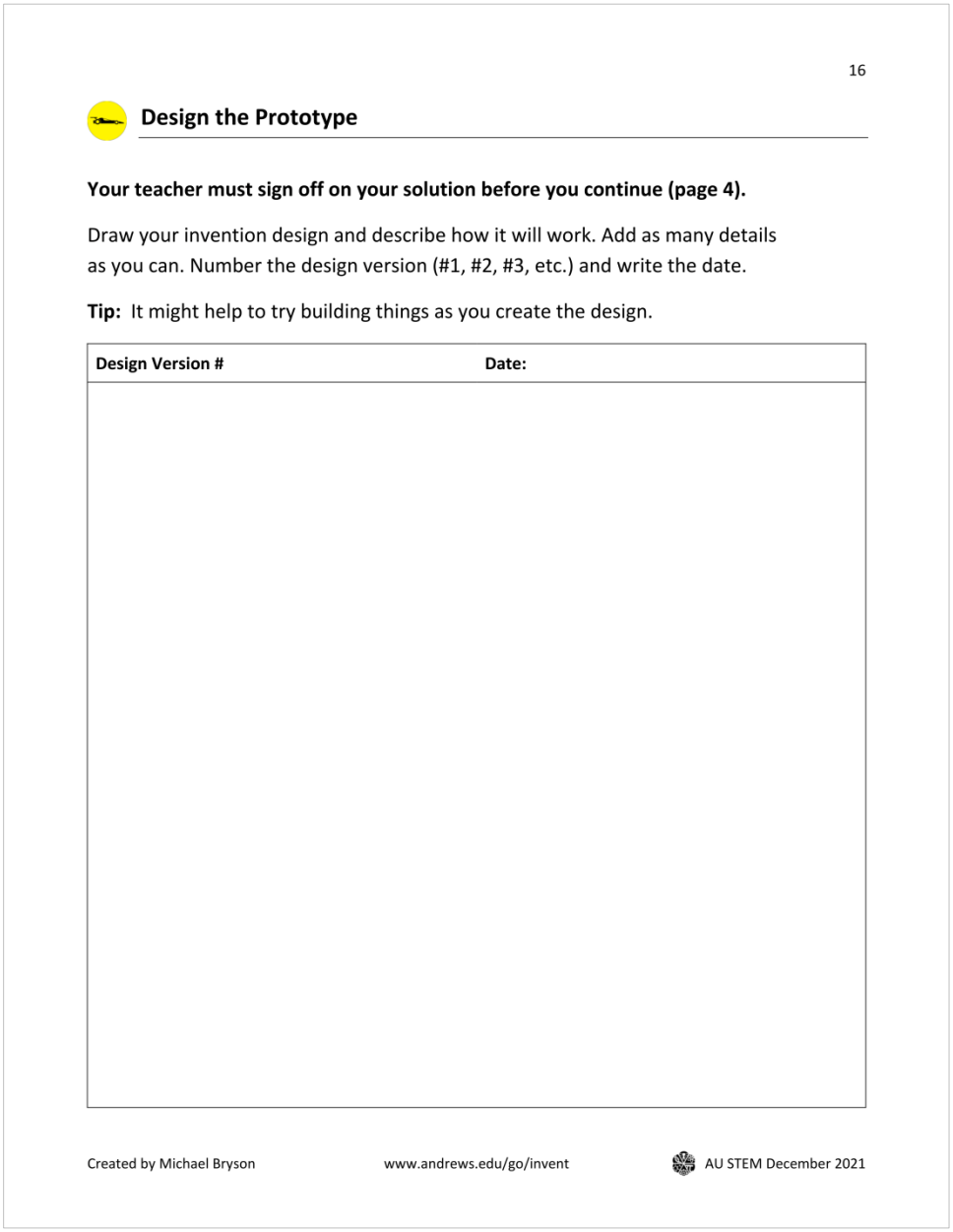
Design the Prototype

Reminder:
Review and sign off on each group's invention idea.

Design:
Before building the prototype, a design must be drawn up based on the chosen solution. This is a detailed plan showing how the invention will work, what it will look like, materials to be used, etc.

Students will work in their groups to do the following:

- Discuss and plan
- Draw their design in the box
- Answer the questions on the following page
- Write the Version # and Date at the top of each design page (Version # will be 1 until they revise it)



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Design the Prototype

Your teacher must sign off on your solution before you continue (page 4).

