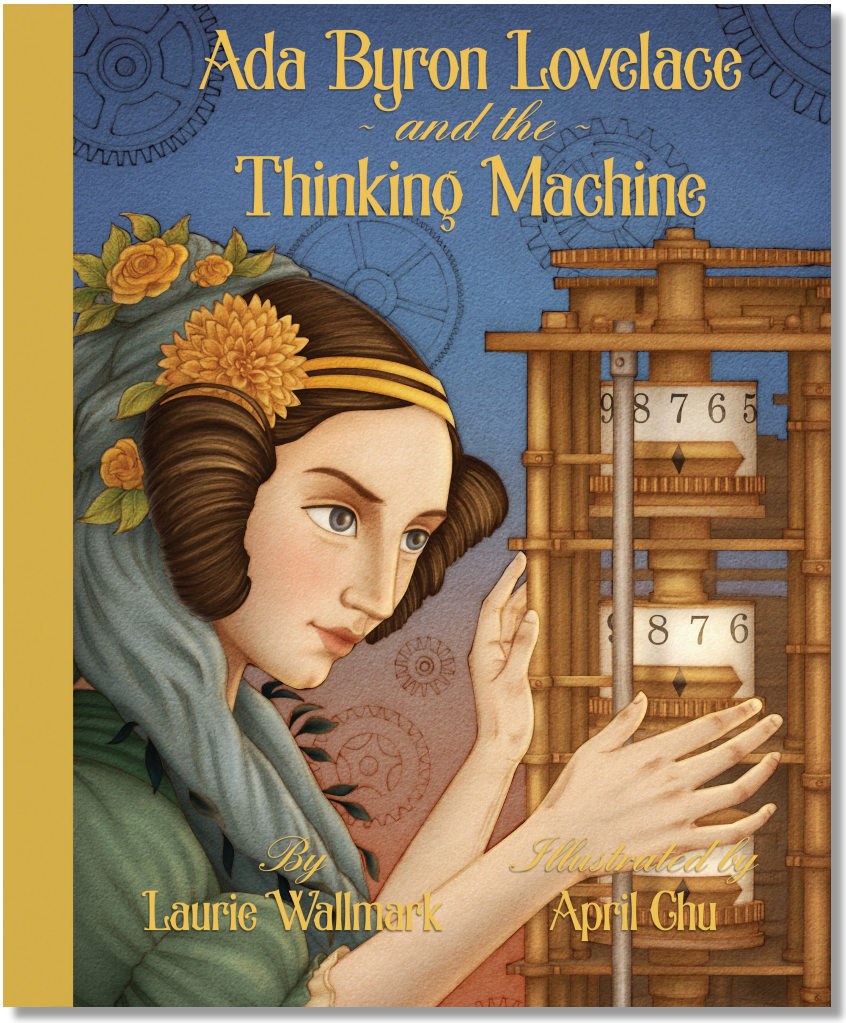
Ada Byron Lovelace
and the Thinking Machine

A teacher's guide created by Marcie Colleen
based upon the picture book
written by Laurie Wallmark and illustrated by April Chu



Published by Creston Books, LLC

"*A splendidly inspiring introduction to an unjustly overlooked woman*."
— Kirkus starred review.

Laurie Wallmark
Author, ***Ada Byron Lovelace and the Thinking Machine***

Laurie Wallmark has published stories in *Highlights*, *Cricket*, and other children's magazines. When not writing, she teaches computer science. *Ada Byron Lovelace and the Thinking Machine* is her first book. She lives with her scientific, mathematical family in New Jersey. For more information, visit www.lauriewallmark.com.

April Chu
Illustrator, ***Ada Byron Lovelace and the Thinking Machine***

April Chu began her career as an architect with a degree from the University of California, Berkeley, but decided to return to her true passion of illustrating and storytelling. She recalls spending most of her childhood drawing whimsical characters in her notebook after school every day, and she hasn't stopped drawing ever since. April currently lives and works in Oakland, California. This is the second picture book she has illustrated. For more information, visit www.aprilchu.com.

