Rube Goldberg Machines

Sample Design Challenge (Elementary School Level)

RUBE GOLDBERG™

iBlocks™

Teq

An iBlock is a cross-curricular learning pathway that enables students to invent, explore, and build important future-ready skills. Use our ideas, or invent your own!

Want a sneak peek at what learning redesigned can look like?

Check out this sample iBlock for the Rube Goldberg Machines Design Challenge. You'll see how the skills matrix and framework outline the entire iBlock, and how the student workbook, teacher's guide, student self-assessments/rubric, and lesson plans comprise each of the iBlock's modules.

What's Inside

1. Skills Matrix
2. Framework
3. Student Workbook
4. Teacher's Guide
5. Student Self-Assessments/Rubric
6. Lesson Plan
+ Professional Development

The **Skills Matrix** is the starting point of your iBlock. For this sample iBlock, the skills matrix outlines the phases and modules of your iBlock, the skills that will be addressed, and gives you pacing guidance.

Skills Matrix

1

STEP 1

Let's collaborate! During the discovery phase, we'll listen to your interests, ideas, and goals. We'll define the primary goal and outcome of your iBlock, and then design the skills matrix to go along with it.

This skills matrix represents the entire sample iBlock.

Skills Matrix

Module	Documentation of Design Process	Gathering Research	Make Logical Inferences from Text	Producing Informative Texts
What is a Rube Goldberg Machine?	✓	✓	✓	✓
Energy Transfer and the Rube Goldberg Machine	✓	✓	✓	✓
Identify Design Constraints & Design Solutions	✓		✓	
Test and Evaluate	✓			✓
3D Printing	✓	✓	✓	✓

Phase

- **Research and Planning**
- **Design and Construction**
- **Testing and Learning**
- **Extensions**

iBlocks: Sample Rube Goldberg Machines Skills Matrix

This skills matrix is made for **Elementary school**. The X-axis represents the skills and concepts addressed in this **iBlock,** and the Y-axis represents the lesson content.

Creating a Problem Statement	Producing Multiple Solutions	Justifying Decisions with Research	Identifying Constraints and Areas of Improvement	Upload and Edit/Optimize a 3D Object in CAD Software	Print a 3D File
✓	✓	✓	✓		
✓		✓	✓		
✓	✓	✓	✓	✓	✓

Consider the Framework as the backbone of your iBlock. It outlines each phase and module with associated tasks and the standards they address.

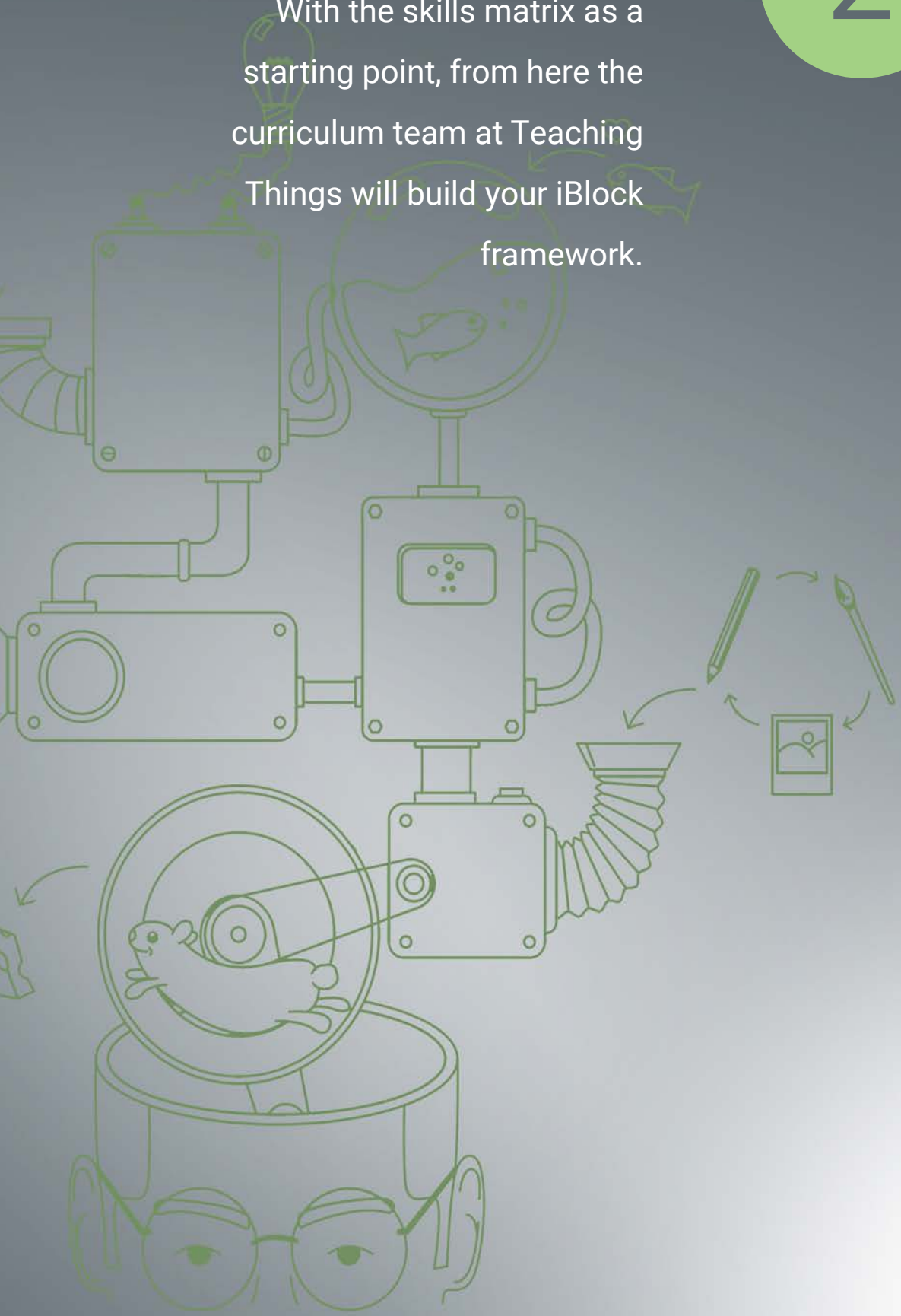
This framework represents the entire sample iBlock.

