

## **SCIENCE FICTION TO PROMOTE SCIENCE: LEARNING LITERACY AND SOCIAL UNDERSTANDING**

**James E. Hollenbeck**  
*Indiana University Southeast (USA)*

**Abstract.** The use of science fiction will open new ways of learning and understanding science. Science fiction has long been discussed as a way to get students and adults alike more interested in science; – literary works could be successfully used to communicate science not only to children or scholars but also to the general public. Research and practical application in the classroom has found that, after reading science fiction stories and watching science fiction entertainment, there was a significant positive effect on the understanding of students who do not study advanced science. Using science fiction helps students to link literacy and science. Science fiction was found to enrich the science content and the abstract found in traditional science textbooks.

**Keywords:** science fiction; science literacy; motivation; alternative teaching; Physics; Biology; teaching

Finding the motivation to encourage students to want to learn science sometimes requires extraordinary sources. One unusual source that has worked for me at the secondary and post-secondary level has been science fiction. The term „science fiction” has become interesting in terms of society, in that the media has overused it to describe any discovery in science that is novel or hard to grasp for the nonscientist to imagine. According to the *Handbook to Literature* (Holman et al., 1992) science fiction is described as: „A form of fantasy in which scientific facts, assumptions, or hypotheses form the basis, by logical extrapolation, of adventures in the future, on other planets, in other dimensions in time, or under new variants of scientific law“. Professors and teachers have been using science fiction films and videos „to illustrate ideas, concepts, and scientific theories to the amusement of their students (DiRado, 1995). Research has shown that science presented in different formats will present details and information in a dramatic format that improves learning and understanding, and detail retention is improved through a dramatic presentation, that cannot be presented by the teacher or even the best of most documentaries (Marzano et al., 2001). According to Mahzoon-Hagneghi et al. (2018), Feathers & Arya (2012) and Reiker (2011), students use illustrations to help process difficult

concepts or words within the text. As an educator, it is important to supply students with the tools they need to understand the visual features of the text to extract meaning from the text. Nodelman (1981) describes „visual grammar” as the way our understanding of pictures is dependent on our knowledge of the convention by which they operate. In other words, when sharing with students a variety of text formats, they come to understand that knowledge can be represented in numerous ways. This is an important skill for students to develop, especially in science, because of the way scientists combine, interconnect, and integrate text with a variety of visual representations (e.g., diagrams, photos, graphs) (Smolkin & Donovan, 2005). By incorporating this idea of visual grammar when reading, students grasp the importance of illustrations and how to use them as a form of information within the text.

Science fiction media can combine science and pseudo-science for entertainment. Science Fiction is best defined by using known facts to tell stories that are plausible in the listed categories: (i) Science, technology, and invention; (ii) The future and the remote past, including all-time travel stories; (iii) Other places i.e.: planets, dimensions, etc.; (iv) Visitors from the before mentioned; (v) Catastrophes; natural or manmade

The term „fantasy „ used in science fiction is described as a work that takes place in a nonexistent and unreal world, i.e. fairyland, or concerns incredible and unreal characters that may use physical and scientific principles not yet discovered or contrary to present experience. The authors in science fantasies need not bother with details such as plausibility or extrapolation of the principles of science. These works are from the imagination to produce works of wonder such as the Harry Potter, The Hobbit, or Star Wars. Exciting adventures, but not intended for science content consumption.

Research shows that science fiction videos to be slightly more effective than traditional educational videos in increasing test scores. Science uses many of the same skills as language arts, including stimulation of the imagination and application of critical thinking skills (Oravetz, 2005). The reading or watching of science fiction television shows and movies are the strongest influences on students for promoting science, according to Purdue University research (SAE, 1994). Science fiction can also help improve attitudes towards real science. Research findings of incorporating the dramatic arts into instruction show that learning detail is improved for both short and long term as compared to lecture and visual instruction (Marzano et al., 2001). Classroom observations and studies have determined that the inclusion of science fiction in the curriculum has improved attitude toward science (Freudenrich, 2000). Science fiction films, animations allow direct visualization of abstract topics, that are difficult for learners to see. By bringing the concepts to meet student’s visual and audio senses learning related concepts, develops an understanding of science processes and is enhanced for better learning. Science fiction allows

for greater learning for students by interdisciplinary learning by demonstrating the interconnectedness of the science disciplines to other academic and knowledge disciplines. Final point, entertainment videos usually cost less than educational videos a bonus for annual science and media center budgets.