Draw your invention design and describe how it will work. Add as many details as you can. Number the design version (#1, #2, #3, etc.) and write the date.

Tip: It might help to try building things as you create the design.

Design Version #	Date:

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Revision:
After the students have built and tested the prototype, they may need to come back and revise their design. If they update the design, print a new copy of the design pages, and increase the version number (#2, #3, etc.).

Design the Prototype (continued)

Version # & Date:
Be sure to write the same version # and date on this page as on the previous.

Question 2 (Materials):
Students can interpret this as the cheap materials for their prototype, the permanent materials for a final product, or they can describe both.

Hands-on Design:
Students may benefit from experimenting as they plan. Trying things as you go is a good way to visualize the design and solve the problem faster.

Narrow the Focus:
Students may attempt something too big or complex. Don't limit their creativity, but if they are struggling or running out of time, you might help them scale it back a little.

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Design the Prototype

Design Version #	Date:

1. How will your invention work? Consider moving parts, power sources, etc.

2. What materials will you use to build it?

3. What tools or help will you need to build it? Will you need a large space to build?

4. Are there any other details you should include?

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Plan Enough Time!
Plan enough time for designing, building, testing, and improving the prototype. These steps will take the most time during the project.

Build the Prototype

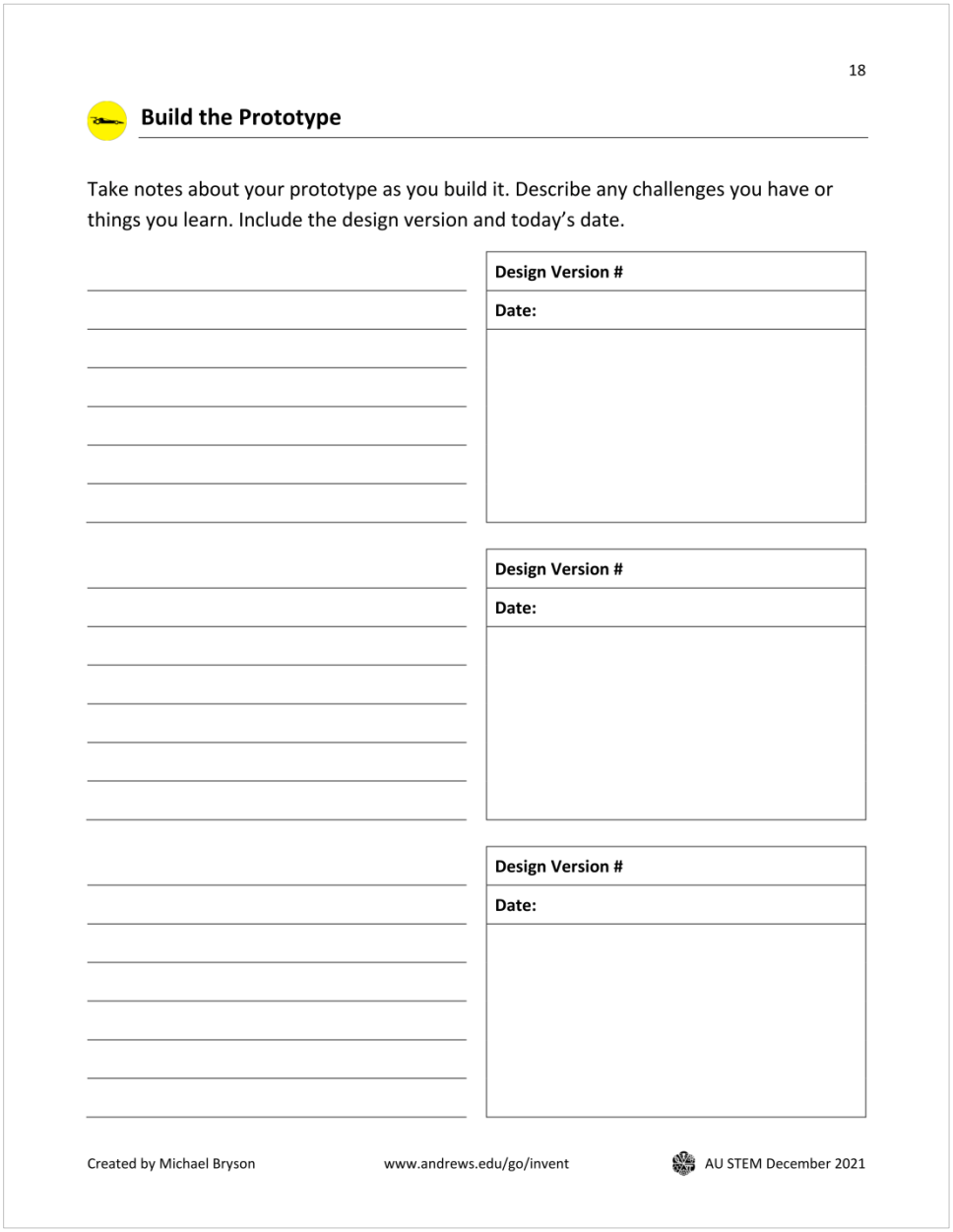
After drawing their design, the students will work with their team to build the prototype.

