Math Mysteries: Ciphers, Games & Magic

In Math Mysteries, students will hone problem solving skills while working together to crack codes, play games, and master magic tricks. Each section (ciphers, games, and magic tricks) is fundamentally based on mathematical concepts and students will have the opportunity to learn through inquiry and problem solving. In the last three weeks of the apprenticeship, students will demonstrate their skill mastery in the National Spy Academy as they solve challenges in teams and ultimately thwart Dr. Chaos' cyber-attack on the school.

### Unit Standards and Objectives

**Standard #1: Citizen Schools students will demonstrate an ability to work as a member of a team.**

Lesson Objectives:
- SWBAT list 3 actions that make someone a good team member.
- SWBAT explain class expectations for conduct within the apprenticeship.
- SWBAT respond appropriately to praise, criticism and constructive criticism.
- SWBAT ask questions to deepen their understanding of teammate's perspectives.
- SWBAT list 2 strategies to negotiate disagreement and reach compromise successfully within a team.
- SWBAT assume shared responsibility.
- SWBAT work collaboratively to tackle an ambiguous task.
- SWBAT evaluate themselves on their ability to collaborate effectively.

**Standard #2: Citizen Schools students will share speaking time and engage in active listening.**

Lesson Objectives
- SWBAT demonstrate using 1-3 examples of empathetic language when responding to teammates.
- SWBAT understands when it is appropriate to speak vs. listen.
- SWBAT adjust work to collaborate in real time.
- SWBAT excitedly explain expectations and plans for WOW! Challenge Day.
- SWBAT evaluate themselves on their ability to collaborate effectively.

**Standard #3: CCSS.MP1 Make sense of problems and persevere in solving them.**

Lesson Objectives
- SWBAT explain what they will learn in this apprenticeship.
- SWBAT decode a Caesar Cipher.
- SWBAT create a Caesar Cipher code and write a message in code. (optional)
- SWBAT decode 1 substitution cipher.
Core Apprenticeship Library

Apprenticeship Sector: Coding & Gaming

Unit: Math Mysteries: Ciphers, Games & Magic

- SWBAT create a cipher and use it to write a note to a CT.
- SWBAT play the game Brussels Sprouts successfully.
- SWBAT predict who will win a round of Brussels Sprouts.
- SWBAT play the game Pick15 successfully.
- SWBAT define isomorphic relationships.
- SWBAT create and perform a “Guess My Number” math trick.
- SWBAT learn and perform an assigned magic trick.
- SWBAT use problem solving skills to decipher 1-2 ciphers that they have never seen before.
- SWBAT complete 2 Practice Challenges successfully in preparation for the WOW!

Essential Questions

- Do you need to be creative to be great at math?
- Which results in greater learning: failing or succeeding?
- How does working with a team improve your ability to solve a problem?

Performance Task Assessment (WOW!)

Although problem solving is a 21st century skill commonly taught and assessed within Citizen Schools apprenticeships, in Math Mysteries, the 21st century skill is collaboration. Additionally, the Common Core State Standard drives the math specific problem solving content.

The Math Mysteries: Ciphers, Games & Magic Performance Task Assessment or WOW! will take place during the 10th week of the apprenticeship as the Spy Certification Test at the conclusion of the National Spy Academy (Weeks 8-10). If your campus has an extra week to work with, consider adding a guest speaker or field trip to an office. See notes about this option in the Lesson At-A-Glance.

The WOW! begins with students expecting to take a test for their Spy Certification. However, Dr. Chaos has planned a cyber-attack on the school to destroy the students’ grade histories and prevent them from getting into college. Additionally, Dr. Chaos plans to change food delivery schedules to the school so that they only have terrible food to eat the rest of the year. Instead of completing a test, the student WOW! Teams must work together to complete challenges and thwart Dr. Chaos’ plan.

WOW! teams will receive a Student Spy Folder and envelope for WOW! Challenge #1 that contains instructions on the first challenge that they are to complete. Once they complete the challenge successfully, they will receive their next instructions.
Teams will ultimately complete three challenges that test both their problem solving and collaboration skills in the three content areas of the apprenticeship - ciphers, games, and magic. Completing these challenges successfully will stop Dr. Chaos and prevent his cyber-attack.

It is recommended that students complete these WOW! challenges as an exciting day of Spy Certification rather than as a performance or demonstration for a larger audience. If you have a WOW! Showcase where you’d also like to feature this apprenticeship, see the note at the end of this section.

