Extrapolation as a Literary Device in Science Fiction

Subjects: English/Language Arts, with Math extension

Grades: 6-8

Essential Question: What does the future hold?

Unit Questions: What is extrapolation? How do science fiction writers use extrapolation as a literary device?

Lesson Overview:
In this activity, students investigate the principle of extrapolation as a literary device. A simple graphical example of a positive correlation is extended to show how extrapolation can predict data trends outside a given data set. Students consider how this principle is used in science fiction. Students collaborate in small groups to write, edit, and revise original short stories showing examples of extrapolation.

Learning Objectives:
Students will be able to:
- Define extrapolation in a formal and literary sense
- Give an example of extrapolation in everyday use
- Identify how extrapolation is used as a literary device
- Write a short story incorporating extrapolation

Academic Standards:

Common Core ELA Standards (Grades 6-8)
- W.3: Write narratives to develop real or imagined experiences or events using effective technique, relevant descriptive details, and well-structured event sequences.
- W.4: Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.
- W.5: With some guidance and support from peers and adults, develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on how well purpose and audience have been addressed.
- L.1: Demonstrate command of the conventions of standard English grammar and usage when writing or speaking.
- L.2: Demonstrate command of the conventions of standard English capitalization, punctuation, and spelling when writing.

Common Core Math Standards (Grades 6 & 7)
- 6.RP: Understand ratio concepts and use ratio reasoning to solve problems.
• 7.RP: Analyze proportional relationships and use them to solve real-world and mathematical problems.

**Time Frame:**
This lesson requires two 45-minute sessions to complete.

**Background for the Teacher:**
What does the future hold? This is one of life’s big questions. We often consider the question unanswerable, yet it is of critical importance. What will happen if humanity continues its present course, for example? Of course, there are many conceivable futures and we cannot say which one we will experience, but extrapolation can help us make predictions that have a reasonable chance of becoming reality.

We use extrapolation every day. For example, when we want to cross the street, our brains automatically extrapolate the movement of an approaching car to predict when it will cross our path. Yet, extrapolation may not always work as expected. If someone drives to work at 45 mph, within the speed limit, he is unlikely to arrive twice as quickly just by driving the same route twice as fast, at 90 mph. The chances are high that the driver will crash or be stopped by traffic police.

In mathematics, extrapolation is defined as the extension of a data set or trend based on known quantities or behavior to predict unknown quantities or future behavior. In a broader sense, extrapolation is synonymous with forecasting and trend estimation.

Science fiction writers often use the principle of extrapolation to imagine future realities. By extrapolating from a known present, authors can predict trends that may prevail over time. They often take creative license to imagine futures that are wildly different than the present, but by rooting their creations in real world data and patterns, they can give us insight into our actions and their potential consequences.

The principle of uncertainty in extrapolation is relevant to literature, since science fiction writers are often wrong in their predictions. For example, in his story “From Earth to Moon,” Jules Verne correctly anticipated the location of the launch of a moon mission very close to today’s Kennedy Space Center. However, his prediction that a giant gun would be used to launch a moon mission was very different from reality: the Saturn V rockets used by NASA.

**Vocabulary:**
**Extrapolation:** The extension of a data set or trend based on known quantities or behavior to predict unknown quantities or future behavior.
Classroom Activities:

Materials for the teacher:
- A copy of Werner St. Paul's “Into Space”
  (http://www.gutenberg.org/files/28617/28617-h/28617-h.htm#Into_Space)

Teacher preparation:
- Review the short story and identify any vocabulary terms and/or concepts with which students may need assistance
- Select alternative or additional short stories from the recommended list as desired

For each group of students:
- Copies of Werner St. Paul's “Into Space”
  (http://www.gutenberg.org/files/28617/28617-h/28617-h.htm#Into_Space)
- Copies of the student handout
- Copies of the Evaluation Rubric
- Graph paper (optional)
- Access to computer with Internet connection (optional)