Provide them with inexpensive materials such as cardboard, paper, tape, glue, etc. (raid the recycle bin or the craft closet). If they want to use other materials, that's fine as long as they meet the Project Guidelines.

If their design calls for higher quality materials, they can still model it inexpensively. For example, a plastic box with metal hinges could be modeled using cardboard and tape.

The prototype is only a model of their design so it doesn't have to work perfectly. If they can make it functional that would be great, but even a static model can demonstrate how the invention works.

Challenge them to think outside the box and find creative solutions as they build their inventions.



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Build the Prototype

Take notes about your prototype as you build it. Describe any challenges you have or things you learn. Include the design version and today's date.

Design Version #
Date:

Design Version #
Date:

Design Version #
Date:

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Take Notes:

As the students work on their prototype, they should describe any challenges, decisions, etc. They will write the Version # for the design they are building and the current date. Print additional build pages as needed.

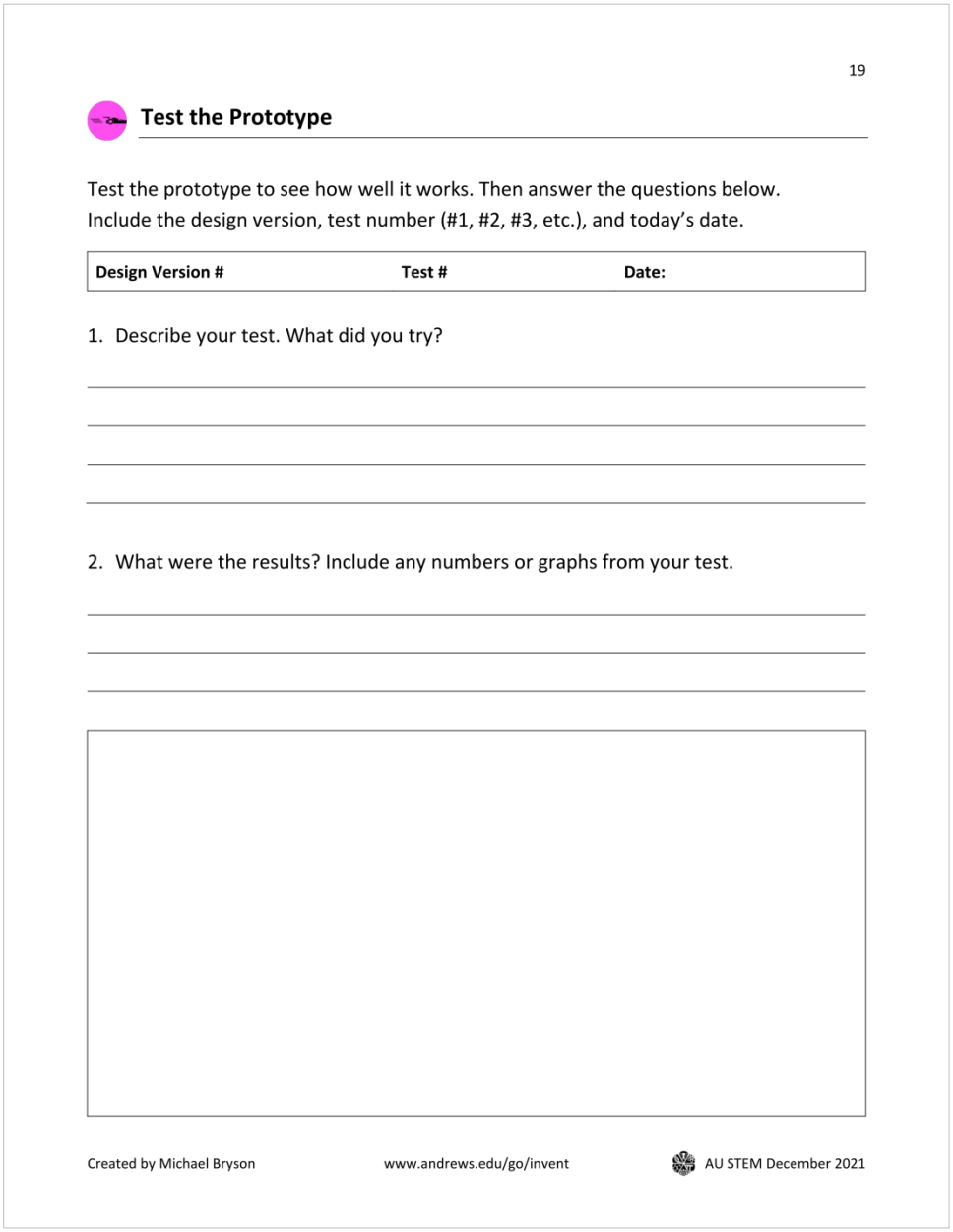