Framework

2

STEP 2

With the skills matrix as a starting point, from here the curriculum team at Teaching Things will build your iBlock framework.



iBlocks:
Rube Goldberg Machines

Framework (sample)

In order to build a Rube Goldberg Machine (RGM) students will research Rube Goldberg and his machines. It is important to allow ample time for students to tinker with the materials and technologies they will be using so that they have hands-on experience with how the materials operate and interact. After they have had some time to observe RGM and the materials they will be using, they can design, build, test and improve their machines. It is imperative to emphasize that RGM will fail often - it is part of the process. Additionally, students will create a theme and a story to go with the machine which can include narration, characters, and of course an intriguing plot! Modules 4 - 8 can work cyclically as you see fit in order for students to be able to produce the best RGM possible. Finally, students will get a chance to show off their work, either at a school event or by entering in the official Rube Goldberg Foundation challenge. This can include an extension of creating a video about their RGM or the process of creating it.

Table of Contents

Research & Planning Phase

Module 2 The Science of Rube Goldberg Machines

Once students have gathered knowledge of Rube Goldberg and the machine he invented, they will research how each component works. In this module, students will observe the domino effect and test various materials to see how they respond and interact differently. Students will also determine how devices may be triggered, and the patterns of chain reactions. Additionally, students will be able to identify the six types of simple machines and recognize the forms they may take in everyday life. From here, students will learn about energy, how the speed of an object relates to the energy of that object, how that energy is conserved as it is transferred and/or converted from one form to another, and about the changes in energy that occur when objects collide. The information gathered in this module will help students understand the concept of simple machines as well as consider design and construction ideas for their own Rube Goldberg Machine in the next phase.

Goal

To use evidence to construct an explanation relating the speed of an object, to the energy of that object, to make observations to provide evidence that energy is conserved as it is transferred and/or converted from one form to another, and to ask questions and predict outcomes about the changes in energy that occur when objects collide.

Next Generation Science Standards

4-PS3-2. Make observations to provide evidence that energy is conserved as it is transferred and/or converted from one form to another.

Next Generation ELA Standards

RI.4.9 Integrate information from two texts on the same topic in order to write or speak about the subject knowledgeably. (4-PS3-1)

Design & Construction Phase

Module 5 Build a Rube Goldberg Machine

Students will build a Rube Goldberg Machine based on their blueprints from Module 4 using consumables, their 3D printed element(s), and the available technology. Students and teachers should be aware of space, timing, and availability of materials. The teacher may want to provide time limits for development.

Goal

To produce a Rube Goldberg Machine using consumables and technology.

Next Generation Science Standards (NGSS)

Engineering Standards

3-5-ETS1-1. Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost.

Content Standards

4-PS3-3. Ask questions and predict outcomes about the changes in energy that occur when objects collide.

Testing & Learning Phase

Module 6 Test and Evaluate

Students will test their builds, evaluate performance, and plan an improvement. The modules in this phase are meant to work cyclically, not linearly. Students will most likely have to test, evaluate, plan, and then test again multiple times until they have created a functional Rube Goldberg Machine.

Goal

To develop a scientifically-sound study to test the RGM and its ability to perform the simple task.

Next Generation Science Standards (NGSS)

Engineering Standards

3-5-ETS1-3. Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved.

Next Generation ELA Standards

5SL1: Engage effectively in a range of collaborative discussions with diverse learners.

Share & Showcase Phase

Module 9 Inventor Showcase

Now that students have perfected their models, it's time to show them off. One hallmark of a successful learning experience is the exhibition of student work, or in this case, a Rube Goldberg showcase! It is important to create an opportunity where students are able to present their design to an authentic audience. This can be accomplished by creating class videos, having a school assembly, inviting other classes to visit, or organizing a friends and parents event. Students can also prepare for Rube Goldberg Machine Contests, challenges, and hackathons!

Goal

To showcase their machine and explain how the system functions, outlining the processes from start to finish.

Next Generation ELA Standards

5SL4: Report on a topic or text, sequencing ideas logically and using appropriate facts and relevant, descriptive details to support central ideas or themes; speak clearly at an understandable pace and volume appropriate for the audience.

Extensions

Module 10 Making Movie Magic

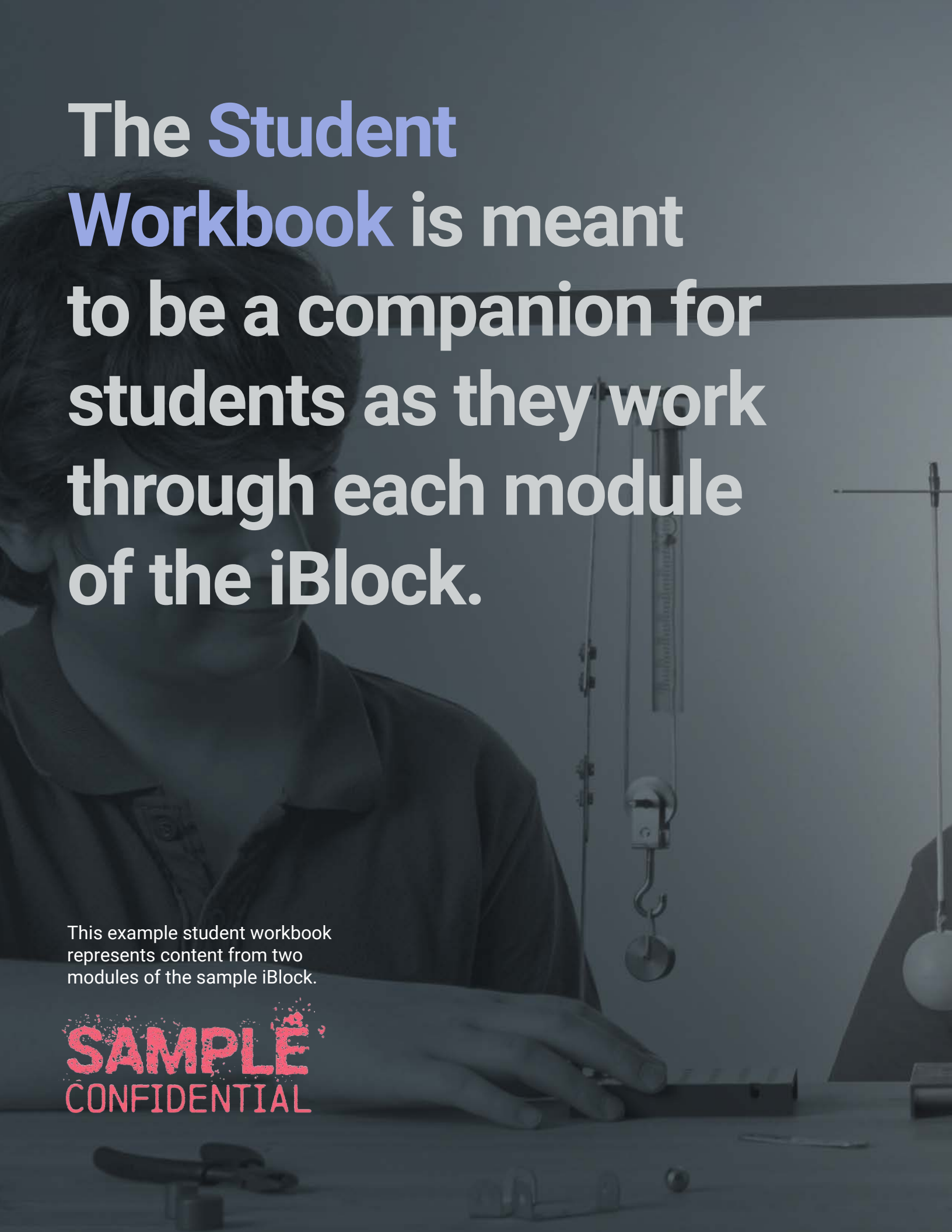
Rube Goldberg and his machines captured the imaginations of millions, in part through clever use of media such as cartoons, movies, animations and more. In this module, students will make some movie magic of their own. Students can make short cartoons, documentaries about their experience creating their RGM, or even create a short film about their story - the only limit here is imagination! There are a plethora of resources for movie creation out there. This module can be started earlier in the design process (especially if students are planning a documentary - they will need to film as they progress through the process). Be sure to bear this in mind before starting the RGM planning and build.