Students will be grouped by teachers into WOW! Teams after week 7 of the apprenticeship. Groups should be assigned based on ability so that differentiated support can be provided and challenges can be modified as needed. Suggested modifications are included in Lesson 10 in the materials provided for each of the WOW! Challenges. Additionally, student groups can then form a sense of team and pride while practicing for the WOW! and solving practice challenges during weeks 8-9.

Goal: Students work in teams to face down Dr. Chaos and thwart his cyber attack on the school. Teams will complete three challenges in the allotted amount of time (one apprenticeship session).

Role: Students work together as the problem solvers or spies in training, using what they’ve learned over the course of the apprenticeship to complete the challenges and stop Dr. Chaos.

Audience: Students will not be performing or completing these challenges publicly, but rather will demonstrate their skills for their teachers: Citizen Teachers, Team Leaders, and volunteers monitoring and running the WOW!

Situation: Criminally driven cyber-attacks are becoming a commonplace problem for governments, companies, and individuals around the world. In this Performance Task, students will have the opportunity to stop a cyber-attack on their school by solving challenges and putting their problem solving skills to work.

Product: Students will solve three challenges that show how they have internalized content and mastered skills as they battle Dr. Chaos and seek to stop his cyber attack.

Standards: On the day of the WOW!, students will be evaluated based on completion of the challenges. Throughout the apprenticeship and including the WOW! students will be evaluated on their mastery of collaboration skills using the Citizen Schools Collaboration Rubric and Tracking Tool.

Note: If your campus also has a WOW! Showcase where you would like to feature this apprenticeship, consider having a small group of students demonstrate their skills at a booth. They could demonstrate how to create or decode a cipher, teach how to play one of more games, or perform magic tricks. While this is an engaging way for students to teach back and share content from the apprenticeship with a larger audience, it will not be a good way to accurately assess all students’ mastery of the standards. Time is planned in Lesson 9 for a co-teacher to work with this small group of students to prepare them for the
WOW! Showcase if needed. This time should be used to practice their performance and talking points, not to create a trifold, show board or poster for the apprenticeship. Creating a display does not align with the standards and thus class time should not be used for this purpose. Instead, consider creating the show board outside of class.

### Lesson Plans At-A-Glance

Lesson Plans are available [here](#).

