

**SCIENCE FICTION MOVIES AS A TOOL FOR REVEALING STUDENTS'  
KNOWLEDGE AND ALTERNATIVE CONCEPTIONS**

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# **SCIENCE FICTION MOVIES AS A TOOL FOR REVEALING STUDENTS' KNOWLEDGE AND ALTERNATIVE CONCEPTIONS**

## **Abstract**

According to renowned physicist Stephen Hawking, "science fiction is useful both for stimulating the imagination and for diffusing fear of the future." Indeed, several studies suggest that using science fiction movies as a teaching aid can improve both motivation and achievement. However, if a movie's plot crosses the line between good and bad science, skeptical eyebrows within the mainstream scientific community begin to rise. Very little research has been conducted on whether factual errors in science fiction movies might generate or perpetuate students' alternative conceptions. This study examines students' conceptions of some key scientific ideas after watching two selected science fiction movies. Our purpose is twofold: 1) To find whether science fiction movies sometimes generate or contribute to students' alternative conceptions. 2) To examine the potential of science fiction movies as an evaluative tool for exposing common patterns of student alternative conceptions so that these may be addressed by subsequent directed instruction. We suggest that science fiction movies are especially useful in this regard because they prompt students to reveal alternative conceptions which although common in our culture may otherwise remain hidden even if the students are directly asked.

## **Introduction and Objectives**

Current trends in science education research and practice emphasize the importance of using a hands-on or inquiry-based approach, where classroom practices make explicit connections to real world phenomena and technologies. Current literature is replete with references to "situated learning" and "anchored instruction". These approaches essentially point out that science learning occurs best when content is presented as an intrinsic part of specific problem-solving situations, preferably within a realistic and

authentic context (e.g., Bransford, 1990). Unfortunately, this is not always possible or desirable in a literal sense, given the practical limitations of the average classroom. Nobody would suggest that students should be directly exposed to the real world applications of explosives or plague epidemiology for example. The use of science fiction as a pedagogical tool therefore seems logical, since it allows the students' imagination and "thought experiments" to create a virtual learning environment that is safe and practical, yet still engaging and reasonably authentic, even though it is entirely fictional. This approach has become ever more tenable in recent decades because science fiction movies and TV shows have become more scientifically diverse and sophisticated, thus creating a wide range of potential teaching scenarios to draw on. In addition, the advent of digital technologies such as DVD players and digital editing have added an element of interactivity and control that can give teachers and students additional latitude in the way they present science fiction in class.

A number of researchers have investigated the various uses and influences of science fiction in both the classroom and informal settings. Cacha (1977) and Hunter (1980) talk about science fiction as a tool for the development of students' imagination and creative work. Other educators have concentrated on using the genre as a vehicle to communicate content knowledge in ways that connect scientific concepts to events within fictional narratives. Cavannaugh, (1996) has observed that science fiction movies enable student learning by allowing them to visualize abstract science concepts and connect related disciplines. Brake and Thornton (2003) described the uses of science fiction in an applied science degree undergraduate program at the University of Glamorgan. They focus on the uses of science fiction to create scientifically literate citizens who are informed decision makers. According to Dubeck, (1993) students can acquire a better understanding of science as a "discovery process" through the use of science fiction movies. Furthermore, he says that discussion of the movies enhances student understanding of science, and trains them to recognize pseudoscientific themes. Allday (2003) describes his use of science fiction movies as a pedagogic tool in high-school physics, but cautions that bad physics abound in many movies. He recommends a useful website (Intuitor, 2002) that

presents detailed explanations of the science behind some of the glaring errors and physical impossibilities that Hollywood special effects can produce.

Apparently, exposure to this genre can be a two-edged sword: On the one hand, the articles cited above suggest that science fiction can generally be an effective teaching tool in the classroom; on the other hand some published work suggests that science fiction can contribute toward negative attitudes about scientific method, and can generate incorrect or garbled scientific concepts. For example, Gerbner (1985, 1987) found a correlation between watching science fiction TV and viewers' negative attitudes toward science as a legitimate problem solving approach. According to Gerbner (1987), popular entertainment can lead to negative attitudes towards science given the fact that in a recent survey of prime time TV 10% of all scientists are get killed and 5% kill someone else. No other fictionally depicted occupational group is more likely to kill or be killed.

To help us understand the apparent contradiction between reports of both negative and positive influences of science fiction, we conducted a study that compared the effects of two different science fiction movies on college students' conceptions of selected scientific phenomena. Specifically we chose scientific concepts which are addressed by either one of the movies exclusively, or by both of the movies, albeit using slightly different approaches. Our goal was to determine whether students drawn from similar samples report different kinds of conceptions depending on the movie they viewed. We also attempted to explore the possibility that, in addition to their role as content-delivering vehicles, science fiction movies may be used as evaluative and investigative tools that can help to reveal students' existing conceptual ecology.

Because this study was conducted by a team of international graduate students, we became secondarily interested in possible differences between the effects of science fiction movies on populations of students from different nations. We will briefly discuss our findings on this issue; however, our results suggest that contemporary science fiction includes themes that are internationally recognized and universally relevant to science teaching.