Goal

To create a digital story of a RGM or the process of building one with appropriate visual, audio, and story structure elements.

Next Generation ELA Standards

4SL5: Include digital media and/or visual displays in presentations to emphasize certain facts or details... and enhance central ideas or themes.



The Student Workbook is meant to be a companion for students as they work through each module of the iBlock.

This example student workbook represents content from two modules of the sample iBlock.

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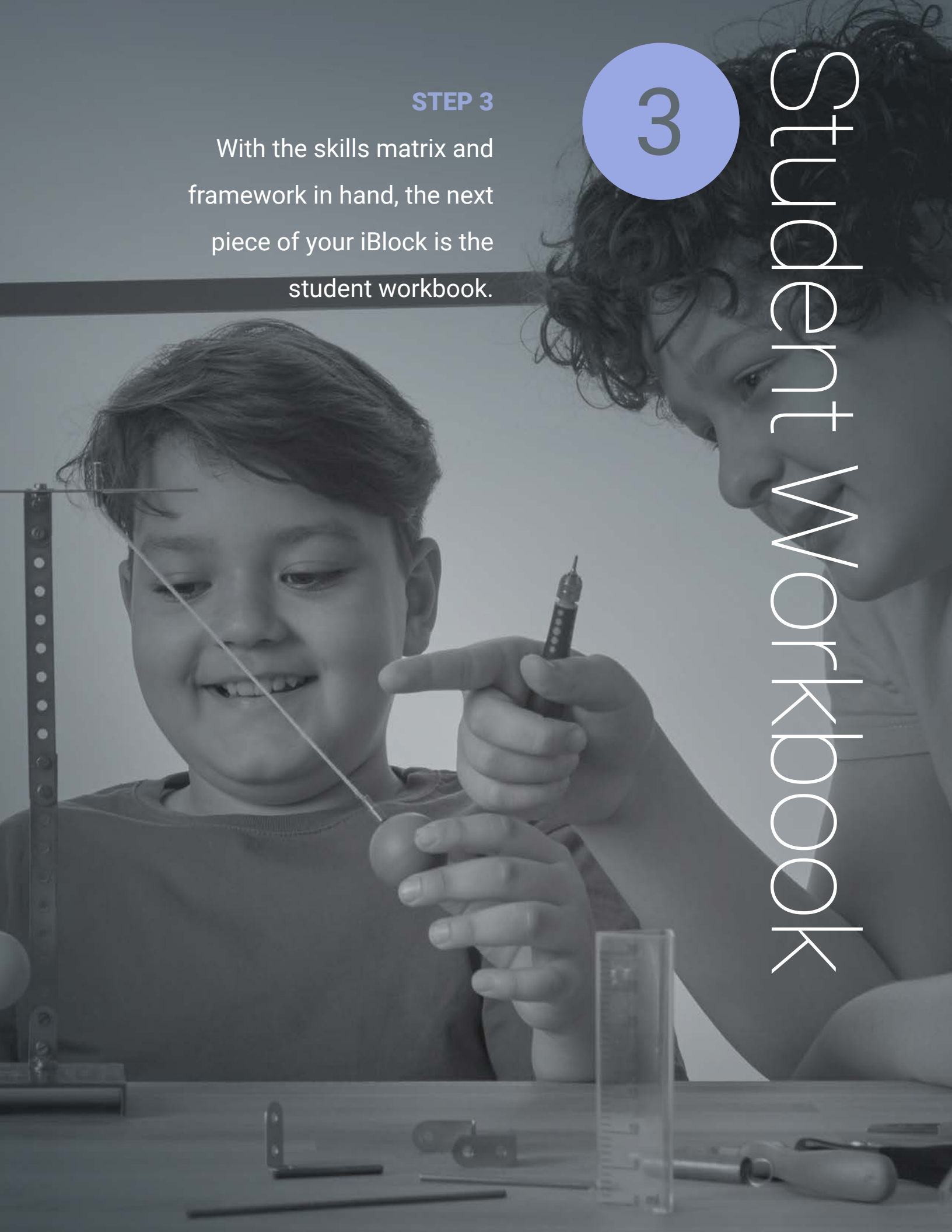

Student Workbook

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STEP 3

With the skills matrix and framework in hand, the next piece of your iBlock is the student workbook.

Research & Planning Phase

Module 2 - The Science of Rube Goldberg Machines

Task - Students will explore authentic research on how a Rube Goldberg Machine works.

Chart 2.A: Simple Machines

In your own words, identify a simple machine, describe how it works, and examples from your everyday life – you can look in your classroom, school, or home.

Simple machine	What it does	Examples

Chart 2.B: Energy

There are many different types of energy. Use the chart below to describe and give an example of each type of energy:

Energy	Describe	Example
Kinetic		
Potential		
Mechanical		
Electrical		

Design & Construction Phase

Module 4 - Design Your Machine Blueprint

3. Which simple machines are you using (from Module 2) and how will they work?

4. How will you turn on and/or activate your machine?

5. How will you know if your design is successful?

6. What limits do you have? How might these limits affect your design?

The Teacher's Guide mirrors the student workbook for each iBlock module, and contains helpful guidance and tips for teachers.