Engage

1. Ask the class, “What is going to happen tomorrow? What is going to happen next week?” Ask the same question for next month, next year, 10 years from today and 100 years from today. The aim is to have students think about the future and our ability to predict it.
2. Explain that as we extend our thinking farther into the future, our ability to predict what will happen with any degree of certainty diminishes. Small uncertainties build up over time.
3. Ensure that students understand we make predictions every day. Some things, such as tides and eclipses, can be predicted more accurately than others, such as long-term weather trends or the activity of the stock market.
4. Place students into small groups and give each group 2-3 minutes to brainstorm and prepare a list of reasons why predictions are important. Students with access to computers can use Bubbl.us or another free online tool to record and organize their ideas.
5. Have students share their ideas with the class. Foster discussion to ensure that students understand prediction can be important for:
   - Understanding the consequences of choices and decisions
   - Knowing how a system is going to behave or change
   - Being able to take advantage of a current situation
   - Preparing for future events, particularly adverse ones
6. Explain that trying to know what will happen in the future is one of life’s big challenges.
7. Explain that scientists use the principle of **extrapolation** to predict the future.
8. Provide students the definition of extrapolation (see beginning of lesson).
9. Explain that extrapolation is often used by scientists and mathematicians, and it is also a literary tool. Most science fiction stories involve some degree of extrapolation, because science fiction stories tend to be set in the future. Science fiction writers use extrapolation to make predictions that make their stories entertaining while simultaneously providing insight into human choices and the consequences of our actions.
10. Explain to students that in the remainder of the lesson they will learn more about extrapolation. Their challenge is to explore the question: How do science fiction writers use extrapolation as a literary device?

**Explore**

1. Explain to students that science fiction writers have often focused their attention on new modes of transportation and technologies that will take humans farther faster.
2. Explain to students that they will perform a simple example of an extrapolation related to this topic. The data below show the top speed for new cars in 1900, 1950, and 2000.

<table>
<thead>
<tr>
<th>Year</th>
<th>Top speed (mph)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1900</td>
<td>8</td>
</tr>
<tr>
<td>1950</td>
<td>85</td>
</tr>
<tr>
<td>2000</td>
<td>115</td>
</tr>
<tr>
<td>2050</td>
<td></td>
</tr>
<tr>
<td>2100</td>
<td></td>
</tr>
</tbody>
</table>

Ask students to use extrapolation to make predictions about what the top speed of cars will be in 2050 and 2100.

3. If students need help, encourage them to look at how the top speed has changed over time (there was a much bigger increase between 1900-1950 than in the subsequent 50 years). Based on this pattern, what are their predictions about how average speed will change in the next 50 years and the 50 years after that?
4. If time allows, have them plot the data in a table. If not, provide the following table.
5. Explain that the extrapolation is from the last data point (2000) to the first unknown data point (2050). The lines from 2000-2050 and 2050-2100 represent the extrapolated data.

6. Have students discuss their findings. Ask them to consider how a science fiction writer might translate this example into a story. (A writer might focus on a new technology that would allow the speed of car travel to increase much more dramatically, or a writer might focus on other forms of transportation after concluding that car travel is unlikely to speed up significantly in the future.)

7. Have students form small groups to brainstorm how the principle of extrapolation might be applied to other real world scenarios. Encourage students to think about technological advances.

8. From their brainstorm, have students create sketches or write a sentence describing possible future scenarios based upon their examples of extrapolation. Scenarios could include:
   - The speed of air travel will increase.
   - The size of computing devices will shrink.
   - The height of buildings will rise.
   - Replacement body parts will be created.
   - Pollution and other environmental threats will increase.

9. Ask a volunteer from each group to share one of their ideas. Discuss whether most of the predictions for the future are positive or negative.

**Explain**

1. Place students in small groups. (You may use the same groups or create new ones.) Ask each group to choose a science fiction film that they have all seen or at least heard about. Popular examples include: films in the Star Wars, Star Trek, Terminator or Jurassic Park series; Avatar; ET; Inception.

2. Have students use T-charts to record examples of extrapolation in the film. In one column, they should write down a real-world trend or science fact. In the other column, they should write a sentence summarizing how the author used extrapolation of the trend or fact. [If necessary, students can use the Internet to access information, including plot summaries, to learn more about the film they choose.]

3. Have each group present its T-chart.

4. After all of the groups have presented, ask students to think about the effects of the filmmakers’ use of extrapolation. As a class, create a list. The list could include:
   - It shaped the characters (e.g., robots).
   - It made the setting more interesting.
   - It created conflict.
   - It heightened suspense.
Extend

1. Emphasize to students that extrapolations can be incorrect. For example, someone might extrapolate that a cake baked at 250°F might bake twice as fast at 500°F. Instead, of course, the cake will likely burn to a crisp.