<table>
<thead>
<tr>
<th>Week</th>
<th>Lesson Objectives</th>
<th>Agenda</th>
<th>Outcomes &amp; Work Products</th>
</tr>
</thead>
</table>
| 1    | ● SWBAT list 3 actions that make someone a good team member.  
      ● SWBAT explain class expectations for conduct within the apprenticeship.  
      ● SWBAT explain what they will learn in this apprenticeship. | ● Hook: Introductions  
      ● Introduction to New Material: Welcome to Math Mysteries!  
      ● Activity 1: Working Together  
      ● Activity 2: Caesar Ciphers  
      ● Activity 3: Fun Facts (optional)  
      ● Assessment: Exit Ticket | Students will build a sense of team in the apprenticeship while beginning their work in ciphers. |
| 2    | ● SWBAT decode a Caesar Cipher.  
      ● SWBAT respond appropriately to praise, criticism and constructive criticism.  
      ● SWBAT create a Caesar Cipher code and write a message in code. (optional) | ● Hook: Expresso Puzzle Race  
      ● Introduction to New Material: Responding Appropriately  
      ● Activity 1: Caesar Ciphers  
      ● Activity 2: Decoding  
      ● Activity 3: Create a Caesar Cipher (optional)  
      ● Assessment: Exit Ticket | Students will master Caesar Ciphers and potentially create their own Caesar Cipher. Additionally, students will learn and practice responding appropriately to praise and criticism. |
| 3    | ● SWBAT decode 1 substitution cipher.  
      ● SWBAT create a cipher and use it to write a note to a CT.  
      ● SWBAT demonstrate using 1-3 examples of empathetic language when responding to teammates. | ● Hook: Expresso Puzzle Race  
      ● Introduction to New Material: Empathetic Language  
      ● Activity 1: Substitution Ciphers  
      ● Activity 2: Decoding  
      ● Activity 3: Create a Cipher  
      ● Activity 4: Write in Cipher (optional)  
      ● Assessment: Exit Ticket | Students will complete their learning on ciphers by mastering a complex Substitution Cipher. Additionally, students will deepen their understanding of empathy and practice responding with empathy. |
| 4    | ● SWBAT play the game Brussels Sprouts successfully.  
      ● SWBAT predict who will win a round of Brussels Sprouts.  
      ● SWBAT ask questions to deepen their understanding of teammate’s perspectives. | ● Hook: Expresso Puzzle Race  
      ● Introduction to New Material: Questions  
      ● Activity 1: Brussels Sprouts: Play the Game  
      ● Activity 2: Who Will Win?  
      ● Activity 3: More Play Time (optional)  
      ● Assessment: Exit Ticket | Students will begin their learning on games by learning and playing Brussels Sprouts in the lesson. Additionally students will learn how asking good questions can facilitate their ability to collaborate. |
| 5    | ● SWBAT play the game Pick15 successfully.  
      ● SWBAT list 2 strategies to negotiate | ● Hook: Expresso Puzzle Race  
      ● Introduction to New Material: Negotiating Diverse Views (Disagreement) | Students will complete the games section of the apprenticeship by learning and playing Pick15. Through a comparison with tic-tac-
<table>
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<tr>
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<th>Core Apprenticeship Library</th>
<th>Apprenticeship Sector: Coding &amp; Gaming</th>
<th>Unit: Math Mysteries: Ciphers, Games &amp; Magic</th>
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<tbody>
<tr>
<td>5</td>
<td>disagreement and reach compromise successfully within a team.</td>
<td>Activity 1: Pick15: Play the Game</td>
<td>toe, students will learn about isomorphic relationships and how using them can make learning math concepts easier. Additionally, students will practice negotiating and compromising skills.</td>
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<td></td>
<td>SWBAT define isomorphic relationships.</td>
<td>Activity 2: Magic Square</td>
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<td></td>
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<td>Activity 3: Isomorphisms</td>
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<td>Activity 4: More Play Time (optional)</td>
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<td>Assessment: Exit Ticket</td>
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<td>6</td>
<td><strong>SWBAT create and perform a “Guess My Number” math trick.</strong></td>
<td>Hook: Expresso Puzzle Race</td>
<td>Students will learn the secrets behind “Guess My Number” magic tricks and will work in a team to create their own magic trick. Additionally, students will practice indicating when is an appropriate time to speak vs listen.</td>
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<tr>
<td></td>
<td><strong>SWBAT understands when it is appropriate to speak vs listen.</strong></td>
<td>Introduction to New Material: Speaking &amp; Listening</td>
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<tr>
<td></td>
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<td>Activity 1: Guess My Number</td>
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<td>Activity 2: Create a trick</td>
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<td>Activity 3: Figure out a friend’s trick (optional)</td>
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<td>Assessment: Exit Ticket</td>
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<td>7</td>
<td><strong>SWBAT learn and perform an assigned magic trick.</strong></td>
<td>Hook: Expresso Puzzle Race</td>
<td>Students will learn a trick from Mathemagic and learn the math that makes their trick work. Additionally, students will think about the differences between working in a team vs working as an individual.</td>
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<td></td>
<td><strong>SWBAT adjust work to collaborate in real time.</strong></td>
<td>Introduction to New Material: Adjusting Work</td>
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<td></td>
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<td>Activity 1: Learn a Magic Trick</td>
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<td>Activity 2: Learn the Math</td>
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<td>Activity 3: Learn a Second Trick (optional)</td>
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<td>Assessment: Exit Ticket</td>
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<td>8</td>
<td><strong>SWBAT excitedly explain expectations and plans for WOW! Challenge Day.</strong></td>
<td>Hook: Intro to National Spy Academy</td>
<td>Students will learn about the National Spy Academy and complete 1-2 Practice Spy Challenges. Additionally they will practice sharing responsibility and completing tasks amidst ambiguity.</td>
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<td><strong>SWBAT assume shared responsibility.</strong></td>
<td>Introduction to New Material: Careers in Problem Solving</td>
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<td><strong>SWBAT work collaboratively to tackle an ambiguous task.</strong></td>
<td>Activity 1: WOW! Teams</td>
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<td><strong>SWBAT use problem solving skills to decipher 1-2 ciphers that they have never seen before.</strong></td>
<td>Activity 2: Practice Spy Challenge 1</td>
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<td>Activity 3: Practice Spy Challenge 1b (optional)</td>
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<td>Assessment: Exit Ticket</td>
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<td>9</td>
<td><strong>SWBAT complete 2 Practice Challenges successfully in preparation for the WOW!</strong></td>
<td>Hook: Expresso Puzzle Race</td>
<td>Students will finish their problem solving and collaboration practice by completing 2-3 Practice Spy Challenges. Additionally, they will reflect on their collaboration skills. If needed, all final preparation for both this apprenticeship’s WOW! and a WOW! showcase will also be completed.</td>
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<td><strong>SWBAT evaluate themselves on their ability to collaborate effectively.</strong></td>
<td>Introduction to New Material: Review Collaboration Skills</td>
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<td>Activity 1: Collaboration Reflection</td>
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<td>Activity 2: Practice Spy Challenge 2</td>
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<td>Activity 3: Practice Spy Challenge 3</td>
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<td>Activity 4: Practice Spy Challenge 3b (optional)</td>
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<td>Assessment: Exit Ticket</td>
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<tr>
<td>10</td>
<td><strong>SWBAT work in teams to complete the Spy Certification successfully.</strong></td>
<td>Kickoff: Begin the Spy Certification Test</td>
<td>Students will work in teams to solve 3 WOW! Challenges to defeat Dr. Chaos and prevent his cyber-attack on the school. After successfully completing the tasks, students and teachers will celebrate the conclusion of</td>
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<td></td>
<td><strong>SWBAT celebrate accomplishment of WOW! Tasks and acquisition of problem solving and collaboration skills.</strong></td>
<td>WOW! Challenge #1</td>
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### Lesson Elements