Test the Prototype

Testing is important because it tells you if you succeeded or if you need to change things.

After building the prototype (or even while they are building), the students will test their prototype to see how well it works.

In general, the prototype should be tested by using it and seeing what happens. If there are things to be measured, that should be part of testing. If the invention will be used by a certain person or group, the students can let them try it and evaluate their experience.

Afterwards, the students will answer the questions to assess how well the prototype performed and find areas for improvement.



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Test the Prototype

Test the prototype to see how well it works. Then answer the questions below.
Include the design version, test number (#1, #2, #3, etc.), and today's date.

Design Version #	Test #	Date:

1. Describe your test. What did you try?

2. What were the results? Include any numbers or graphs from your test.

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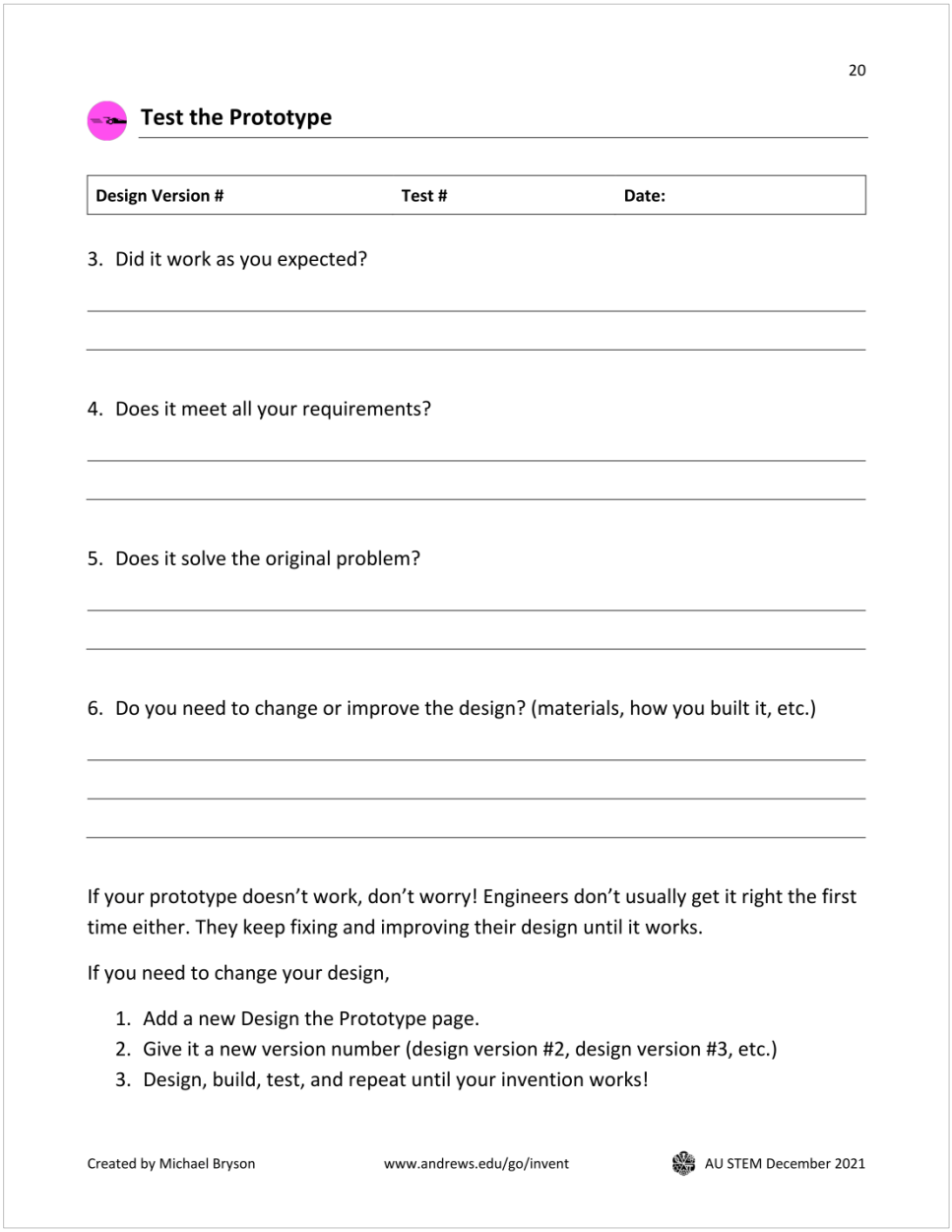
Numbers & Graphs:
Students can record any numerical data from their tests in the box on this page. This is a great opportunity to incorporate math concepts with appropriate tables and graphs.