This example teacher's guide represents content from two modules of the sample iBlock.

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Teacher's Guide

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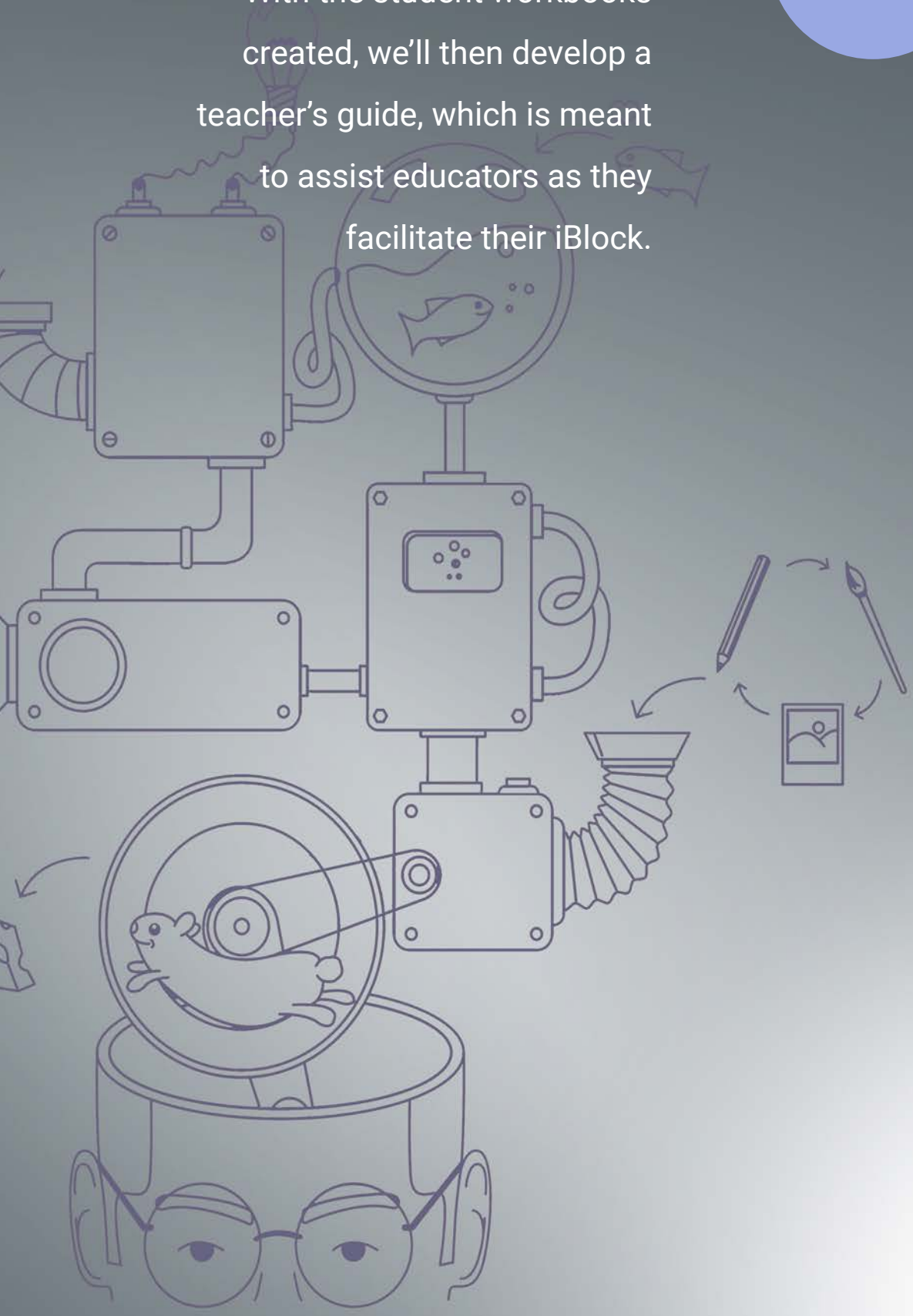
STEP 4

With the student workbooks created, we'll then develop a teacher's guide, which is meant to assist educators as they facilitate their iBlock.



Research & Planning Phase

Module 2 - The Science of Rube Goldberg Machines (continued)

Chart 2.A: Simple Machines
Rube Goldberg Machines are made up of a variety of simple machines. In your own words, describe what a simple machine is, how it works, and then find some examples from your everyday life – you can look in your classroom, school, or home.

Possible Outcomes:

Simple machine	What it does	Examples
Screw	Push/pull objects together, tighten, lift	Bolt, drill bit, bottle top, lightbulb
Incline plane	A sloped, stationary object (raised at one end)	Wheelchair ramp, truck loading gate,
Pulley	Change direction of force	Flagpole, block and tackle, crane
Wedge	Triangular tool with a thick edge and thin edge	Nail, knife, zipper, door stopper
Wheel and axle	Increases force (spin), or increases distance covered (fan)	Doorknob, screwdriver, windmill
Lever	Provides leverage, move heavy things with less effort	Seesaw, wheelbarrow, shovel

Teacher Tip:

A scavenger hunt for simple machines is a great way to engage students in the identification process. Here are some ideas:

- Take a tour of the school building/grounds.
- Have teams compete to find the simplest machines in a room/area.
- Have students identify simple machines at home.
- Have students document the simple machine with photographs (this can be good for post-hunt discussion if students are unsure about identifying a certain object).

Research & Planning Phase

Module 2 - The Science of Rube Goldberg Machines (continued)

Checkpoint:

- At this point students should be given time and materials to experiment with simple machines and types of energy. There should be a variety of materials for them to use and questions in this section should be answered after they have had a chance at hands-on discovery and after the teacher has guided students through the particulars of the physics (and equations) involved.

Chart 2.B: Energy

There are many different types of energy. Use the chart below to describe and give an example of each type of energy:

Possible Outcomes:

Energy	Describe	Example
Kinetic	Energy of an object in motion	Pool balls hitting each other
Potential	"Stored" energy, or energy that isn't currently being used, often due to position	Car at the top of a roller coaster
Mechanical	Energy used to do work. Kinetic + Potential = Mechanical energy	Hitting a nail with a hammer
Electrical	Energy that comes from an electric charge/conductor	Batteries

5. How does the speed of an object relate to the energy of that object? How about the weight of an object?

Possible Outcomes:

- The faster something goes the more energy it has. The more weight it has the more energy it has.

Design & Construction Phase

Module 4 - Design Your Machine Blueprint (continued)

3. Which simple machines are you using (from Module 2) and how will they work?

Possible Outcomes:

- Students should demonstrate their knowledge of simple machines and their ability to use them in this section. Inclined planes, pulleys, and levers will most likely be the most popular.

