

IMSA Fusion

IMSA Fusion is a teacher professional development and student STEM enrichment program for Illinois students who are talented, interested and motivated in mathematics and science. IMSA Fusion places a special emphasis on students who are historically underrepresented in those areas. Fusion works with teachers and students in grades 4-8.

In brief, the program goals are:

- Maintain or increase students interest, involvement and literacy in science and mathematics
- Enhance the knowledge and skills of teachers in science, mathematics, and technology; stimulate excellence in schools
- Stimulate excellence in schools' science and mathematics programs
- Help increase access to programming for students who are historically under-resourced in science, mathematics and technology and for all areas of the state

By design, the IMSA Fusion curriculum is inquiry based, problem centered and integrative. The learning experiences focus on helping students “learn how to learn” and emphasize logic, mathematical thinking and experimental scientific thinking. Topics relate to the students’ lives, thereby arousing their curiosity and increasing their motivation to learn.. Teachers from each participating school are supported with on-going professional development for the delivery of the curriculum and use of appropriate pedagogy.

Secret Communications: Sharing Concealed Messages

Designed for Grades 6-8

Secret Communications: Sharing Concealed Messages presents learners with examples of various encryption methods. Opportunities abound to use inquiry as an approach to get into the mind of the code writer in order to decipher messages encrypted in various fashions.

Exposure to such examples empowers learners with the capacity to transfer and extend their knowledge of logical schemes and rules to different and novel situations. This ability is an earmark of genuine understanding.

Students striving to derive the greatest benefits of this unit will:

- become more aware of different reasons for encrypting information
- apply their knowledge of mathematical systems to encrypt and decipher messages
- apply their knowledge of language systems to encrypt and decipher messages
- learn mathematical relationships that underlie coding and encryption methods
- experiment with different means of communicating concealed messages
- develop the habits of mind of persistence and tenacity in deciphering coded messages
- gain an understanding of the role of creativity and insight by encrypting and deciphering concealed messages

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Unit Summaries

Guess and Check

As an introduction to the ideas explored in this unit, the first lesson, “**Guess and Check**” provides students with “secret messages” that they are challenged to decipher. During the process they will use their knowledge of the English language to employ strategies that will allow them to make progress in reading the message. They will come to learn that solid background knowledge coupled with committed persistence and tenacity can lead to successful results.

Caesar’s Cipher

One of the simplest encryption methods involves the substitution of letters of the alphabet to match them with different letters of the alphabet or the numbers 1 – 26 by sliding them from their usual position to a slot that is a given number of characters removed from the original position. Such an encryption is the “**Caesar’s Cipher**”. Students will construct a tool and use team strategies to enable them to decipher and create messages based upon “**Caesar’s Cipher**”.

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Finding the Right Route

Some ciphers require a “Key” in order to decode the message. “**Finding the Right Route**” taps students’ ability to make careful observations that help suggest the transposition key that leads to deciphering the secret message. The role that the teacher plays in guiding and suggesting pathways of inquiry is critical in this lesson.

On or Off: Reading the Code

The ability to describe or identify something quantitatively allows us to rank order things, use statistics and probability to assist in decision making, and to make predictions based upon previously gathered information. Using numbers is also a strategy to encode secret messages. Most people are familiar with our base-10 number system but there are other number base systems that are useful as well. The base-2 number system can be used to write numbers as is done in the base-10 system. An advantage of the base-2 system that uses combinations of “Yes” or “No” or, alternatively, “On” or “Off” conditions is that we can use a variety of physical situations to represent these conditions. Students will use the “North” or “South” properties of magnetism to decipher and encrypt numerical messages written in the base-2 number system while working through the lesson “**On or Off: Reading the Code**”.

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Symbolic Encryption Lesson

Not all concealed messages use the alphabet or numbers as encryption characters. The **“Symbolic Encryption Lesson”** employs symbols as encryption characters. Upon being presented with a mysterious message, students engage in an inquiry that requires teamwork and guidance in order to construct a template and rule that allows them to decipher the message and create messages of their own using the newly discovered code.

Locking onto an Idea: Considering the Possibilities

Codes can also be used to prevent entry into places that are intended only for those who know the code. The familiar “combination” lock will be investigated to learn the difference between combinations and permutations. **“Locking onto an Idea: Considering the possibilities”** leads students through a series of tasks that bring out the possibilities embedded in different systems.

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Digitized Message Transmission

The benefits of choosing Morse Code as the mechanism of communication lie chiefly in the many modes in which it can be transmitted. Once the character representations for the letters of the alphabet are known messages can be both encrypted and deciphered with relative ease. “Digitized Message Transmission” first introduces the elements of Morse Code to students and then explores various ways to transmit the messages.

Seeing is Believing

Some secret messages are not as explicit as others. While “would be” code crackers might be able to see an encoded message they may not be able to decipher it. A more clandestine procedure is to prepare the message so that it cannot even be seen. Invisible messages can be hidden in readable narratives or combined with unintelligibly encrypted communications. Students will be forced to think in new ways in order to discover this encryption approach in, “Seeing is Believing”.

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Tag Team Secret Messages

In the lesson “Tag Team Secret Messages” students form teams and choose an encryption method previously learned from the unit to encrypt a list of phrases. Keeping the method a secret, they pass their coded list of phrases to another team to decipher. A variety of strategies will be used by the teams to uncover the method of encryption.

Who Holds the Key?

Today’s secure internet protocols are derived from a system known as “public key encryption” which makes use of one-way functions. In “Who Holds the Key?” students will be introduced to an asymmetric cipher and will learn the reasoning behind using an asymmetric cipher. Then, students will use graph theory and the idea of one-way functions to construct a Perfect Code public key cryptosystem for other teams to try and crack.

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Secret Codon: A Genetic Cipher

“Secret Codon: A Genetic Cipher” explores the way the human body uses DNA codes to build the various proteins that make each human unique. An internet-based animation will allow students to observe the processes of transcription and translation which allows protein synthesis to occur in the cells. Students will encode a message using a table of DNA codons, send the complementary codons to a partner to be transcribed into mRNA, and then use an mRNA Secret Codon Wheel to decode the message.

The Final Challenge

“The Final Challenge” is an integration of the knowledge gained of some basic encryption approaches with the creativity, tenacity, and persistence needed to follow a trail of encrypted messages that lead the teams to a final goal. This lesson requires teamwork and advanced inquiry techniques as students race to complete the challenge and reach the goal so that they can assist others in the task.

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This unit “Secret Communications-Sharing Concealed Messages” introduces some basic coding and encrypting strategies. Far more sophisticated and complicated approaches remain for students to explore as they continue to develop their understanding of mathematics and language. For now, the researchers and investigators pursuing the activities in this unit can apply their skills, talents, and knowledge to achieve success in getting “into the mind” of the agents attempting to get their messages across without being read and understood. Good Luck!