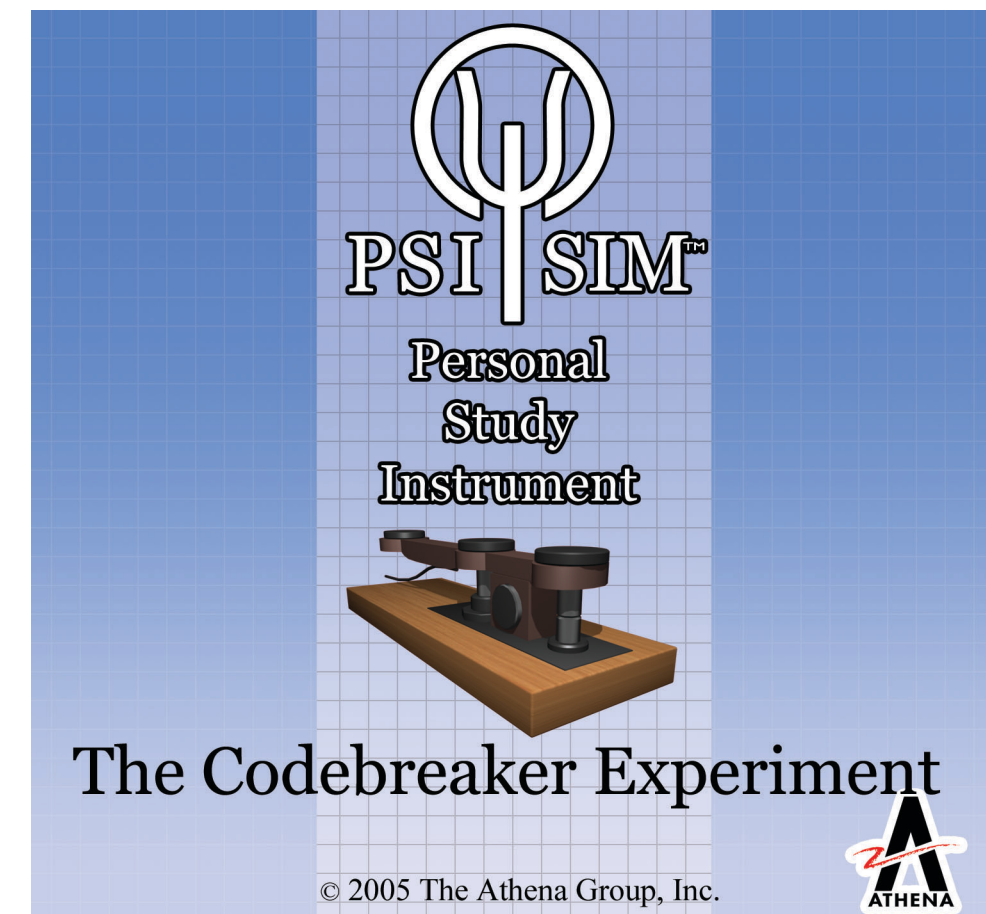


Teacher's Guide for the
Codebreaker Experiment



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Introduction to PSI Sims

Welcome to PSI Sim's learning environment. The series was designed to provide your students with virtual experiences that help them learn scientific, mathematical, and technological concepts and processes. The simulated experience offers a number of benefits when compared to the traditional lab activity.

- Students who missed the classroom lab can safely use the simulation at home, after school, or independently in class. The experiment is self-contained and safety is not an issue since all materials in the experiment are virtual.
- Students can quickly complete multiple experiments in a relatively short time. Materials do not have to be collected, stored, or cleaned up. This leaves much more time for the actual scientific investigation.
- The supporting materials, many which are multimedia-based, offer a variety of presentations to the students to enrich the experience. Connections and extensions of the concept(s) are presented in an entertaining way to the students.
- Multimedia components in the *Challenge* and *Methods* sections use voice to assist struggling readers with science concepts.
- Research has indicated that students who use virtual lab experiences *prior* to the traditional lab activity completed the traditional lab more quickly and tended to focus more on the scientific concepts presented in the lab instead of on the step-wise lab procedures. The virtual experience is *not* intended to replace the traditional laboratory activity. Students gain valuable process skills while completing labs and, therefore, labs should remain an integral part of your curriculum.