Teacher Tip:

- You can choose to set requirements for this part. Students can be given a set number of each type of machine you would like them to include. This will both guide their build and provide additional limits and challenges.

4. How will you turn on and/or activate your machine?

Possible Outcomes:

- Answers will vary and can include pushing a button, launching a robot, tipping a domino, etc. Students should be as creative as possible with this and weave it into their story.

5. How will you know if your design is successful?

Possible Outcomes:

- The task set was completed and all components worked together.

6. What limits do you have? How might these limits affect your design?

Possible Outcomes:

- Limits can include teacher-imposed requirements, material availability, space, time, etc.

Design & Construction Phase

Module 4 - Design Your Machine Blueprint (continued)

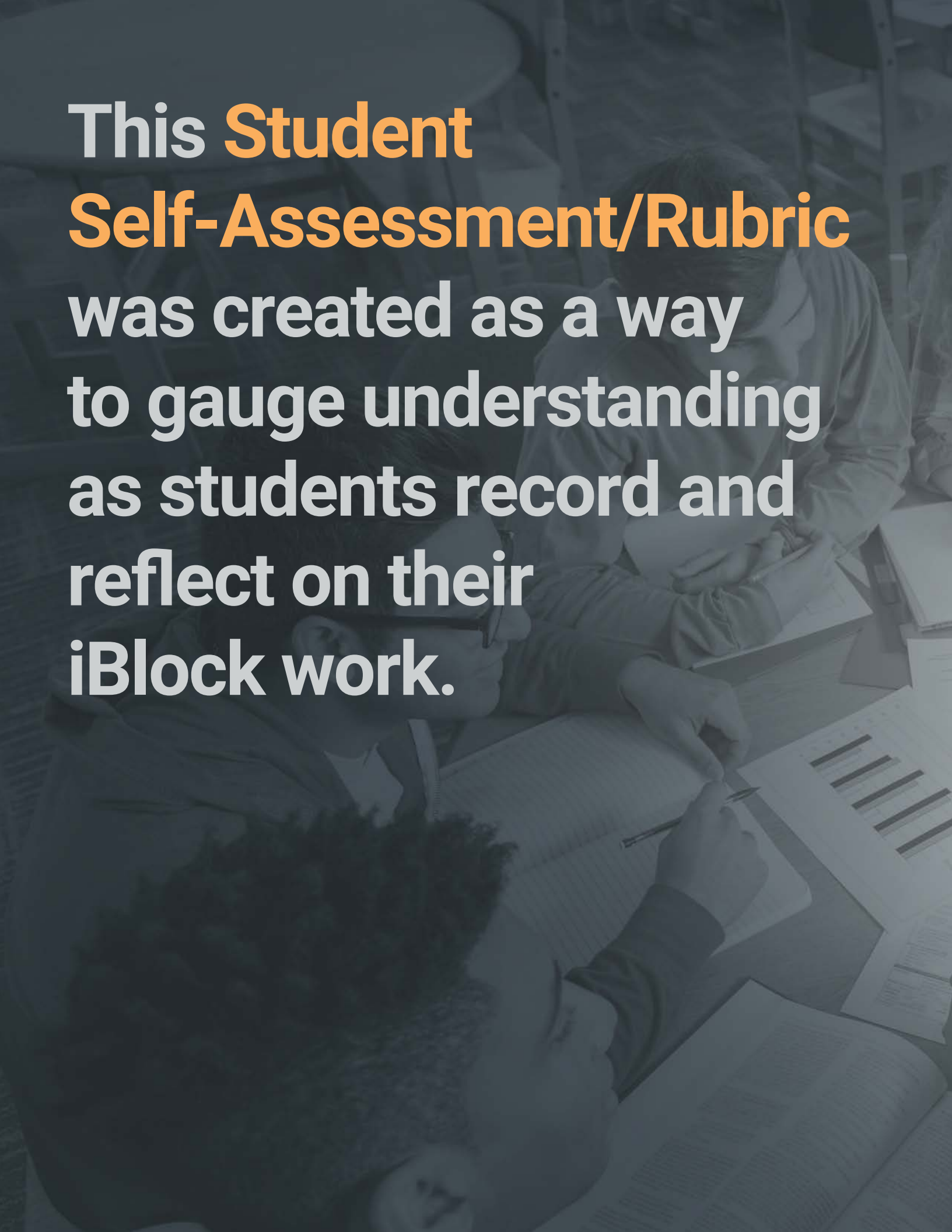
7. Sketch your machine design in the space below. Label each step using the alphabet just as Rube Goldberg did for his cartoons. Then write a paragraph or two describing how the machine works using the letters to show which step you are describing.

Possible Outcomes:

- Sketches will vary.

Suggested Resources:

- How to Make a Rube Goldberg Machine: **http://bit.ly/iblocks_rube_14**
- Interactive Digital Rube Goldberg Machines: **http://bit.ly/iblocks_rube_15**
- "littleBits Geeky Techs Rube Goldberg Challenge 2": **http://bit.ly/iblocks_rube_littlebits2**
- "Rube Goldberg Meets the Invention Age": **http://bit.ly/iblocks_rube_inventionage**



This **Student Self-Assessment/Rubric** was created as a way to gauge understanding as students record and reflect on their iBlock work.