**Hook**

Opening ritual used each week to build excitement

In lessons 2-9, students will solve Expresso Puzzles in a competitive race to see which pair of students can solve the most puzzles. In Week 2, it is recommended that teachers use the basic level of Expresso Puzzle. In the weeks following, it is recommended that CTs and TLs align the difficulty level of the Puzzle with the student’s math abilities. For example, in a class of 16 students, you might have 3 pairs of students who work to solve puzzles with only addition and subtraction, 4 pairs of students who work to solve puzzles at a basic level with all 4 operations, and 1 pair of students who works to solve puzzles at a moderate level with all 4 operations. It is recommended that you increase the difficulty of the puzzles as students master the concepts.

In week 2 and 3 plan to intentionally teach how to solve the puzzles. In weeks 4-6, fade out the teaching component and focus on student led problem solving. By weeks 7-9, students should need little direction for the Hook activity.

There is minimal time allotted to check the students work. Print answer keys along with the handouts to minimize the amount of time spent determining a winner.

Two handouts are included in each lesson - 1 basic and 1 moderate both using all 4 operations. Use the following links to find handouts for more levels and types of puzzles.

- Expresso Puzzles
  - Basic, 2 operations
  - Moderate, 2 operations
  - Basic, 4 operations (included in lesson resources also)
### Core Apprenticeship Library

**Apprenticeship Sector:** Coding & Gaming  
**Unit:** Math Mysteries: Ciphers, Games & Magic

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<thead>
<tr>
<th>Math Mysteries: Ciphers, Games &amp; Magic</th>
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<tr>
<td>○ <strong>Moderate, 4 operations</strong> (included in lesson resources also)</td>
</tr>
<tr>
<td>○ <strong>Advanced, 4 operations</strong></td>
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<tr>
<td>● Kakooma Puzzles:</td>
</tr>
<tr>
<td>○ <strong>Basic 4</strong></td>
</tr>
<tr>
<td>○ <strong>Moderate 7</strong></td>
</tr>
<tr>
<td>○ See all puzzles site above for more</td>
</tr>
<tr>
<td>● Sudoku Puzzles:</td>
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<tr>
<td>○ <a href="http://www.puzzles.ca/sudoku.html">http://www.puzzles.ca/sudoku.html</a></td>
</tr>
<tr>
<td>○ <a href="http://www.printmysudoku.com">http://www.printmysudoku.com</a></td>
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</table>

### Assessment

**How you will measure student learning (i.e., exit tickets, student writing, student presentations, etc.)**

- Student performance on Expresso Puzzles and demonstration of math ability should influence what level of difficulty CTs and TLs select for individual students to solve the next week. Assessment of math level can influence level of Expresso Puzzle, modifications of challenges, and extensions taught in various lessons.