This booklet was produced to give you and your students support before, during, and after completing the experiment. Much of the material presented in this booklet also appears in the experiment. Blackline masters of student data sheets can be reproduced directly from this booklet or may be printed directly from the *Methods* section in the experiment under *Collecting Data and Reporting*. The publisher grants purchasers of the product permission to make classroom sets of the *Student Data Sheets*.

Where does this fit into my curriculum? The conceptual focus of the *Codebreaker Experiment* centers on finding and using patterns in data sets. Key terms associated with the experiment are:

- Communication,
- Codes,
- Digital data,
- Analog data, and
- Patterns.

National Science Education Standards addressed in the experiment include:

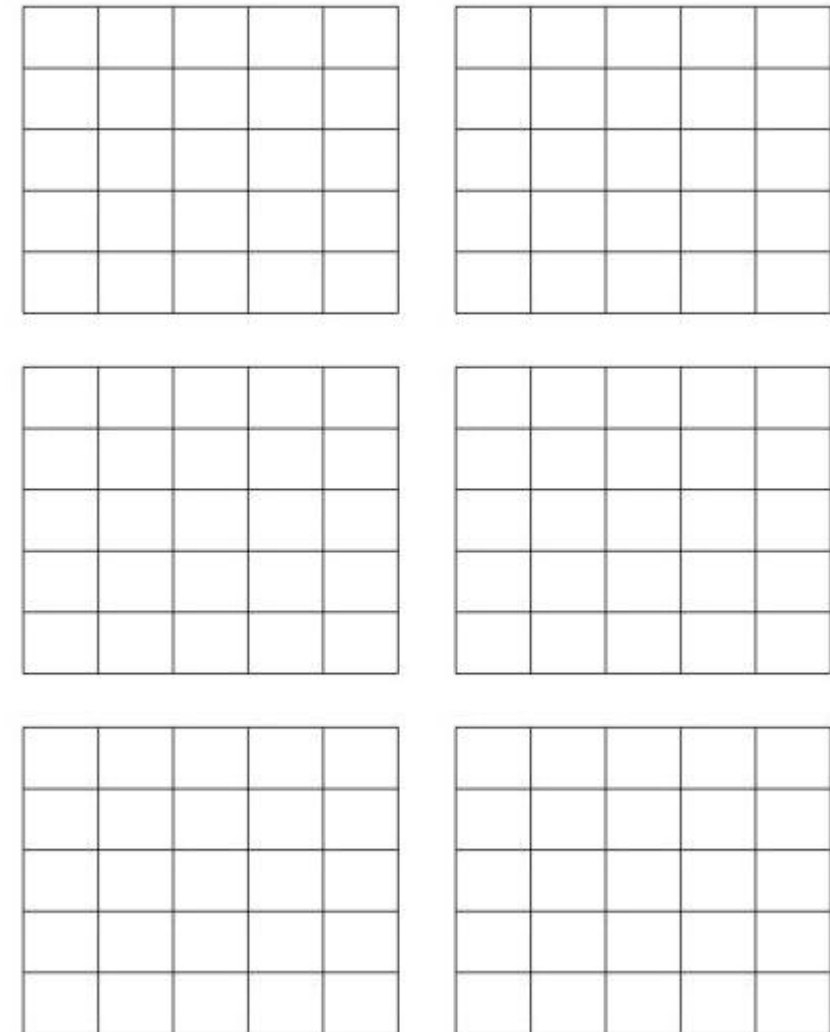
- Science and Technology
 - Abilities of technological design
 - Understanding about science and technology
- Unifying Concepts and Processes
 - Evidence, models, and explanation
 - Change, constancy, and measurement

How long will this take? The *Codebreaker Experiment* simulation can be completed in about 45 minutes. However, assessments, extensions, and additional activities can take much longer.

How should I use the *Codebreaker Experiment*? You know how best to implement materials into your curriculum. PSI Sim modules can be applied in many contexts and extended based on curricular goals and objectives. They can also be used “as-is” without extensions, allowing the student to undertake their own inquiry. Teachers apply technology in different ways. Although some teachers feel that they should show every aspect of PSI Sims to the students before the student interacts with it, we feel it best to allow students to investigate the details of the environment on their own. Remember, there is an onboard simulation walkthrough available in the *Methods* section of the environment to help students understand how the simulator works. Of course, in cases where students don’t have access to computers, the teacher may use the PSI Sim very effectively in a directed lesson. However you use PSI Sims in your class, we hope that you and your students find it an effective way to teach and learn. Good luck!