Marcie Colleen
Curriculum Writer

This guide was created by Marcie Colleen, a former teacher with a BA in English Education from Oswego State and a MA in Educational Theater from NYU. In addition to creating curriculum guides for children's books, Marcie can often be found writing picture books of her own at home in San Diego, California. Visit her at www.thisismarciecolleen.com.

How to Use This Guide

This classroom guide for *Ada Byron Lovelace and the Thinking Machine* is designed for students in first through fourth grade. It is assumed that teachers will adapt each activity to fit the needs and abilities of their own students.

It offers activities to help teachers integrate *Ada Byron Lovelace and the Thinking Machine* into English language arts (ELA), mathematics, science, and social studies curricula.

All activities were created in conjunction with relevant content standards in ELA, math, science, social studies, art, and drama.

Common Core Aligned for Grades 1-4 in both ELA and Math

1st grade: ELA.RL.1.1,2,3,5,7; RI.1.1,2,3,4,6,7,8,9; W.1.2,3; SL.1.1,2; L.1.1,2,4; MATH 1.OA.3; 1.MD.4

2nd grade: ELA.RL.2.1,3,5,6,7; RI.2.1,2,3,4,6,8,9; W.2.1,2,3; SL.2.1,2,5; L.2.1,2,3,4; MATH 2.OA.1

3rd grade: ELA.RL.3.1,3,4,7; RI.3.1,2,3,4,6,7; W.3.1,2,3,4,7,8; SL.3.1,2,3,4,5; L.3.1,2,3,4; MATH 3.OA.1; 3.MD.2

4th grade: ELA.RL.4.1,2,3,4,6; RI.4.1,2,3,4; W.4.1,2,3,4,7; SL.4.1,2,5; L.4.1,2,3,4; MATH 4.OA.1,5

Table of Contents

English Language Arts

Reading Comprehension

Before reading *Ada Byron Lovelace and the Thinking Machine*

Look closely at the Front Cover ~

- Describe what you see.
- Who do you think the woman is? What is she doing?
- Imagine you are the woman in the illustration. How does her pose make you feel?
- When do you think this story takes place? Today or a long time ago? What clues on the cover tell you this?
- Can you guess what the story might be about? What are some clues that tell you the setting?

The Back Cover~

- Read the quotes on the back cover.
- Do these quotes make you want to read the book? Why or why not?
- Who are the quotes from? Why do you think these people's thoughts were included on the back cover? What makes their words important?
- What do you learn about the book from these quotes? Make a list of all of the words that stand out to you.

Now read or listen to the book.

Help students summarize in their own words what the book was about.

- Describe Ada's mother. Describe Ada's father.
- Which does Ada prefer, numbers or words?
- When Ada is lonely, what keeps her company?
- What invention leads Ada to experiment with wind during a storm?
- How does Nanny feel about Ada's experiments? How is this different from how her mother feels?
- Ada gets the measles and it leaves her paralyzed and blind. How does her mother help her keep her mind sharp? Does Ada need to be able to walk or see in order to do math?
- How does Ada's mother support her love of numbers and math?
- Who was Mary Fairfax Somerville?
- Who was Charles Babbage? How did Charles Babbage and Ada meet? Describe their relationship.

- What was Babbage's Difference Engine? How could this machine assist inventors like Ada?
- Like Ada's Flying Machine, Babbage's Analytical Engine was never built. But what did Ada do to help further the Analytical Engine's possibilities?
- How does Ada's influence live on today?

Let's talk about the people who made *Ada Byron Lovelace and the Thinking Machine.*

- Who is the author?
- Who is the illustrator?
- What kind of work did each person do to make the book?

Now, let's look closely at the illustrations.