Test the Prototype (continued)

Fill in the Design Version # and Date at the top of each testing page to keep track of which version the test was for. If they perform multiple tests on the same version, they can number the tests.



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Test the Prototype

Design Version #	Test #	Date:

3. Did it work as you expected?

4. Does it meet all your requirements?

5. Does it solve the original problem?

6. Do you need to change or improve the design? (materials, how you built it, etc.)

If your prototype doesn't work, don't worry! Engineers don't usually get it right the first time either. They keep fixing and improving their design until it works.

If you need to change your design,

1. Add a new Design the Prototype page.
2. Give it a new version number (design version #2, design version #3, etc.)
3. Design, build, test, and repeat until your invention works!

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Test it Again:
If the students change their design or switch to a new design, they will need to test the prototype again. Print another copy of the testing pages and write the new design number.

Improvement:
After testing, the students will likely need to fix things. Remind them that this is a normal part of the process. They shouldn't be discouraged if it fails the first time (or even the second or third time). Every great inventor fails before they succeed, but they keep trying until it works! If improvements are required, simply go back to the appropriate step and try again. If they change the design, remember to increase the Design Version number (#2, #3, etc.).

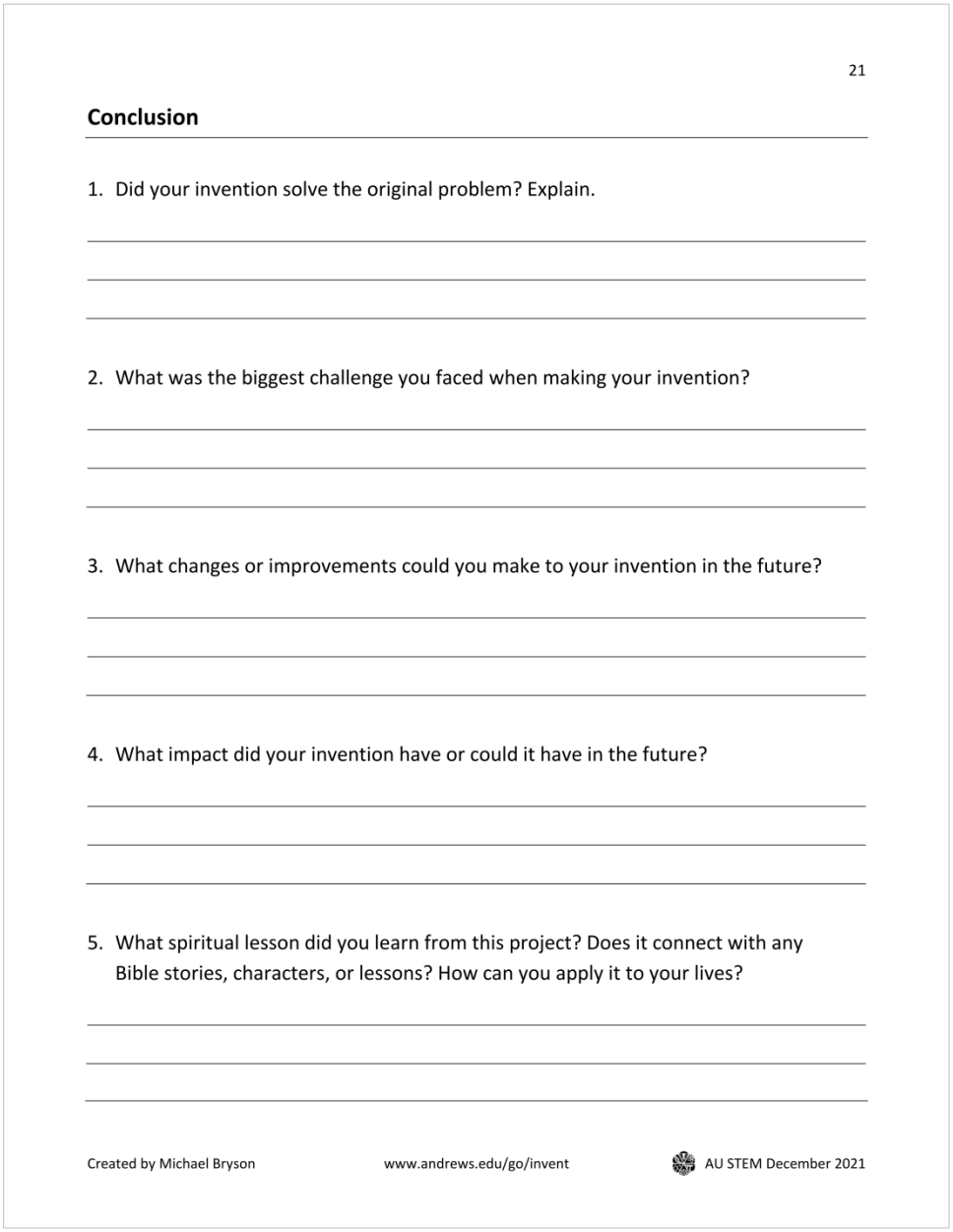
Conclusion

At the end of the project, each group will fill out the conclusion page to summarize what they did.

Questions 1-4:
The students will summarize their work.

Question 5:
This question relates their project to a Bible story, character, spiritual lesson, or anything from the Bible that connects in some way.

For examples, see the Biblical Connection section in the Teacher Resources on our website.



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Conclusion

1. Did your invention solve the original problem? Explain.

2. What was the biggest challenge you faced when making your invention?

3. What changes or improvements could you make to your invention in the future?

4. What impact did your invention have or could it have in the future?

5. What spiritual lesson did you learn from this project? Does it connect with any Bible stories, characters, or lessons? How can you apply it to your lives?