- Student mastery of problem skills will be evaluated during the activities in which they practice their skills and in an exit ticket filled out during the Assessment portion of the lesson.

- Student mastery of collaboration skills will be evaluated and tracked using the Citizen Schools Collaboration Rubric and Tracking Tool in every lesson. The Tracking Tool is introduced in Lesson 3 and reintroduced in Lesson 8. All teachers are recommended to use a tracker on a clipboard in every lesson, Lessons 3-10. Students will complete a self reflection of collaboration skills in Lesson 9.

### Structures

**Learning structures, tools or student grouping strategies**

- Students will work in pairs during the Hook and in groups during the problem solving activities throughout all lessons. As the apprenticeship progresses, students will increasingly be assigned to groups based on math ability and instruction will be targeted to their ability.

### Procedures

**Special procedures used each class (ie handing out folders, rearranging seating, etc.)**

- Depending on where the apprenticeship takes place, special procedures may be needed for bathroom breaks, arriving and leaving the apprenticeship and the management of materials for the space.

### Optional Extensions

**Math ability levels vary widely at this age. You might have an apprenticeship full of new 6th graders who are below grade level; you might have an apprenticeship full of 8th graders in algebra. Or you might have an apprenticeship with both of these types of students with every ability level in between. Therefore, in many lessons there are optional extensions written in to allow you to differentiate for your students. If you have multiple co-teachers, consider using an Alternate teaching structure as needed to teach different levels of math to different small groups of students. The optional extensions included in**
the lesson plans are provided to help you differentiate easily.

Additionally, Activity 3 (or sometimes 4) is written as an optional activity in lessons 1-9. If your apprenticeship is 75 minutes, you will not have time to teach this activity. If your apprenticeship is 90 minutes, you may want to facilitate this activity or you may want to extend another activity. Use your knowledge of your students and their interests and abilities to decide how to use this additional 15 minutes.

<table>
<thead>
<tr>
<th>Implementation Notes</th>
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</thead>
<tbody>
<tr>
<td><strong>Supplies</strong></td>
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<tr>
<td>Materials, tools, technology</td>
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<tr>
<td>● Notebooks and pencils (1 per student)</td>
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<tr>
<td>● Mathemagic by Raymond Blum - secondhand copies available on Amazon for ~$4 or you can “check it out” from the National Program Department. All necessary copies are provided as scanned pages in the Lesson Resources in each lesson, but extensions and additional tricks are provided in the book.</td>
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<tr>
<td>● File folders (1 per student) - 1 box of 100 costs ~$6 on Amazon</td>
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<tr>
<td>● 9x12 Manila Envelopes - 1 box of 100 costs ~$8 on Amazon</td>
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<tr>
<td>● Printing and copying as noted in the lessons</td>
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<tr>
<td><strong>Budget</strong></td>
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<td>● Total cost of items above totals ~$20</td>
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<td>● Total cost of all additional weekly supplies = minimal, office supplies</td>
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<td>● If you facilitate a field trip (optional extra week), consider transportation cost.</td>
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<tr>
<td><strong>Supporting Materials &amp; Resources</strong></td>
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<tr>
<td>handouts, books, materials</td>
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<tr>
<td>● See Mathemagic in “Supplies.”</td>
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<tr>
<td>● Consider providing additional challenges for students to solve as optional homework if students are really excited about the activities. For example, additional secret codes to crack, directions for new math games (dots, sprouts, nim, etc.), extra magic tricks to master are all great extensions that could be optional activities for students.</td>
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<tr>
<td><strong>Location</strong></td>
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<tr>
<td>Tables/desks, or classroom, gym, kitchen, outside, etc.</td>
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<tr>
<td>For the individual lessons, only a typical classroom or conference room is needed. Students will need space to work in breakout groups to solve challenges, but that can be accommodated using a normal size space. For the WOW! a larger space will be needed. See Lesson 10 for full information.</td>
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<tr>
<td><strong>Choice and Voice</strong></td>
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<tr>
<td>Key decisions students make</td>
</tr>
<tr>
<td>Students will select their problem solving strategies in solving challenges in Weeks 8-10. For the most part, these decisions do not influence the direction of the apprenticeship, but rather the direction of their method to solve a problem or complete a task.</td>
</tr>
<tr>
<td><strong>Modifications for Student Needs</strong></td>
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</tbody>
</table>
| Recommended modifications are provided throughout to help CTs and TLs tailor this apprenticeship to meet every student's level of math ability. The choice of Expresso Puzzle in the Hook and the
### Supports and changes to help meet the needs of all learners

Assignment of teams plus the modification of all Practice Challenges and WOW! Challenges are the main means of modification throughout this unit.