Student Self-Assessments/Rubric

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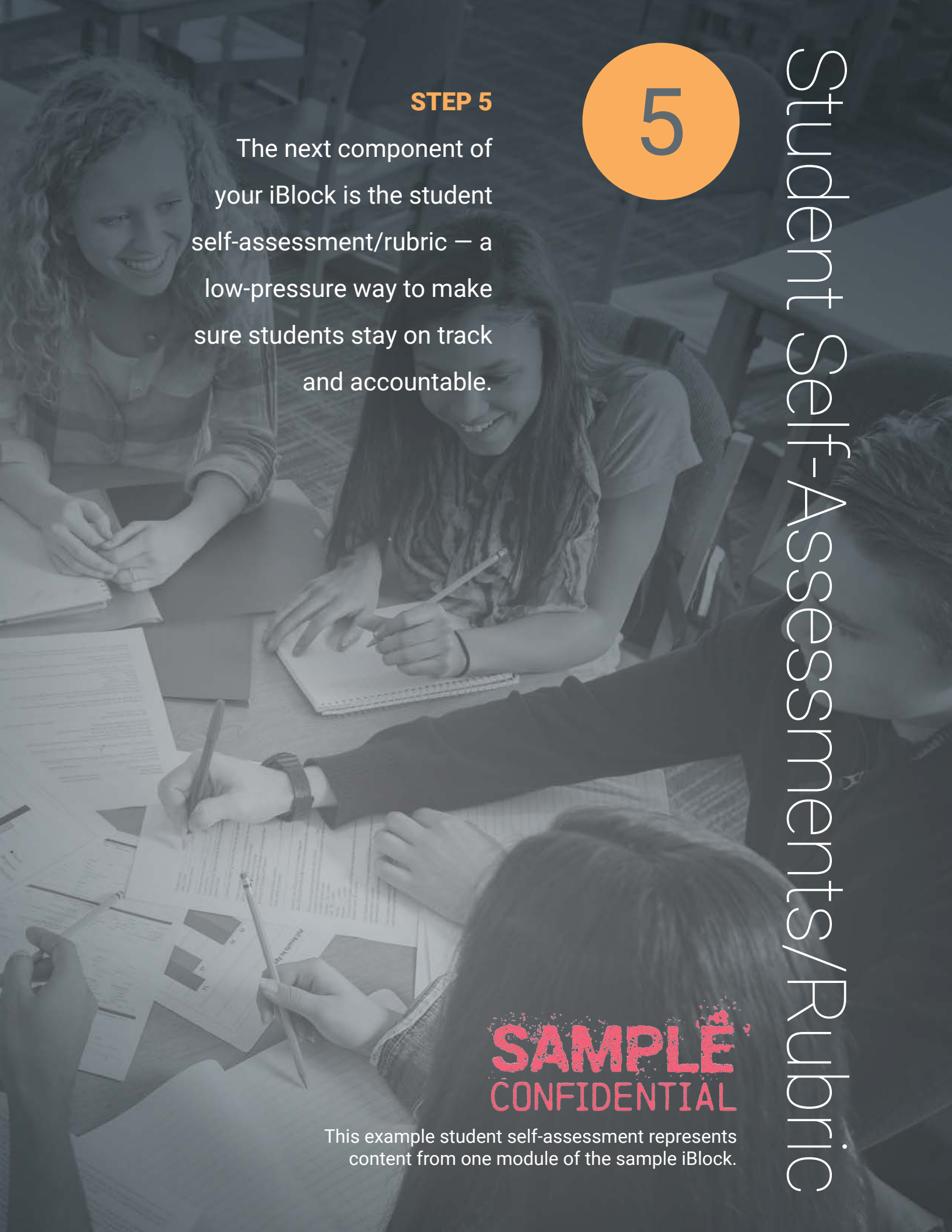
STEP 5

The next component of your iBlock is the student self-assessment/rubric — a low-pressure way to make sure students stay on track and accountable.



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This example student self-assessment represents content from one module of the sample iBlock.

Design & Construction Phase

Module 5 Build a Rube Goldberg Machine

How did you do? Read the rubric below to reflect on the skills you've learned in this module. Circle the sentence that best indicates your level of understanding for each skill/concept.

Skill/Concept	Emerging 1	Progressing 2	Proficient 3	Exceeding 4
Gathering Research	I attempted to use credible sources and my research was somewhat relevant to my project.	I used 2-3 credible sources that include a few different media types.	I used more than 3 credible sources across multiple media types.	I used a wide variety of credible sources that are relevant to the topic across multiple media types.
Producing Multiple Solutions	I developed a solution to the problem.	I developed a few solutions to the problem.	I developed multiple realistic solutions.	I developed and applied multiple realistic solutions.
Making Decisions Using Research	I made decisions using limited research.	I made some decisions using research.	I made research-based decisions.	I evaluated multiple perspectives to make research-based decisions.
Identifying Limits and Improvements	I occasionally made improvements based on identified limits.	I often made improvements based on identified limits.	I consistently made improvements based on identified limits.	I made logical improvements based on given and independently identified limits.
Providing and Receiving Constructive Feedback	I gave limited quality feedback to my peers and made limited changes to my work based on the feedback I was given.	I gave some quality feedback to my peers and made some changes to my work based on the feedback I was given.	I gave quality feedback to my peers and made appropriate changes to my work based on the feedback I was given.	I gave quality feedback with recommendations to my peers and followed up with those who gave me feedback after I made changes to my work.
Collecting and Analyzing Data	I collected and analyzed my data, but some of my data was not collected and/or I made decisions not supported by my data.	I collected and analyzed my data. I made decisions partly based on my data.	I collected all of my data and used it to make decisions.	I collected all of my data and made complex decisions based on several pieces of data.

Design & Construction Phase

Module 5 Build a Rube Goldberg Machine (continued)

Skill/Concept Table (continued)

Skill/Concept	Emerging 1	Progressing 2	Proficient 3	Exceeding 4
Identifying Parts of Stories and Story Structure	I showed a limited understanding of story structure and could occasionally identify different parts of a story in examples.	I showed some understanding of story structure and usually identified different parts of the story in examples.	I showed complete understanding of story structure and consistently identified different parts of the story in examples.	I showed advanced understanding of story structure, including additional elements based on genre, and came up with my own examples to illustrate the parts of a story.
Applying Scientific Ideas to Design, Test, and Improve a Device	I attempted to use scientific ideas to design, test, and improve a device.	I understood scientific ideas and occasionally applied them to Design, Test and Improve a project.	I understood scientific ideas and frequently applied them to Design, Test and Improve a project.	I used my understanding of scientific ideas to design, test and improve a project, then used my experience to further my understanding and continue the iterative process.
Engaging in Collaborative Discussions	I rarely participated during collaborative discussions.	I sometimes participated during collaborative discussions.	I actively participated during collaborative discussions.	I actively participated in collaborative discussions and frequently addressed new ideas to move the discussion forward.

This example Lesson Plan shows you what a fleshed out and ready-to-use lesson plan will look like.