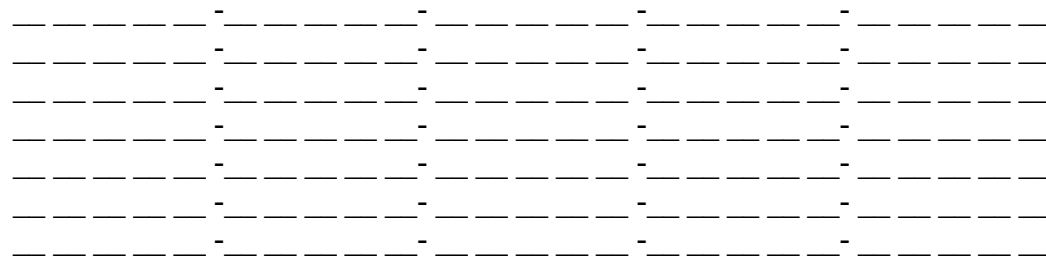
The Codebreaker

Grids



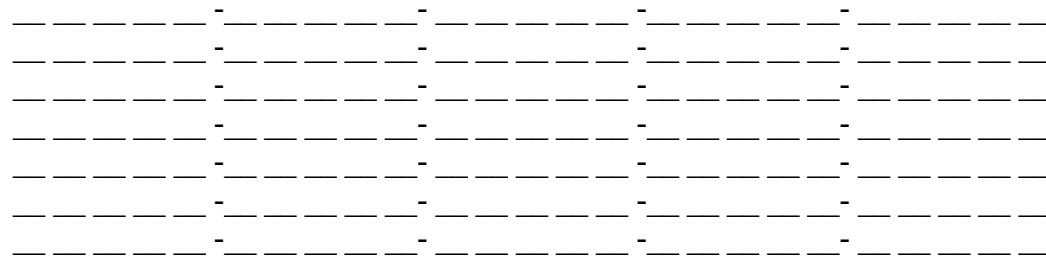
The Codebreaker

Code 1



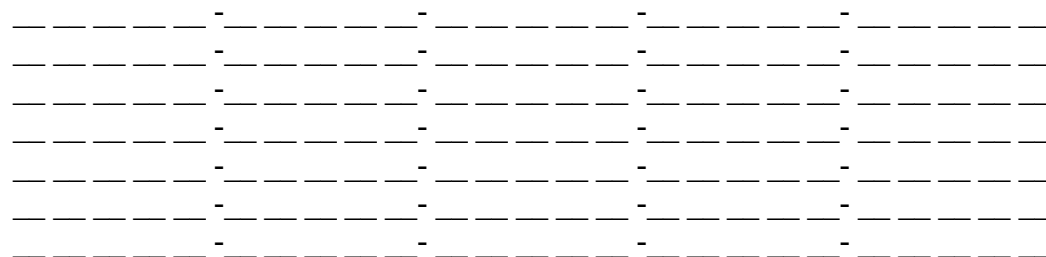
The Codebreaker

Code 2



The Codebreaker

Code 3



What about the noise?

The *Codebreaker Experiment* relies on audio to enrich the educational experience. We suggest that students use headphones to best use the CD. Sound is not a critical component of the simulation. However, we encourage you to use the sound with the *Challenge*, *Methods*, and *Help* sections.

How do I get started?

1. After loading the software on the computer(s), begin using it by opening the program. Refer to the CD case for installation instructions and system requirements. We strongly suggest that you review the entire contents of the experiment *before* presenting it to your class.
2. Once opened, an introductory video and screen appears. This introduction may be bypassed at any time by clicking on other parts of the screen such as *Challenge* or *Methods* icons. Any video may be paused by clicking it once. To resume, click again. If video controls are available, use the buttons and sliders to control the videos.
3. After viewing the introduction, click on the *Challenge* icon to review the experiment's challenge.
4. Next, click the *Methods* icon to see background material and how-to instructions for completing the experiment. The *Methods* section contains a *Simulation Walkthrough* that uses a video to guide students in their investigation.
5. The Collecting Data & Reporting icon connects the students to a text-based procedure. A printable Student Data Sheet can be produced from this page by clicking the link at the top of the *Collecting Data and Reporting* page.
6. Clicking on the *Simulation* icon starts the virtual experiment.
7. The *Help* icon may be clicked on at any time for some basic useful information.