- Check out some of the following details that April Chu includes. Can you find:
    - "Epitaph to a Dog"
    - A mechanical flying bird
    - A toy horse with wings
    - "Flyology"
    - A turtle
    - A stow-away frog
    - Babbage's mechanical doll

In the style of April Chu,

- Research the dress styles of the mid-nineteenth century and look closely at how people are dressed in *Ada Byron Lovelace and the Thinking Machine.*
- Print out photos from the Internet of people dressed in that style.
- Draw your own character wearing clothing from this time period.
- Display the finished drawings in the classroom.

Reading Nonfiction

While reading *Ada Byron Lovelace and the Thinking Machine* aloud to the class, have students take notes in two columns:

- *Things We Learned*
- *Questions We Have*

Pause before each page turn to add notes to the columns. These columns can either be individual or hung on the board and worked on as a class.

Things We Learned (Facts)	Questions We Have	Answers We Found

- Once the story is read, discuss the *Questions We Have* column.
    - Were any of these questions answered as the story went along?
    - If so, ask students to find the answer within the text.
    - Record the answer next to the question in a third column labelled *Answers We Found.*

- For all remaining questions in the *Questions We Have column*, that have yet to be answered, students will need to take the steps to find answers, either through Internet or book research.
    - Discuss how to find answers to questions through research.
    - Assign students to specific questions to help them focus.
    - Record all answers in the *Answers We Found* column.

- After the answers have been shared with the class, engage in a discussion on research practices.
    - What was the most difficult about finding answers?
    - Was it easier to find answers on the Internet or in a book?
    - Which source is more reliable, the Internet or a printed book? Why?
    - How can you determine whether or not to trust a source?
    - What tips would you give someone who is about to do research?

- Read the Author's Note at the back of the book.
    - Create an additional chart to document what information in the Author's Note was included in the story and what information was not included.
    - Why do you think Wallmark chose to include certain information and leave other information to the Author's Note?
    - Choose three facts from the Author's Note and explain why you think each was not included in the story.

Extension: Design and illustrate posters representing each Fact, Question, and researched Answer based on *Ada Byron Lovelace and the Thinking Machine* and display them within the classroom.

Writing Activities

How to Write Technical Directions and Instructions

Programs, like Ada's, tell a computer what to do and how to do it. The instructions have to be detailed and precise, since, as Ada remarked, computers can't think for themselves.

These activities lend themselves nicely to a conversation about being accurate and detailed in explanations, particularly in writing.

Treasure Hunt

Hide an object in the room, then give a student written (or verbal, depending on class reading level) step-by-step directions that will lead them to it. For example, "Walk forward. Stop. Now turn to your right, towards the bookcase. Reach down. Open the cabinet door."

Once the object has been found, students may pair up and take turns hiding an object and giving the instructions to their partner to find it.

Making a Sandwich

As a class, create a list of instructions on how to make a peanut butter and jelly sandwich. Be careful to not miss a step.

1) Gather the ingredients: a jar of peanut butter, a jar of jelly, and two slices of bread.
2) Get your tools: spoon, knife, plate, etc.
3) Lay the pieces of bread side by side on the table.
4) Open the jar of peanut butter.
5) Place the knife in the jar and scoop out some peanut butter.
6) Spread the peanut butter on one of the slices of bread.
7) Open the jar of jelly.
8) Using the spoon, scoop out some jelly and spread the jelly on the other piece of bread.
9) Place the pieces of bread together, joining the jelly and the peanut butter sides.
10) Using the knife, cut the bread in half.
11) Place on plate.
12) Eat.
13) Clean up and put the jars of peanut butter and jelly away.

For some extra fun, bring in all of the tools necessary to complete a recipe and have the students walk you through step by step. If they miss a step, hilarity might ensue!

My Amazing Invention ~ a creative story

Lead students in a discussion about inventions.

- What is your favorite machine?
- Who invented it?
- If you could invent anything, what would you invent and why?
- What would you need to create your invention?

Create a fictional story, pretending to be an inventor who has created something amazing! Include a blueprint drawing to best explain how it is built. Be imaginative.

Each story should include a beginning, a middle and an ending.

Optional: Create the story together as a class.