## **Methodology**

The study was conducted using a sample consisting of allied health students from an urban community college in Midwest (n=21), non-biology major undergraduates from a large Midwestern university (n=4) and undergraduate science education students from one of the metropolitan universities in Turkey (n=36). The samples were primarily chosen based on accessibility; however, as the study progressed the authors realized that sampling college level students with some amount of exposure to science was desirable since the sample essentially matched the demographic profile of the investigators people conducting the study. The students of each country were randomly assigned to watch one of the two selected movies- Abyss, or Jurassic Park Part I-. After viewing the movies, students were asked to fill out a questionnaire consisting of fifteen Likert scale questions and three open-ended items. (The instrument is available at: <http://140.254.31.4/scifi.html> ). The reliability analysis of the instrument suggested an alpha level of 0.50, which is adequate for first generation instruments (Nunnally, 1978). One challenge we faced during our research was the issue of voluntary participation. We realized that regardless of the interest level of the students to science fiction, watching a movie and completing a survey takes quite a bit of time, thus decreasing the number of volunteer participants. Therefore, in the future we might consider embedding the process (watching the movie and implementing the survey) in our curriculum so that we can both guarantee participation and use it as a metacognitive learning exercise for the students.

The questions were designed to examine students' understanding of scientific issues addressed in the movies as well as analyze their ability to critically evaluate plausible and implausible depictions of scientific phenomena. Some questions considered general concepts that appeared in both movies, other questions focused more on specific concepts that only appeared in one or other of the two movies. We hoped that this approach might allow us to see the specific effects of each movie by comparing the answers of students who have seen the movie with those who have not. We also looked for correlations between students' answers, their gender and interest in the science fiction genre. Since there are relatively few studies in this area we used a grounded, exploratory approach in

data analysis and looked for emerging patterns that might help us form new hypothesis and identify areas for future study.

The two movies used in this study were chosen because they included a diverse blend of science concepts, portrayed with varying degrees of scientific accuracy. We felt that this blend of good and bad science was important for the study because we are particularly interested in observing students' ability to separate fact from fiction and in the possible consequences for student beliefs when fact and fiction are indiscriminately mixed together.

### **Findings and Discussions:**

Based on descriptive analysis, data from both countries showed a normal and homogeneous distribution. A total score was calculated for each of the participants using Likert scale items. Analysis of variance suggested no statistically significant difference between surveys submitted by students from different countries and no statistically significant difference between the total scores of surveys submitted by students who saw different movies. Also no statistical difference was found between the genders. These outcomes might be due to several factors such as the low power calculated in the analysis or the nature of the effects of the two movies. In addition, the possible limitations in translating complex terminology of scientific concepts from English to Turkish might be another factor. We tried to address this issue by using independent native-Turkish speaking peers to make sure that the questions were adequately translated.

T-test analysis was also conducted to determine potential differences at the survey item level. We anticipated that this approach could give us a better understanding of the differences in scientific concepts being investigated. Our findings showed three significantly different items due to the different movie and six items due to differences between the countries.

Among the participants who watched Abyss and Jurassic Park-I, items 8, 10 and 11 were statistically different. (( $F(1, 58)=0.01, p<.05$ ); ( $F(1, 58)=0.01, p<.05$ ); and ( $F(1, 58)=0.04,$

p<.05) respectively). Items 8 and 11 were indeed directly complements a seen from the movie Abyss, which indicated us the high possibility of the negative effect of the film on students' conceptions.

Item 8- “Waterproof watches can function at any depth.”

Item 11-“Electrical appliances can function in salt water because salt conducts electricity”

We found that 52% of the participants who watched Abyss reported alternative conceptions regarding the effect of pressure on waterproof watches; whereas only 11% of the students who watched Jurassic Park revealed an alternative conception on the same concept indicating negative effect of the movie. The last statistically significant item was, 10 “Highly successful organisms adapt well to new environments”, which was strongly addressed in the movie Jurassic Park-I. Participants who watched this movie revealed higher percentages of alternative conceptions on this statement compared to the ones who watched Abyss. (M Jurassic Park-I=44.0%, M Abyss=8.3%) In both of the cases it has been observed that movies led to an increase in alternative conceptions in certain items.