Do students enter their data into the computer?

No, all information should be recorded on the paper version of the Student Data Sheet. You may have your students enter data into spreadsheets or other data analysis programs; however, these are not included with the experiment.

The Codebreaker Experiment

My students didn't finish the experiment. How do they save their work?

The *Save Screen* and *Save Data* buttons in the simulation can be used to save an image of the current state of the simulation. The *Save Screen* and *Save Data* buttons do not save the simulator's state, but simply a snapshot of the screen and numerical data collected.

Can my students integrate saved simulation data and images into their lab reports?

Yes, the images can easily be pasted into word processing or presentation documents. The saved data is automatically formatted in a web page that students can also link to a presentation.

Can I make some suggestions about the Codebreaker Experiment?

Yes! We'd love your comments and feedback. Please see the CD case for contact information or email us at:

psisim@athena-group.com

The Codebreaker Experiment



THE CODEBREAKER

Student name _____

Period _____ Date _____

1. Using the Decoder, try to decode this (tricky!!) code:

```
1111110000111110000111111
1000111001101011001110001
0111000100001000010001110
0010001010100011111110001
1111110001111111001010001
11111100011111101000111111
```

2. In the Methodology section called "Mapping the Cosmos" you watched the skies divided into squares. The squares were then divided into 8 rows and 8 columns. Can you see why it would be difficult to decode if you didn't know that the code was from an 8 by 8 grid? In our experiments, we used a 5 by 5 grid. You may have noticed a string of binary digits at the end of The Challenge. If you assume that the code uses a 5 by 5 grid, can you decode it?

3. Are pictographs like hieroglyphics different than binary codes? How?

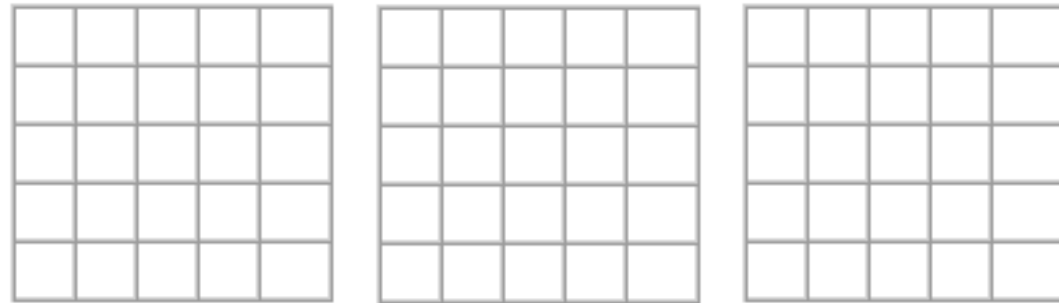
4. Think of a word that describes a way that you use codes in your life. Now code that word in the simulation. Give the code to one of your classmates and see if your classmate can figure it out. Try to figure out the code they coded.

5. In The Challenge, you saw (and heard) a telegraph sending a code. The code being used was Morse Code. If you like studying about codes, try to find out about Morse Code and then see if you can decode the coded message you heard.



3. Using the grids below, and what you learned from the *Codebreaker Experiment*, decode the following message:

**1111110001111111000010000
1111110000111110000111111
0111000100001000010001110**



4. Coded messages are everywhere, you see them in highway signs, you hear them when you push buttons on your telephone, and, if you had difficulty seeing, you might feel them when you read. Braille is used to help people who can't see to read by feel. Each letter is a series of bumps, or raised dots. Here is a Braille Chart for the letters:

Translate the following message in Braille:



Content Background

The *Codebreaker Experiment* is one of the most cross-disciplinary in the PSI Sim set. The central theme of the module is that humans communicate using patterns. These patterns may be visual, audio, or use multiple senses, but decoding patterns is a major component of the communication process. The *Codebreaker Experiment* is also designed to allow students to enjoy “sending codes” to one another.