2. In class or as homework, have students read Sterner St. Paul’s story, “Into Space,” which was written in 1930, and evaluate the story for correct versus incorrect predictions. (Note: Students may need some extra time to do research to check on the accuracy of the author’s predictions.) Students can create a T-chart listing correct and incorrect predictions. For example:

<table>
<thead>
<tr>
<th>Correct Predictions</th>
<th>Incorrect Predictions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Travel to the moon</td>
<td>An electrical method for neutralizing gravity</td>
</tr>
<tr>
<td>No air a few miles from Earth</td>
<td>Airship neutral to gravity</td>
</tr>
<tr>
<td>Trip to Mars using rocket</td>
<td>Manned mission to the moon in ~30 hours</td>
</tr>
<tr>
<td>Artificial satellite</td>
<td>Atmosphere on moon</td>
</tr>
</tbody>
</table>

3. As a class, review students’ findings. Discuss the theme(s) of the story and the effect of the author’s use of extrapolation to help develop the theme, plot, setting and/or characters.

4. Optional: If you would like to give students more exposure to the science fiction genre and science fiction writers’ use of extrapolation, have them read one or more of the stories on the recommended list.

5. Distribute the student handout so students can refer back to it at a later time.

Evaluate

1. Have students work independently to write a short story showing one or more examples of extrapolation. During planning, students should identify the following elements in their stories:
   - Theme(s)
   - Plot
   - Setting
   - Characters
   - Use of extrapolation

Once students have written drafts, they should pair up to review, discuss and help edit each other’s work using the evaluation rubric.

Additional options:

2. Students can form small groups and choose one or more of the stories to present as a skit. Once the skit is presented, have students critique the story line considering the above story elements and identify and comment on the use of extrapolation.
3. Students write a brief constructed response to explain how science fiction writers use extrapolation as a literary device. They should include specific examples from the texts they explored during the lesson.

Math Extension
Have students extrapolate the data in the following table and indicate the type of series they used to extrapolate the data.

<table>
<thead>
<tr>
<th>Series</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Red</td>
<td>Orange</td>
</tr>
<tr>
<td>Letter</td>
<td>Word</td>
</tr>
<tr>
<td>Pianissimo</td>
<td>Piano</td>
</tr>
</tbody>
</table>

Answer key:

<table>
<thead>
<tr>
<th>Series</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Red</td>
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</tr>
</tbody>
</table>

Reflection Activities
1. Have students consider the concept of extrapolation. If time allows, they can create a concept map to put the lesson’s topics in context. For guided inquiry, have students address the following questions:
   - What are the main ways writers use extrapolation in their stories?
   - How would you write a science fiction story without using extrapolation?
   - List five professions or careers where extrapolation is used every day.

Web resources
Defining SF with extrapolation, estrangement, & novum:

Project Gutenberg Science Fiction:
http://www.gutenberg.org/wiki/Science_Fiction_%28Bookshelf%29

Analyzing a Passage:
http://www.goshen.edu/english/litanalysis-html
STUDENT HANDOUT – Extrapolation as a Literary Device

Extrapolation: The extension of a data set or trend based on known quantities or behavior to predict unknown quantities or future behavior.

What is extrapolation?
Have you ever wanted to predict the future? Extrapolation is a method to predict future events based on current knowledge. Scientists use mathematical extrapolation to predict a wide range of situations. For example, weather forecasts and predictions of patient responses to various medical treatments rely on mathematical extrapolation.

Does extrapolation require a lot of math?
Extrapolation for scientific prediction usually requires mathematical equations. For example, a linear graph has an equation such as \( y = cx + a \), where \( c \) and \( a \) are constants. If we want to predict \( y \) for a certain value of \( x \), we just plug the value for \( x \) into the equation. But extrapolation for writing stories generally does not require math. Mostly it requires imagination! Most writers are not skilled mathematicians. They use their imaginations to create possible scenarios based on known facts and events.

How do science fiction writers use extrapolation in their stories?
Writers use extrapolation to create believable scenarios about possible futures. They take a known event, fact or trend and use it to speculate about what might happen. Most science fiction includes extrapolation as a way to predict future possibilities.

Is extrapolation important?
Scientists and mathematicians use extrapolation to help model important data. The models provide a way of anticipating future events. For the longer-term, extrapolation can help people understand the possible consequences of choices and decisions made today. For example, scientists project that Earth’s population will increase to 9 or 10 billion before population growth starts to slow. We can use our knowledge of overpopulation in some countries to extrapolate what will happen if many other countries become overpopulated. Technology is constantly improving. Computers today are more powerful and smaller than computers a few years ago. We can extrapolate to anticipate the power and size of computers in the future. These kinds of projections make extrapolation an important tool for understanding the direction of social, economic and technological change.