In terms of the country, 6 items were identified as significantly different; items 1, 3, 6, 8, 10, 14. Overall, analysis of these six items suggested that high percentages of participants in US reported alternative conceptions on most of the items except items 8 and 14, which can be attributed to the science backgrounds of the students constructed by different curriculums.

| <b>Item</b> | <b>Percentages<br/>(Abyss)</b> | <b>Percentages<br/>(Jurassic Park-I)</b> |
|-------------|--------------------------------|--|
| Item 1      | 42.1%                          | 18.9%                                    |
| Item 3      | 21.7%                          | 43.2%                                    |
| Item 6      | 8.6%                           | 13.5%                                    |
| Item 8      | 52.1%                          | 10.8%                                    |
| Item 10     | 39.1%,                         | 70.3%;                                   |
| Item14      | 8.7%                           | 10.8%                                    |

The level of interest to science fiction movies was also investigated as a factor of effect on students' conceptions. The question that was raised in our minds prior to the study was "is there any relationship between the level of interest to science fiction and ability to identify correct scientific concepts". Analyses suggest that there is a significant relationship in terms of level of interest in science fiction and the scores participants received in the survey. ( $F(58,2), 0,00, p<0.5$ ) The more interested students were in science fiction movies, the more they seem to understand the scientific process and determine scientific concepts correctly. (Mean<sub>high interest</sub>=47.5; Mean<sub>low interest</sub>=42.7) This correlation is interesting, but more work is needed before we can suggest what its cause might be.

We also qualitatively analyzed students' responses on three open-ended items. What we found appears to suggest that science fiction movies have the potential to influence students' existing conceptions in either a positive or a negative way.

Some of the conceptions we investigated in our study were;

1) The possibility of respiration using an oxygenated liquid passed through the lungs:

*Denise:* "Babies live in fluid before birth so anything is possible."

*Dan:* "It seems a logical scenario; however, I am not sure how the lungs would respond to the pressure caused by the liquid..."

*Jennifer:* "Well I am not really sure but think it could be possible. The question is how would the fluid get out of the lungs? Reabsorbtion? They turned the mouse up side down by his tail we don't have tails "

*Mandy:* "I believe it is possible, I remember reading something about it..."

It occurred to us that most of the respondents based their ideas on their previous conception that babies can breathe in the amniotic fluid before birth. We found that they were more likely to be in an attempt to justify the scene from the movie rather than critically analyzing it. A few students, however, managed to apply some scientific reasoning even though they did not go into any great depth. It may be possible that given enough time and resources these participants could go into deeper understanding of the issues.

2) The possibility of cloning extinct organisms from fossil DNA.

Emilia: “Why not...Scientific technology is progressing so rapidly they can do anything nowadays...They cloned Dolly, so why not another animal..”

Sam: “No. The elements would have destroyed too much genetic material. Humans were not around to preserve DNA for cloning at that time.”

Most of the students answered this question in ways that suggest they believe science can accomplish anything. Only a few seemed to question the plausibility of this scenario. Some of the responses mention the cloning of Dolly, with which they have some familiarity through scientific news, as an explanation for the possibility of cloning extinct animals.

3) What, if any scientific phenomena did you learn from this movie?

John: “From the movie I learnt that people can dive to any depth with the right diving suit...”

Some of the students stated that they haven't learned anything different than what they already know, whereas some, such as John stated they learned a new concept which in fact was an alternative conception.

As can be seen from the above statements the movies apparently influenced students' views of science and their scientific concepts. Overall, the participants described relatively positive views of the capabilities of science, as opposed to some of the literature cited earlier. (Gerbner 1987). However, this might be solely due to the representations of scientists and scientific processes presented in the movies that were selected for the study.

Analysis of our results led us to three major conclusions: 1) Science fiction movies can be an effective tool for prompting students to reveal or describe alternative conceptions of scientific phenomena. In some cases these alternative conceptions may be generated by the movie itself, in other cases the movie merely helps to illuminate alternative conceptions that are a common part of our collective culture. 2) Since some questions were answered differently depending on what movie was watched, we can say that watching science fiction movies can have some affect on student conceptions. The exact nature of the affect seems to be hard to predict, but in at least some situations it seems that science fiction movies can generate or strengthen students' alternative conceptions, even if the science they portray is factually sound. 3) We noticed that the questionnaire often promoted students' to express their dissatisfaction with the state of their own knowledge; after answering the questions, many students expressed a strong desire to learn the "correct" answers. It occurred to us that these students may be expressing what Posner et al. (1982) have referred to as "dissatisfaction with their conceptual ecology", also sometimes called "cognitive dissonance". It could be that science fiction movies accompanied by a questionnaire may be a good way of introducing "virtual anomalies" that challenge students' conceptions of scientific principles. When students observe fictional events in the movie that are incompatible with their existing mental models, this may cause them to re-examine their beliefs more earnestly and effectively than they would if they were simply told the standard mainstream scientific view. 4) We found a significant relationship in terms of level of interest in science fiction and the scores participants received in the survey. ( $F(58,2), 0,00, p<0.5$ ) Students who reported that they frequently watch science fiction movies seem to be more likely to understand scientific process and concepts. ( $M_{\text{high interest}}=47.5; M_{\text{low interest}}=42.7$ ) This appears to contradict our

earlier finding that science fiction movies can sometimes generate alternative conceptions. If this were true, how can it be that those students who watch the most science fiction seem to be the most scientifically knowledgeable? One possibility is that science fiction movies generate alternative conceptions primarily among students who only watch them occasionally while students who watch a lot tend to be more scientifically literate, and therefore less prone to alternative conceptions. This finding suggests some intriguing possibilities for future study.

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