### Student Background Knowledge and Skills Needed

This unit is written towards an on grade level, 6th grade math ability. Ideally students are familiar with 2 variable equations and solving for one variable. If not, modifications are suggested. If students are more advanced, extensions are suggested.

To begin this apprenticeship, students should be able to work functionally within a group. If a student significantly struggles to work with others, they will benefit from, but likely struggle with, the collaboration skills practiced.

### College and Career Readiness

**College Connection:** Problem solving and collaboration skills practiced in this apprenticeship will benefit the students as they continue on through high school and college in any academic subject area. Critical thinking and working with others are key skills that come up again and again in every content area. Additionally, these skills are practiced and immediately applicable in continued studies in mathematics.

**Career Connections:** Problem solving and collaboration skills are integrated into every career path and field. However, students will also be exposed to specific career paths that use these skills - cryptology, criminology, cyber security and more.

### Co-Teaching Roles

Recommendations for co-teaching structures are included in every lesson. Co-teachers will be instrumental in providing differentiated instruction to a diverse group of students. Plan ahead to give co-teachers specific instructional roles as noted in individual lessons.

### Special Resources

- **Field trips, excursions, guest speakers**

There are two opportunities for field excursions or special guest speakers/teachers that will enhance the overall apprenticeship and need to be planned far in advance. In Week 8, time is provided to review career pathways that use skills taught in the apprenticeship and optionally to include a guest speaker from a relevant professional field.

Additionally, some campuses have an extra week to work with either by facilitating the apprenticeship WOW! in Week 11 or due to an additional week integrated into the semester. It is recommended that CTs and TLs plan to use this extra week to do a field trip to a local office or to welcome a guest speaker from a relevant field. If you have this option, consider inserting this week between weeks 6-9.

As you consider setting up this authentic exposure for your students, many options are available. There are many types of professionals who use math creatively in their work and many who use it in ways that have been taught in this apprenticeship. This might be a cryptologist or criminologist from a
local university, a professional from the cyber security industry, or someone who works in national security. Data security and encryption is necessary for literally any company that collects data. Consider contacting a telecom company or computer software company’s tech department and ask their encryption/data security team if anyone there would like to volunteer to be a speaker in your class.

Use the following websites for more ideas and resources:

- [http://www.ed.ac.uk/polopoly_fs/1.56838!/fileManager/Careers_in_Cryptology.pdf](http://www.ed.ac.uk/polopoly_fs/1.56838!/fileManager/Careers_in_Cryptology.pdf)
- [http://www.maa.org/careers](http://www.maa.org/careers)

Additionally, during your apprenticeship, plan to stay abreast of national and corporate cyber security related news. Share news stories with students and facilitate a discussion of the connection of skills they are learning to these topics. If necessary, replace the Hook or Activity 3 to find time for these conversations. There have been many news stories and current events in the last few years that feature these topics and connect to relevant career pathways in this apprenticeship. See the following links as samples current to when this unit was completed.

- [US Govt Hacked](#)
- [Edward Snowden](#)
- [Sony Pictures Hack](#)
- [Corporations Fight Cyber Attacks](#)

Note to CT/TL: Create a poster-sized visual of the information listed below, display and reference weekly in your classroom.

Visual overview for students of their 10 week apprenticeship:

- **Week 1:** Welcome to Math Mysteries!
- **Week 2:** Caesar Ciphers
- **Week 3:** Substitution Ciphers
- **Week 4:** Brussels Sprouts
- **Week 5:** Pick15
- **Week 6:** Guess My Number Magic Tricks
- **Week 7:** Performing Magic Tricks
- **Week 8:** National Spy Academy: Getting Ready to WOW!
- **Week 9:** National Spy Academy: Final Practice for WOW!
- **Week 10:** Spy Certification WOW!
Here are examples:

EXAMPLE 1:
https://drive.google.com/a/citizenschools.org/file/d/0B1Ac8nDh50UyZXRqdXvTvTjQV0U/edit?usp=sharing

EXAMPLE 2:
https://drive.google.com/a/citizenschools.org/file/d/0B1Ac8nDh50UyRWRJZnJNTlVycURNZ3ZaaWZIVjZrcWRaSkdl/edit?usp=sharing