Lesson Plan

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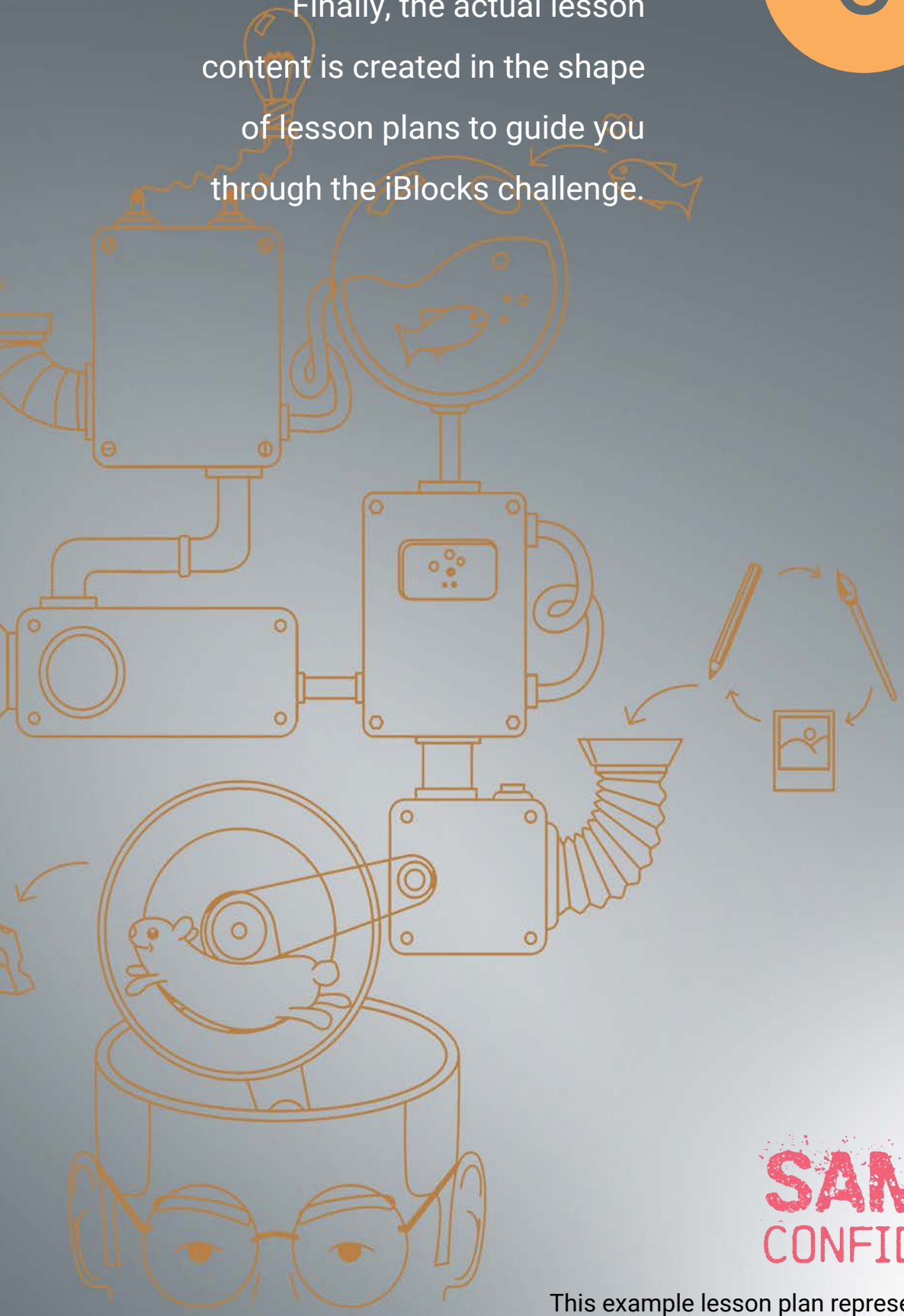
STEP 6

Finally, the actual lesson content is created in the shape of lesson plans to guide you through the iBlocks challenge.



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This example lesson plan represents content from one module of the sample iBlock.

Research & Planning Phase

LESSON 5

Complete this lesson during:

Module 2 The Science of Rube Goldberg Machines

Brief Lesson Description:

Students will learn about energy, how the speed of an object relates to the energy of that object, how that energy is conserved as it is transferred and/or converted from one form to another, and about the changes in energy that occur when objects collide. The information gathered in this module will help students understand the concept of simple machines as well as consider design and construction ideas for their own Rube Goldberg Machine in the next phase.

Learning Goals:

To use evidence to construct an explanation relating the speed of an object to the energy of that object; to make observations to provide evidence that energy is conserved as it is transferred and/or converted from one form to another; to ask questions and predict outcomes about the changes in energy that occur when objects collide.

Required Materials:

- Student Workbook
- Teacher's Guide
- Model videos of RGMs
- Internet access and student devices
- Video resources (see Framework)
- Whiteboard

Standards:

Next Generation Science Standards (NGSS) Content Standards:
4-PS3-1, 4-PS3-2, 4-PS3-3

Science and Engineering Practices:
4-PS3-3, 4-PS3-2, 4-PS3-1, 4-ESS3-1

Disciplinary Core Ideas: PS4.A, PS4.B, PS4.C

Next Generation ELA Standards:
RI.4.1, RI.4.3, RI.4.9, W.4.2, W.4.7, W.4.8, W.4.9

Next Generation Math Standards: MP.2

Lesson Plan

Estimated time for completion (in 40-minute class periods): 1-2 class periods

Introduction

Do Now: What is energy? Give at least two examples of how we use energy in our daily lives.

- Students will complete the Do Now.
- Teacher will lead a short class discussion on the answers.

Research & Planning Phase

LESSON 5

Complete this lesson during:

Module 2 The Science of Rube Goldberg Machines

- Teacher will explain the four main types of energy and ask students which they think will be used in an RGM.
- You may choose to model the activity by showing a short video clip of an RGM and identifying the types of energy used.

Lesson Activity Procedure

1. Students will find videos of RGMs (see Framework for resources) and identify the types of energy being used in the steps of that machine.
2. Teacher will lead a class discussion on what types of energy were found and the examples. You may also choose to include the chain reactions students have previously built and recorded in your examples as part of the discussion.

In Module 2 of the Student Workbook, have students complete the following:

- **Chart 2.B: Energy**
- **Questions 5-7: Research on Energy**

Assessment

Teacher should also do an informal formative assessment of students as they complete group work.

Have students complete Module 2 of their Student Self-Assessments.

Closure

Teachers will lead a short discussion on energy types and energy transfer as it relates to RGMs.

Students should add their answers to the questions and a reflection of the lesson activities as a journal entry (this can be done in class or for homework).

Professional Development

Our team will provide technical and instructional support, professional development, and any guidance necessary to ensure you get your iBlock up and running in the best way possible.

Essential iBlock Package

This package includes all components you need to implement a meaningful project-based learning experience.

[1] Skills Matrix + [2] Framework + [3] Student Workbook + [4] Teacher's Guide + [5] Student Self-Assessments/Rubric + [6] Lesson Plans

+ Complimentary implementation video to support your iBlock in the classroom

+ Additional professional development support available

iBlocks Series

Because iBlocks grow with students, they are a great way to continue exploring skills and interests in a particular field. With a series, you have the ability to extend learning from year to year and connect student learning across your building. Recommended series include topics like Building Literacy, Robotics, and Space Systems.