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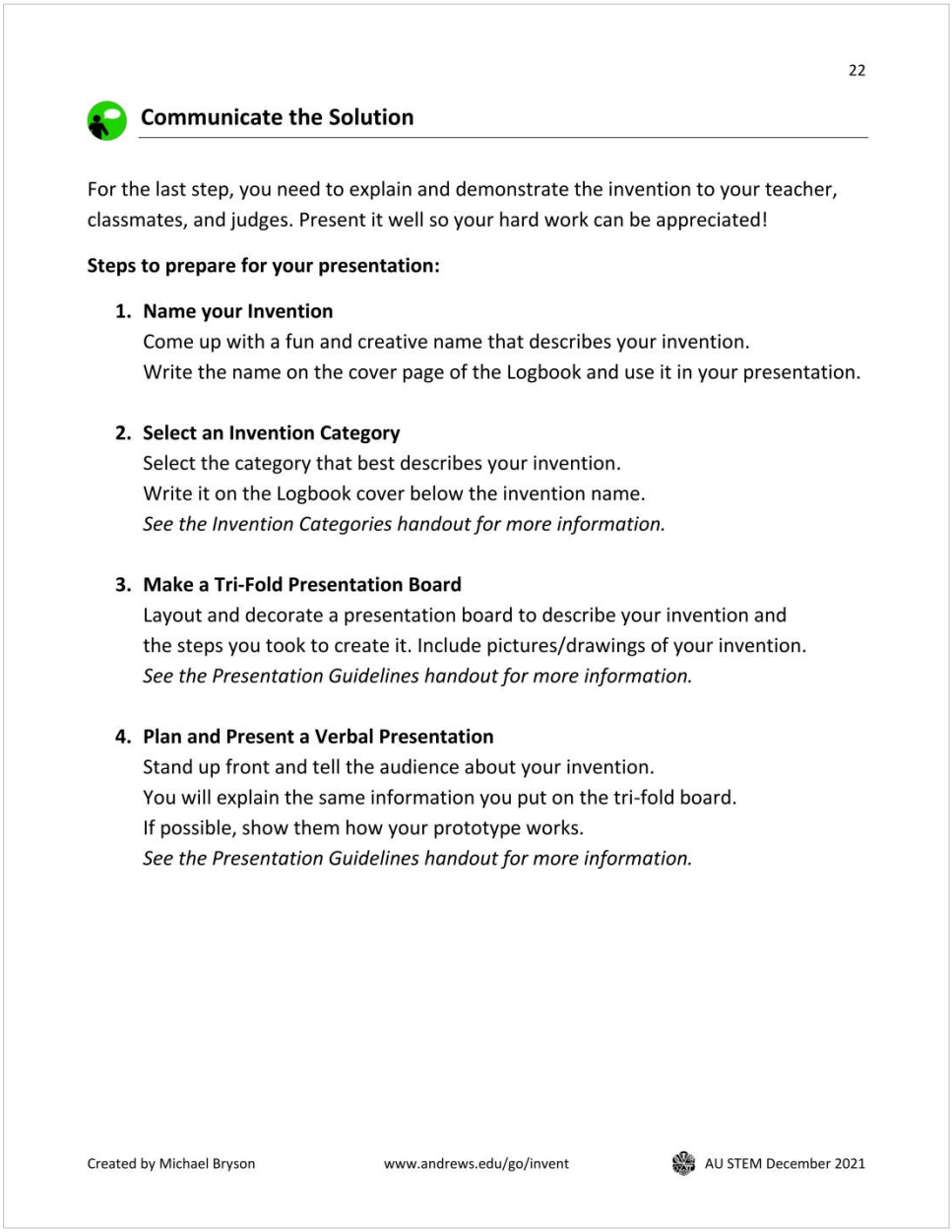
Communicate

Name the Invention:
After the students have finished their prototype, they can choose a catchy name that describes their invention and write it on the cover.

Invention Category:
Help the students choose the appropriate invention category and write it on the cover below the name.
See the Invention Categories handout for more information.

Prepare to Present:
Each group will prepare a tri-fold presentation board and a verbal presentation about their project.

The tri-fold board will follow the engineering design process with one section for each step. The verbal presentation will cover the same material.
See the Presentation Guidelines handout for more information.



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Communicate the Solution

For the last step, you need to explain and demonstrate the invention to your teacher, classmates, and judges. Present it well so your hard work can be appreciated!

Steps to prepare for your presentation:

1. **Name your Invention**
   Come up with a fun and creative name that describes your invention.
   Write the name on the cover page of the Logbook and use it in your presentation.

2. **Select an Invention Category**
   Select the category that best describes your invention.
   Write it on the Logbook cover below the invention name.
   See the Invention Categories handout for more information.

3. **Make a Tri-Fold Presentation Board**
   Layout and decorate a presentation board to describe your invention and the steps you took to create it. Include pictures/drawings of your invention.
   See the Presentation Guidelines handout for more information.

4. **Plan and Present a Verbal Presentation**
   Stand up front and tell the audience about your invention.
   You will explain the same information you put on the tri-fold board.
   If possible, show them how your prototype works.
   See the Presentation Guidelines handout for more information.