EXAMPLE 3:
https://drive.google.com/a/citizenschools.org/file/d/0B1Ac8nDh50UyRWRJZnJNTlVycURNZ3ZaaWZIVjZrcWRaSkdl/edit?usp=sharing
<table>
<thead>
<tr>
<th>Teaching Model</th>
<th>Description</th>
<th>Why should we use it?</th>
<th>When should we use it?</th>
</tr>
</thead>
</table>
| Parallel Teaching | Class is split into two (or more) small teams. Same content is taught to each team. | -Low student-teacher ratio  
-Greater proximity to high-risk students  
-Co-teachers have equal presence and responsibility in the classroom | -When we can plan effectively together to ensure we teach the same content to each group well.  
-Classroom’s physical structure permits it.  
-For lessons with heavy independent work  
-Need to provide a lot of individual attention |
| Station Teaching | Class is split into two (or more) small teams. Different material taught to each group simultaneously and then teams switch or teachers switch. | -Low student-teacher ratio  
-Co-teachers have equal presence and responsibility in the classroom.  
-More variety in teaching methods for teachers and students | -When a lesson can be split into two mutually exclusive and equally timed parts (e.g. using a camera/critiquing a photo, chopping vegetables/measuring ingredients)  
-When the classroom’s physical structure permits it  
-For lessons with a lot of knowledge or skill-building |
| Team Teaching    | Both teachers actively teach the material taking turns during the lesson to lead teach. While one teacher is lead teaching the other goes around to groups or individual students. | -One teacher can pay attention to high-risk students while one teacher leads the full class.  
-Co-teachers have equal presence and responsibility in the classroom. | -When it’s difficult to effectively split a lesson into two stations  
-When a lesson has lectures and independent practice time  
-If most SPED students can follow whole-group instruction  
-Best used with well-developed co-teaching relationship  
-For lessons with a lot of group work |
| Alternative Teaching | One teacher remediates a small group of students (pre-teach, re-teach, supplement, or enrich) and catches them up for the main lesson. | -Low student-teacher ratio.  
-To remediate in class for a small group of students.  
-To catch students up who may not have understood/missed previous lessons | -When the benefits from a few minutes of remediation/pre-teaching will preempt greater misunderstandings for the lesson.  
-When the classroom’s physical structure permits small group in one part of the room. (CTs should not be |
Core Apprenticeship Library
Apprenticeship Sector: Coding & Gaming
Unit: Math Mysteries: Ciphers, Games & Magic

<table>
<thead>
<tr>
<th>One Teach, One Assist</th>
<th>being taught by the</th>
<th>left alone in the classroom with</th>
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<tbody>
<tr>
<td>One teacher lead</td>
<td>the other teacher.</td>
<td>students.</td>
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<td>teaches the whole</td>
<td></td>
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<td>lesson and the other</td>
<td>To redirect behavior</td>
<td>If there is a particularly</td>
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<td>teacher works with</td>
<td>from an especially</td>
<td>high-needs student(s) in the</td>
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<td>low functioning</td>
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<tr>
<td></td>
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<td>specific support.</td>
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<td></td>
<td>To pay greater</td>
<td>During direct-teach</td>
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<td></td>
<td>attention to a</td>
<td>sections of the lesson</td>
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<td>student who needs</td>
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<td>interaction in</td>
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<td>order to keep up</td>
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The Pitch

Preparation:
- Select 2 magic tricks from the tricks provided in Lesson 8 or from Mathemagic to perform for the Apprenticeship Pitch. Consider using tricks that have two different students select cards from a deck of playing cards to incorporate more student involvement. Practice performing the trick until you can do so flawlessly.