Custom iBlock

If you'd like your instructional staff to participate in the iBlock design and development process beyond the hours specified by your package, please let us know before your purchase order is issued. Any collaboration outside of the scope specified in each package will be billed at a daily rate, and should be reflected in the initial purchase order, as it informs the iBlock creation process.

Collaboration and Support

Looking for additional support? Our professional development team would be happy to help your school implement your iBlock(s). We offer customizable PD to fit the needs of any school or district including in-person, remote, and online options.

What is an iBlock?

Easy lift, high reward

Because iBlocks are student-led and teacher-guided, they offer a robust and creative environment for everyone. Testing, grading, and formal evaluation are eliminated, and instead, students demonstrate mastery and learning through self-evaluation, discussion, and overall engagement with the project.

An enhancement to your existing curriculum

Enrich your existing curriculum with an iBlock, or use it to kick off a STEM initiative. An iBlock is designed to supplement your instruction with content that gives students a place to invent, explore, and take ownership of their learning.

An out-of-the-box solution

Each iBlock includes everything you need to implement it effectively in the classroom, from a framework that aligns to national standards, to student workbooks, a teacher's guide to help you facilitate, and even self-assessments to help students keep their learning on track.

Driven by design thinking

In each iBlock you'll see a strong focus on engineering design concepts like researching, constructing, testing, evaluating, and redesigning, since an iBlock teaches students that learning is a journey — not a straight line.

Built around a capstone project

Each iBlock culminates in a capstone project that brings together everything students have learned throughout their iBlock, from their earliest research to their latest redesign.

The iBlocks Impact

Bring STEM into the classroom with activities that excite students, take the pressure off teachers, and align to important learning standards.

Prepare students for the future with project-based activities that develop skills like critical thinking, teamwork, and creativity.

Provide students with hands-on learning that puts them in the lead as they investigate, explore, and create!

An iBlock offers...

Transferable Skills

iBlocks engage students in the design process, ensuring that they build proficiencies around critical and inquiry-based thinking, problem-solving, communication, and decision making that will sustain them throughout their lives.

Advanced Literacy

iBlocks contain suitable vocabulary, writing prompts, discussion starters, and pitch and argument crafting, to promote academic success with advanced literacy styles and techniques.

Social-Emotional Learning

Social-emotional learning (SEL) is intrinsic to every iBlock. While students engage with their project-based learning, they will be prompted to assess their performance, talk about challenges they faced, learn how to overcome them, and build resilience. In addition, students will build teamwork skills, learn how to give and receive peer feedback, and engage in responsible decision-making.

iBlocks™

Project-Based Learning

Are you ready to explore?

Contact Teq to start the
iBlocks conversation!

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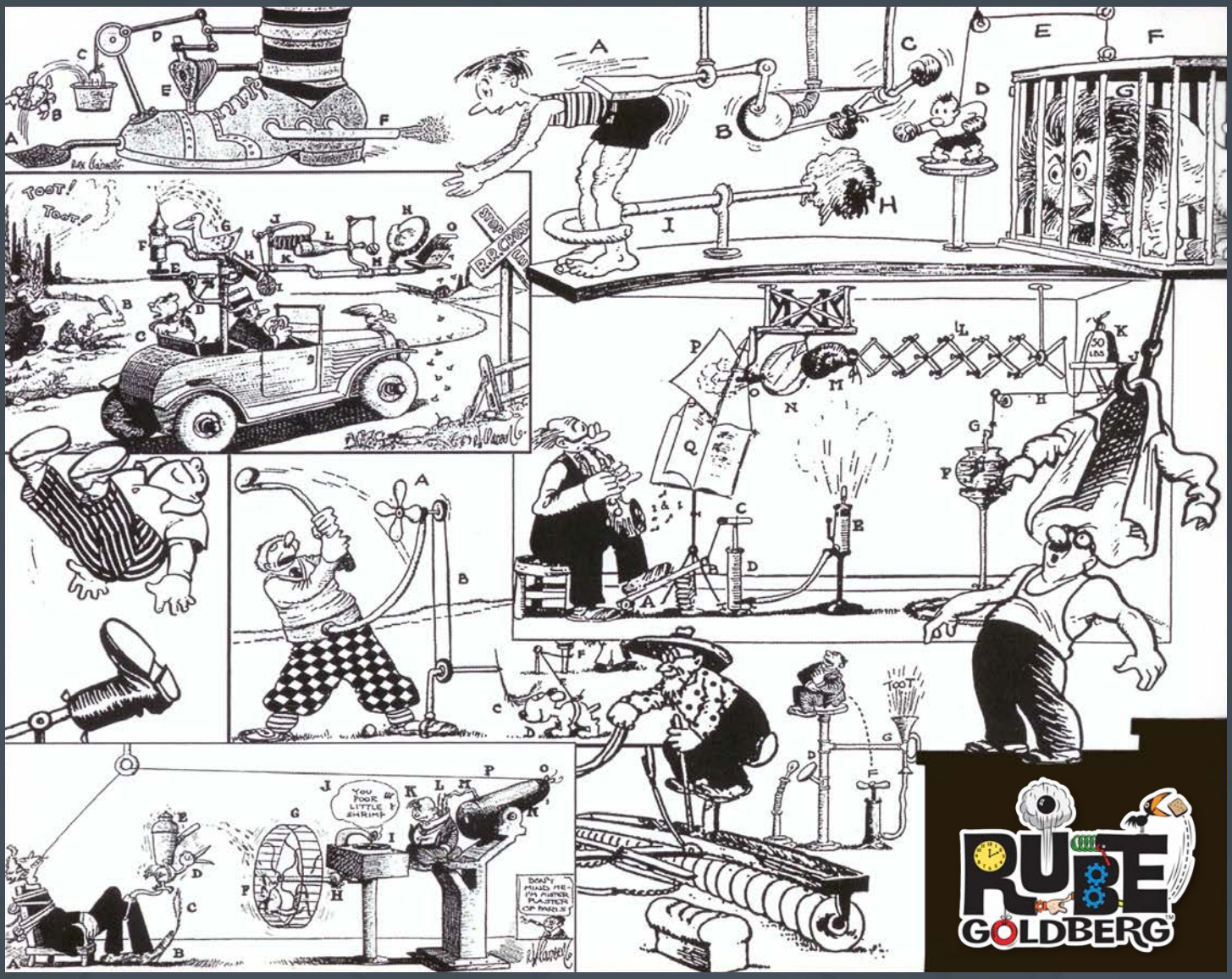

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