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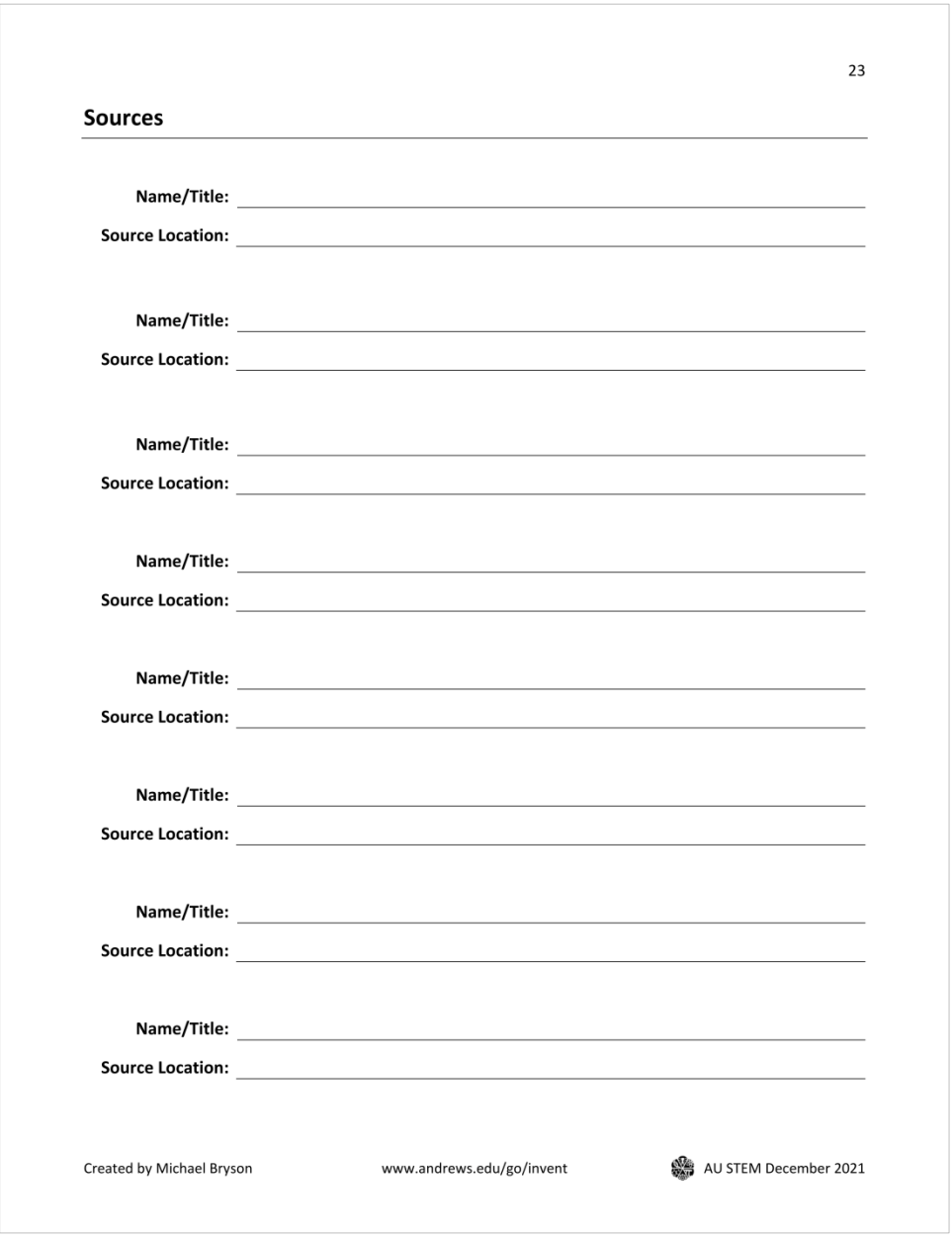
Sources

The students will keep a list of their research sources throughout the project. They should provide a brief citation where they used the information and a detailed citation here.

You can choose how they format the citations and what details to include, but at a minimum they need the name/title of the source and the location where they got it (book, website, interview, etc.). This will help them become accustomed to giving credit for information they use.

The sources in this list will be from the Research step and any other time they researched information for the project. Print additional source pages as needed.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Sources

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