Pitch:
- **Perform** your magic trick theatrically.
- **Introduce** yourself and the apprenticeship.
  - Provide a student-friendly description of the apprenticeship: “In this apprenticeship, students will do two things: solve really cool problems and get better at working in teams. We will decode encrypted messages, play games, and do magic tricks. All of it is based on math, but all of it is fun and engaging. What on earth are we talking about?”
- **Write on the board** (or chart paper): Math Mysteries
- **Write:** MAGIC
  - **Say:** You know that the magic trick I just performed has to do with numbers but once you join my apprenticeship and I teach you some of the simple math behind it, you’ll be able to perform similar tricks for your family and friends. They will be amazed!
- **Write:** CIPHERS or SECRET CODES
  - **Say:** This apprenticeship isn’t all about magic though - it’s about some of the mysteries of math! For example, have you ever wanted to write a message in code to a friend? We will learn how, not only to write in code, but also how to crack other people’s codes.
- **Write:** GAMES
  - **Say:** We will also learn two different games and play them. You will learn how to win and how the math behind the games works! Think tic-tac-toe but way, way, way better.
- **Write:** SPY TRAINING
Say: For the WOW! the students will act as spies in training for the National Spy Academy and complete several spy challenges that use the problem solving and teamwork skills learned in this apprenticeship.

- (if time permits) Perform another magic trick or demonstrate one of the math games.
- **Wrap up:** Thank the students for their participation. Explain that this apprenticeship will involve a lot of fun problem solving and a lot of math. They should not “be afraid” of this apprenticeship if they don’t like math though - it will be nothing like their typical math class!

**Special Notes:**

- It is key that students know this apprenticeship has a math focus, but also that in this apprenticeship students will have the opportunity to have fun and be creative.
- Talk up the problem solving and inquiry, highlighting how students will play games, crack codes, and perform magic tricks as the main activities in the apprenticeship.
- **Optional:** If you have taught this apprenticeship previously, consider showing pictures or video clips from the apprenticeship and or WOW! to show how exciting this apprenticeship is.

**Materials Needed for Pitch Day**

1. Whiteboard or chart paper, markers
2. Magician props (classic top hat, wand, deck of cards)

**Apprenticeship in Action**

Written by Onalie Sotak, 5 time CT and author of the original unit, Codes, Games and Magic.

I became involved with Citizen Schools because I wanted to share my enthusiasm for mathematics with kids who are just starting to get into deeper mathematical concepts at a middle school age. My interest in math really blossomed in middle school due to some great teachers, and I wanted to be another avenue for younger kids to be inspired and better understand how math exists all around us in our daily lives.

My initial involvement was as a co-teacher with three other co-workers in 2012; I then took the themes and outline from the initial class and developed this into a more formalized curriculum. I’ve taught this same Apprenticeship curriculum for the next four semesters; working with four different teachers from Citizen Schools at two middle schools around Boston, MA. This apprenticeship has impacted ~60 students so far, and also involved ~15 different co-workers to help co-teach along the way. I received the Bronze Level President’s Volunteer Service Award (PVSA) in 2013 and the Gold Level award in 2014 for my work.
When working with Citizen Schools, you not only get to work with students but you also build new relationships with the Citizen Schools employees, and strengthen existing relationships with co-workers who assist in teaching the apprenticeship with you. I've loved being able to have an outlet at work to engage with an entirely different set of individuals with different needs. Working with kids forced me to re-engage with Math differently than I had in years and reminded me just how fun and powerful basic mathematical concepts can be. Citizen Schools is a unique opportunity to provide impact to kids directly in your community, and I loved the idea of being able to share with kids who hopefully will be my coworkers one day. Thank you Citizen Schools!

Apprenticeship Description for WOW! Communications

In Math Mysteries, students have honed problem solving skills while working together to crack ciphers, play games, and master magic tricks - all based on math concepts! In the last three weeks of the apprenticeship, students have demonstrated their skill mastery in the National Spy Academy as they solved various spy challenges in teams. Ultimately they completed their Spy Certification test and faced Dr. Chaos as he threatened to destroy their grade history in the biggest ever cyber attack on the school. Thankfully their problem solving and collaboration skills were developed sufficiently and they were able to thwart this attack and protect their data!

Apprenticeship Acknowledgements

“Math Mysteries: Ciphers, Games, & Magic” was developed, modified and edited by Mandy Haeuser Gandin and Amy Hoffmaster. This curriculum is based on an original unit titled “Codes, Games, and Magic” created by the Google team: Bob Cassels, Nicolas
Minutillo and Onalie Sotak and taught 5 times by Onalie Sotak with co-teaching support provided by many Google employees. The initial themes of the unit were compiled by Nicolas Minutillo and fleshed out into a more formal curriculum by Onalie Sotak. We'd like to recognize the entire Google team and especially Bob Cassels, Nicolas Minutillo and Onalie Sotak for their support in the development of the new “Math Mysteries” curriculum and the creation of the original “Codes, Games, & Magic” curriculum. Thank you!