I Want to Study Numbers: Writing a Persuasive Essay

Sometimes other people do not quite understand the work of an inventor or creator. Her nanny didn't understand her need to get dirty and experiment. Some tutors thought she should only study "ladylike" subjects such as needlework and art. Society didn't believe that women had a place in the world of mathematics and sciences. At times like these, a little persuading can help.

Ask your students if they know what "persuade" means. If not, can they make any guesses?

Discuss:

- What it means to persuade
- Times you might want to persuade someone (e.g., persuade your parents to let you stay up late, persuade your teacher to not give a test)

Writing to persuade tells the reader what you believe, gives the reader at least three reasons why you believe it, and has a good ending sentence. You want to try and convince the reader to agree with you.

Pretending to be Ada Lovelace, have students write a persuasive essay to someone who disapproves of girls studying math. Use the following TREE structure:

T = Topic sentences	The topic sentence tells the reader what you think or believe. Example: *I am writing to you*

	because I believe strongly in your work and, as a fellow mathematician, I would desire to study under your tutelage.
R = Reasons	The reasons why you believe what you believe. Write at least two to four sentences supporting three reasons. Use evidence directly from the text.
E = Ending	Wrap it up with a conclusive sentence.
E = Examine	Look closely. Do you have all of your parts?

Share your essays with the class. Which is the most persuasive? Why do you think so?

Speaking and Listening Extension: Create a TV commercial or PowerPoint presentation to encourage people to read *Ada Byron Lovelace and the Thinking Machine.* Be sure to incorporate the TREE structure!

<u>Language Activities</u>

New Vocabulary: Brainstorming

All inventors and creators brainstorm, but what is brainstorming?

- To demonstrate, show the class a paper plate.
    - Then, give the class two minutes (use a timer) to list as many things as possible that the paper plate can be used for.
    - Record their ideas on the board.
    - Once the two minutes is up, review the list on the board.
    - Explain that what they were just engaged in was brainstorming.

Look up "brainstorming" in the dictionary. (Depending on the level of your students, a student volunteer can do this or the teacher can.)

- Read the definition.
- Explain that a brainstorm is when you take all of the ideas in your head and let them out, kind of like how a cloud lets out all of the rain during a storm.

Explain the "rules of brainstorming."

- Nothing is a bad idea. Do not criticize any ideas while brainstorming.
- Hitching is welcome. Listen to others' ideas and let their ideas spark new ideas in you. This way, through group brainstorming, ideas often build upon each other.

- Be off-the-wall. Outrageous and humorous ideas are welcome.

Now knowing what we do about brainstorming, let's try some brainstorming activities.

- Categories Game. Have students sit in a circle and take turns brainstorming items in the announced category. For example, "animals." Go around the circle and have each child name an animal. They cannot repeat a response that another child gave. Go around the circle more than once if kids seem to have more ideas in that category. Other potential categories include fruits, vegetables, colors, items of a specific color, creatures that swim, musical instruments and things with wheels.

- Hypotheticals. Move brainstorming into the abstract by having students brainstorm answers to hypothetical questions. For example, ask them what might happen if people could fly, like Ada wanted to. Record all of the answers so they can be read back to the class when the brainstorming is finished. Rather than going around a circle and putting pressure on kids to think of something new, have students raise their hands to share answers. If a child is quiet, call on him/her early in a round before too many obvious answers have been said.

- Silly Answers. Teach students that they should share anything they can think of in a brainstorm, even if it does not seem like the best answer, by having them share the silliest answers they can think of to some questions. For example, brainstorm the silliest way to get from one end of the room to another. Turn it into a physical activity by having them demonstrate their silly methods, too. When students start running out of ideas, ask: "Who can think of something even sillier?" to prompt more responses.

After better understanding brainstorming, discuss:

- The value of brainstorming.
- Why brainstorming is so important to inventors and creators.
- Examples from *Ada Byron Lovelace and the Thinking Machine* that show brainstorming.
- How students could use brainstorming in their everyday life.