Selecting the appropriate resource is important. Other resources for selecting science books include Teacher's Choices from the International Literacy Association and Children's Book Council, Outstanding Science Trade Books for Students K12 from National Science Teaching Association (NSTA), and the Notable Children's Book List from the American Library Association (Mahzoon-Hagneghi et al., 2018). Some ways to alleviate the frustration of choosing books that are appropriate for science instruction are using checklists, selection criteria, rubrics, evaluation scales, and bibliographies. Many samples of these are widely available to evaluate fiction and nonfiction children's books for science education (Mahzoon-Hagneghi et al., 2018; Donovan & Smolkin, 2002) developed a series of 10 questions for evaluating fiction trade books for science class (Fig. 1).

- Is the science concept recognizable?
- Is the story factual?
- Is fact discernible from fiction
- Does the book contain misrepresentations?
- Are the illustrations accurate?
- Are characters portrayed with gender equity?
- Are animals portrayed realistically?
- Is the passage of time referenced adequately?
- Does the story promote a positive attitude toward science and technology?
- Will children read or listen to this book?

**Figure 1.** Checklist for choosing student's media to teach science

### **Making it successful**

Remind them they are to learn from the film, not just watch. To be effective, the science fiction video must become part of an active learning situation and not a passive one. This begins by creating a classroom where the students interact with each other and the video is incorporated in activities, laboratories, and discussions. Present a vocabulary list before the video is shown. This assists the students in focusing their attention on the scientific and technical concepts that they will be

learning about during the film. A list of questions with the vocabulary words and a set of guided questions to be completed as the students watch the video will help students identify important concepts to the students. As they follow the story and identify scientific events this will assist them in developing listening and observation skills. Make watching the video an active event and at relevant times, stop the video and discuss the science occurring. This strategy helps students to reinforce and capture the missed concepts. Making the connections between science fiction, literacy and science is the goal.

### **Integration of science fiction in your classes**

The most common theme that science fiction is used in the classroom is for students to pick out flaws in science fiction movies or television shows. This approach fails to develop critical thinking skills and can result in students distrusting anything science-related. The use of science fiction offers more in helping students to recognize good science and how science works, while at the same time addressing the basics of literacy. Many themes can be developed on how to teach science fiction. Themes can mirror your curriculum, by choosing a story, movie, or related entertainment that will reinforce or provide a holistic view of the application of science in the non-science realm. One example to share is the evolution of Science, Technology, and Society thorough the 20th Century using Mary Shelley's novel *Frankenstein or the Modern Prometheus*. I use this novel as it is recognized as the first science fiction novel and first English novel of the romantic/gothic era (Aldiss, 1995). Second, the story and media adaptation of Frankenstein is familiar to my students. Mary Shelley's Frankenstein can be read from two main levels; science fiction as human nature. The whole novel moves around the invention of a scientist and the result of it. The dangerous aspect of experience in the scientific field is the subject matter of the novel. The movies that were produced over time from the early 1900s to the present day show how societal attitudes and technological applications have evolved over the last century. Principle themes that should be emphasized are bioethics, biology, questions of morality and science, and application of technology.

The first movie produced about the novel was in 1910 by Edison Studios. In this movie, the monster is created in a cauldron from chemicals as that was the technology of the time. The 16-minute short film was shot in three days at the Edison Studios, and the production was deliberately designed to de-emphasize the horrific aspects of the story and focus on the story's mystical and psychological elements. The technology is based on heat and chemistry. Before the monster can do anything terrible, he sees himself in the mirror realizing he is too ugly to ever win a bride, he disappears. The changes were made from the original story because they thought that some of the parts of the novel would be repulsive to the audience.<sup>1)</sup> After all, this is the societal norm of the turn of the century. The complete movie can be found on you-tube, under the 1910 Frankenstein.

The second Frankenstein movie of attention described by Horton (2014) is the 1931 version produced by Universal Studios sets the measure of all future science fiction/horror films. The movie „Frankenstein” is the first of its kind and the studio nervous about the public’s perception of the movie issues this advisory at the beginning of the movie:

[H]ow do you do? Mr. Carl Laemmle feels it would be a little unkind to present this picture without just a word of friendly warning: We are about to unfold the story of Frankenstein, a man of science who sought to create a man after his image without reckoning upon God. It is one of the strangest tales ever told. It deals with the two great mysteries of creation; life and death. I think it will thrill you. It may shock you. It might even *horrify* you. So, if any of you feel that you do not care to subject your nerves to such a strain, now’s your chance to uh, well, – we *warned* you!!