The methods section of the simulation contains information about the history of communication, includes cave wall images from Luxor, Egypt, and mentions some milestone technologies including the telegraph, the enigma machine, and modern communication tools. The wide scope of the module allows the teacher to discuss cultural communication tools (smoke signals, for example), historical communication tools (the use of mirrors to communicate from castle to castle), electronic methods of communication (and the wiring of the world), and ultimately digital communication using bits. Of course, language represents a pattern of communication as well, though a typical student definition of language may not include this fact.

There are many interesting applications related to the *Codebreaker Experiment*. The basic idea of the simulation is that students can create straightforward codes that represent letters (or icons) using zeros and ones. The simulator is essentially a machine for coding and decoding such codes. The lesson can be extended, however, to include other mathematical manipulations, larger scientific issues, and to question the simulation model itself. For example, the simulator presents a 5 by 5 grid to contain 0s and 1s. It is sometimes difficult to construct a “perfect” letter on such a small grid. What if the grid were 8 by 8? Would it be easier to give a letter more detail? Obviously. However, then each letter would contain 64 digits instead of 25. It would be harder to store and manipulate each digit, which would require more memory space (in a computer at least) and take longer to send (since it is a longer string of characters). The issue of tradeoffs is always present in scientific and technological discussions, and is one of the National Science Education Standards.

In the previous example, we discussed the *Codebreaker Experiment's* grid, or matrix. If we wanted to introduce some technology into the lesson, we could define some new terms using the simulator. The resolution of the simulator's screen is 5 by 5. Typical computer screens have a resolution of 800 by 600, or 1024 by 768, or 1440 by 900. The 5 by 5 simulator screen has 25 cells, or picture elements, often called pixels. If we increased the resolution of our simulator to 8 by 8, we would have 64 pixels in the same space. That is, more resolution, with smaller pixels. A pixel is the smallest unit (or part of an image) for a given resolution.

It is possible to make codes more difficult to crack by sending them as a long string of zeros and ones without breaks between letters. As long as the code receiver knows that each letter occupies a 5 by 5 grid, s/he can separate the long string of characters correctly. However, if the person trying to crack the code doesn't know the grid size, it will take longer to crack. Understanding how to "parse" information is an important part of a communication interchange.

Finally, the issue of compression can be addressed through the *Codebreaker Experiment*. What if the first part of a code being sent was 1111110000 (as is the case when sending a capital "E")? Is there a shorter way to send this? Why not just say 6 ones and 4 zeroes? Of course, the students could send their codes this way. However, if they did, it would not be a binary code, since 6 and 4 are not binary numbers--they are decimal numbers. So, if you are interested in teaching binary arithmetic, or conversion between decimal and binary numbers, *The Codebreaker Experiment* presents the opportunity. While we're on the topic, how many digits would the 6 and 4 in the above example require if the code were truly binary and the first digits represented how many followed by which (0 or 1?) Remember, there might be up to 25 ones or zeros! Fortunately, the *Codebreaker Experiment* does not require any discussion of compression.

Assessment Items

1. Throughout history, people have communicated using patterns. List three ways different methods people have used to communicate *over long distances*.
2. The Morse Code was developed by Samuel Finley Breeze Morse, who as you have learned was not a scientist, but an artist. The first message ever sent by a telegraph was "What hath God wrought" from the Supreme Court in Washington to the Baltimore railway depot on May 24, 1844. Perhaps the most famous message in Morse Code, however, is the message S O S, which stands for "Save Our Ship." Using the Morse Code chart (included), write down the code for S O S.

International Morse Code

A .-.	N -. .	0 -----
B -... .	O -----	1 .-----
C -.-. .	P .-.-. .	2 ..-.-.-
D -.. .	Q -.-.-.	3 ...-.-
E .	R .-.-.	4-
F ..-.-.	S ...	5-
G -.-.-.	T -	6 -.....
H	U ..-.	7 -.-... .
I ..	V ...-	8 -.-.-..
J .-.-.-.	W .-.-.	9 -.-.-.-.
K -.-.-.	X -.-.-.	Fullstop .-.-.-.
L .-.-..	Y -.-.-.	.-
M --	Z -.-..	Comma --
		..-.-
		Query ..-.-..