Math

Beat the Thinking Machine *(CCSS 1.OA.3; 2.OA.1; 3.OA.1; 4.OA.1)*

Ada's fingers would ache after hours of calculating numbers. She decided to create a faster and easier way—and using Babbage's Thinking Machine.

Do you think you could beat the Thinking Machine?

Have students brainstorm the many ways to calculate numbers: in your head, counting on fingers, using pencil and paper, using models or props, an abacus, a slide rule, a calculator, a desktop computer, a smart phone app, etc.

Then, provide a stopwatch and a list of calculations to be computed.

Create a chart, like the one below, to record how long it takes to complete the calculations using the many different methods. Have each student record their own times and then compare them to the times recorded by the others in the class.

Method of Calculation	**Time**	**Time Difference from the Fastest in the Class**	**Class Average**
In your head			
Counting on fingers			
Calculator			

Math Without Numbers

Inventors and engineers use math skills every day, even when they don't use numbers. These skills are important to anyone who is thinking critically and solving problems.

Help your students practice with the following activities:

Classifying and grouping games: *(CCSS 1.MD.4; 4.OA.5)* Mixing many kinds of blocks and ask students to classify them by size, color, or shape. Older children can classify and group themselves based on birthday months, height, color of clothing, etc.

Estimation: *(CCSS 3.MD.2)* Using several sized containers and dried beans, students are to guess which containers will hold the most beans and which containers will hold the least beans. Have students put the containers in order according to their capacity.

Once the class has agreed on the order, fill each container with beans, one at a time. Count how many beans are in each container. Were they right about the order?

Patterning: Build a simple pattern using M&Ms, buttons or pieces of paper. Start with an alternating pattern (called an AB pattern): one red candy, one green candy, one red, one green, and so forth. Be sure to repeat the pattern at least once. Next, students should continue the pattern by building a sequence that's exactly like the initial pattern. "How did you know to start with a red?" or "Why did you use a green here?" Some more difficult patterns to practice are: AAB, ABB, AABB, and ABC.

BONUS:

- How do you think classifying and grouping, estimating, and patterning assist inventors and engineers like Ada Lovelace?
- How would you use these skills in your daily activities?

Science

The Scientific Method

The Scientific Method is an eight step series that engineers, scientists and inventors use to problem solve.

Step 1: Ask a Question
Step 2: Do Research
Step 3: Guess an Answer (also called a Hypothesis)
Step 4: Test Your Guess/Hypothesis
Step 5: Did it Work? Could it Be Better? Try Again
Step 6: Draw a Conclusion
Step 7: Write a Written Report of Your Results
Step 8: Retest

After introducing the eight steps to the class, lead them through a discussion.

- Describe how these eight steps help with problem solving.
- What do you think would happen if you skipped a step?
- Why do you think step 8 is important?
- Can you find evidence that Ada Lovelace used many of these steps in *Ada Byron Lovelace and the Thinking Machine*? How so? Use textual examples.
- Develop your own version of a flying machine. Would it work? Could you actually create it?
- Create an eight page Scientific Notebook. Each page will include a separate step in the process. Imagine you are Ada Lovelace and fill each page with your notes,

drawings, and ideas about your flying machine as you move through the process. Refer to *Ada Byron Lovelace and the Thinking Machine* for ideas, as well as your own creative imagination.

Build a Bridge Challenge

This challenge allows students to test out the Scientific Method for themselves as they problem solve a way to build a bridge that really works! Of course, a little imagination is going to go a long way here, too!

- Set up two tables or desks in the classroom that have a fairly large gap in between them (approximately 3-4 feet is ideal.)
- Explain to students that they will be working in groups of 2-3 to build a bridge to connect the two pieces of furniture.
- Provide the students with several craft items (rulers, paper, cardboard tubing, empty boxes, tape, glue, etc.) Check the recycling for other ideas of materials.
- Each group's bridge must:
    - Connect the two pieces of furniture.
    - Be a construction, not merely a long piece of cardboard laid across the gap.
    - Be strong enough to hold four Matchbox cars as they cross from one side to the other.
- The groups must create an eight-page Scientific Notebook for their bridge and carefully document their use of the Scientific Method throughout the process of building their bridge.