The 1931 movie vividly shows the technology of the 1930s evident of all sorts of electrical devices of all sorts with sparks and such. The monster is shown as a patchwork of body parts sewn together and of course energized by that new energy source: electricity. Students can see in the film how electricity is now the energy of choice. The morality of creation is called in question and debated by the scientist and those around him, and they agree that it is not natural, and the monster is destroyed at the end of the film.

Mary Shelley’s Frankenstein, produced in 1994, with the new technology and applications of the 1990s’ shows a truer to the original text in its adaptations with current (1990’s) application in anatomy, biochemistry, physiology, physics, and bioethics. The creation of the monster is now accomplished by electric eels, amniotic fluid gathers from births in the hospitals, harvested organs, questions of morality. Critics hailed this as the truest to the Shelley novel. The Frankenstein movies like many other science fiction movies can be used to teach the evolution of technology, scientific advancements and societal opinions of science and technology.

### **A map to teach a science fiction/science unit plan**

Science fiction stories are more interesting to students than reading a textbook by itself. When the students become more actively involved with the story, they will question and learn the science content while the story elements are discussed and analyzed. There is an abundance of positive research information about connecting science and language arts in the science classroom, including the use of science fiction. Science uses many of the same skills as language arts, including stimulation of the imagination and application of critical thinking skills (Oravetz, 2005). The instructor must plan to integrate good science fiction into the curriculum to improve the understanding of science and language literacy. The science, and curiosity are all wrapped up in a package, waiting to be used for improving literacy

and critical-thinking skills—it does not get more convenient. Literacy concerns the communicating of ideas from one mind to another, including component skills such as vocabulary, language structure, reading, and writing clearly with purpose. Critical thinking blends with literacy in the interpretation and extrapolation of ideas. There should be an understanding of the source as well as context, which is particularly important to students sifting their way through myriad print and visual resources on science. Students should become familiar with the author and times that they lived and why they were writing. Czerneda (2006) has provided this strategy to introduce students to science fiction and literacy in Fig. 2. Students have analyzed literature for years in English classes but just never thought, in most cases, of applying those skills to reading science. Teachers can use science fiction author Eric Choi's story and biography (at [www.sciencenewsforkids.org/pages/scifizone/choi.asp](http://www.sciencenewsforkids.org/pages/scifizone/choi.asp)) as source material for this activity. Teachers should provide biographical information after students have reached a consensus about the author.

The first activity is used to develop critical reading skills related to scientific articles. Students prepare by analyzing a work of science fiction and examining the underlying science idea in terms of the attitude and knowledge conveyed through the story about the author, following this with research on the author. Students examine their preconceptions, which can be useful to reveal stereotypes.

### **Teacher preparation**

- Prepare the Analysis Cards (Figure 2), either as reusable stand-alone or handouts. Each card should be on a separate page.
- Obtain a science fiction short story (3,000–5,000 words) for the class to analyze. To find a story matched to your current science topic or issue, contact a source such as the Science Fiction Museum and Hall of Fame, the Science Fiction and Fantasy Writers of America, or the Merril Collection of Science Fiction, Speculation, and Fantasy (see „Science fiction internet resources” on p. 39). Review the cards and prepare answers to the questions for this story yourself.
- Obtain science nonfiction such as articles from Discover, Popular Science, and Science News magazines, newspaper „science” columns, brochures from varying sources, print versions of media broadcasts, or documentaries (ideally both current and older than 20 years) for students to analyze. A wide variety is preferable to allow a comparison of credible and some less credible sources while honing critical reading skills. Students could bring in articles or request news transcripts. Excerpts from science textbooks can also be used effectively.

## Procedure

**[Note:** I prefer that students work in small groups to allow discussion and consensus. However, this can be done as a class activity.]

### Part I: Science fiction

1. Provide students with a short story and allow them time to read to themselves. If time does not permit a full story, or if reading levels vary greatly, choose an excerpt to read aloud to the class. (Provide interested students with the complete story later.)
2. Give each group a different Analysis Card. Allow 10 minutes for student groups to discuss and answer the questions on their cards. Encourage students to make their best guess. You want them to pick up impressions from the writing presented to them. After the discussion, you can share more detailed information about the author.
3. Have a member of each group read aloud their card to share their group's response with the class. Discuss the answers as a class.

**[Note:** Students should gain an awareness of source, in terms of influences on the author and what the author wishes to convey through the story. As well, they should have an awareness of context. While great stories transcend time or setting, the social and scientific landscapes of when and where the story was written, and its context, have a profound impact.]

### Part II: Nonfiction science

1. Once you feel students have successfully applied critical reading skills to one (or more) science fiction stories, move immediately to the nonfiction part of this activity. It is important to have students read this material while still in the mindset of analyzing the story.
2. Give each group a copy of a nonfiction science article and Analysis Cards 3, 5, and 6. Focus class discussion of student results per article on the credibility of sources and assumptions by the various authors about the scientific knowledge of readers.

**[Note:** If students have difficulty learning about a nonfiction author, they should rely on the reporting source as part of their criteria for credibility. Students should be able to list the clues they would use to help them rank such sources including apparent bias in surrounding materials, reputation and history of the publication process (e.g., was the material peer-reviewed?), and funding. This can be an important lesson in assessing the credibility of materials taken from the internet. As for context, you will likely be using material written within students' own social and scientific experience. Again, point to the publication itself as an indicator. An interesting extension is to repeat with older material.]

**Figure 2.** Scientific literacy activity: improving critical reading skills in science using science fiction (Czerneda, 2006)

#### **Analysis Card 1**

Based on this story, how would you describe the author? Think about: age; sex; physical description; occupation (other than writing); education; attitude toward science; and attitude toward people.

#### **Analysis Card 2**

1. What area of science is the author exploring in this story (biology, chemistry, physics, other)? How do you know?
2. What is the scientific premise of this story? Express the main idea in a „what if” statement.

#### **Analysis Card 3**

1. When do you think this story was written? What clues did you use to make this decision?
  - What effect might this have had on the author’s approach to this story’s scientific premise?
2. Where do you think this story was written? What helped you decide?
  - What effect might this have had on the author’s approach to this story’s scientific premise?

#### **Analysis Card 4**

What point(s) is the author trying to make about science in this story? Do you agree or disagree? Why?

**Analysis Card 5**

1. How did the author present the scientific information needed as background to this story?
  - an expert witness (a character who knows and talks about the science)
  - narrative (description)
  - assumption (assumed a certain level of scientific knowledge from readers)
2. If there was an „expert witness,” how did the author convince you that this character could be believed?

**Analysis Card 6**

What was the role of science presented in this story? Think about:

- If any of the characters in the story were scientists, how were they portrayed?
- What role did science play in the problem that the characters faced in the story?
- What role did science play in the resolution of that problem?
- What does the author have to say about the role of science in society (either today's or that portrayed in the story)?

**Figure 3.** Analysis cards (Zcerneda, 1999)

Second, a similar analysis of a popular science article which, like any literature, has an author who brings specific knowledge and intention to that writing, as well as works within a certain societal context and time. The result of this activity is to expand student appreciation of the source of the science they read, as well as improve their ability to assess its credibility. To assist students six analysis cards are distributed to the students to guide them in Fig. 3.

The result of this activity is to expand student appreciation of the source of the science they read, as well as improve their ability to assess its credibility. This approach can be used in the assessment of movies and television shows. When using media in the classroom be mindful of school policies about the use of media in the classroom, the age of your students and community standards (Donovan & Smolkin, 2002). The use of science fiction should be used to open new ways of learning and understanding science. Flynn & Hardman (2019) found that, upon reading the science fiction stories and watching science fiction entertainment, there was a significant positive effect size on the understanding of students who do not study advanced science. Using science fiction should link literacy and science for your students will enrich the science content and the abstract found in their traditional science textbooks.

## NOTES

1. <https://www.thevintagenews.com/2017/01/10/frankenstein-released-in-1910-is-the-first-motion-picture-adaptation-of-mary-shelleys-frankenstein/>

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✉ **Prof. James E. Hollenbeck**  
ORCID iD: 0000-0003-0192-8145  
Indiana University Southeast  
New Albany, IN., USA.  
E-mail: jehollen@ius.edu