Once all bridges have been built to connect the two pieces of furniture, test them out one by one as a class. Did they work? Retest? If they didn't work, head back to the drawing board like a real inventor.

Offer up awards to increase the competition.

- Strongest Bridge
- Most Attractive Bridge
- Most Materials Bridge
- Least Materials Bridge
- Silliest Bridge

Necessity is the Mother of Invention

Today, inventions do so many things we take for granted.

- Create a list of some of the machines or inventions that make our daily lives easier. Who invented these machines? When?

If you could invent something, what would it be?

Design your invention and create an infomercial or PowerPoint presentation demonstrating what it can do and convincing others to buy it.

Show your commercial or presentation to the class.

Social Studies

Famous Female Inventors

Assign a famous female inventor for students to research in the library and on the Internet. A list of 10 are below, but do not feel limited to those on the list.

- Margaret Knight
- Melitta Bentz
- Caresse Crosby
- Katharine Burr Blodgett
- Stephanie Kwolek
- Hedy Lamarr
- Bette Nesmith Graham
- Mary Anderson
- Ruth Wakefield
- Marion Donovan

Possible sources for information:

- Nonfiction books
    - *Girls Think of Everything: Stories of Ingenious Inventions by Women* by Catherine Thimmesh, illustrated by Melissa Sweet (Houghton Mifflin 2000)
- Encyclopedias
- The Internet

Take notes and gather as much information as possible on the following five topics about your inventor:

- Early Life/Childhood/Family

- Life as an inventor
- Famous work
- Legacy
- Other fun facts

Once the information is gathered, work to create either an illustrated poster or booklet of the findings.

Celebrate Ada Lovelace Day!

As stated in the Author's Note: *Every October, people around the world observe Ada Lovelace Day (www.findingada.com), a holiday to celebrate women in technology. Thousands of Internet bloggers post about the many women who work as computer programmers, engineers, and scientists. Ada would be delighted to know her accomplishments encourage girls to enter the world of computers.*

Celebrate Ada Lovelace Day in your classroom. It doesn't even have to be October to highlight the achievements and accomplishments women have made in the fields of engineering and science.

Possible ideas:

- Research and present on women inventors
- Create a class blog in which students can write entries regarding women in the STEM fields
- Dress as your favorite inventor
- Serve themed food (chocolate chip cookies were invented by a woman!)
- Decorate the room with tributes to historical female inventors
- Ask a female scientist or engineer to come speak or Skype with the class (a local college, laboratory, or hospital could be a great resource)
- Engage in STEM activities to develop the curiosity of science, technology, engineering, and mathematics in all students—not just females. (see Science: Build a Bridge Challenge)

Gender Bias in Science

We hope students today realize that girls can do and be anything boys can. But, bias still exists in the science, technology, engineering, and mathematics fields.

Ada Lovelace Day is a great day for a discussion on gender bias in these fields. While we rarely recognize biases within our own thinking, this activity, adapted from www.smarttutorcom, will raise consciousness and spark discussion.

1. Ask children to draw a picture of a scientist. They may not ask any questions to you or any of their peers. They must simply draw the first scientist that comes to their minds, with no talking or sharing.
2. Then, students should create a brief written description of who their scientist is and their scientist does.
3. Ask them to share their drawings and descriptions with the class.
4. While students are sharing, chart the number of male and female scientists that students create on a graph. Do not reveal what you are doing to avoid skewing the results.

Discuss the results. More often than not children draw mostly male scientists in lab coats with chemicals or something of the sort. Share the graph with the students. Do the results show an internalized gender bias? Challenge the class to discuss where they feel this bias comes from and why it is harmful to society.

Use Ada Lovelace's experience in *Ada Byron Lovelace and the Thinking Machine* as an example.

- How have the STEM fields changed for females since Ada's time?
- How have they stayed the same?
- How can we take steps to end gender bias in the sciences?