

# ***Luck is Not a Factor:*** **Representations of Female** **Protagonists' STEM Skills within** **Blockbuster Movies by James Cameron**

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*Edutainment researchers have recommended that movies and other media with compelling portrayals demonstrating the value of STEM (science, technology, engineering, and mathematics) skills can serve as educational tools for achieving immediacy in the mathematics classroom (Burkard & Ross, 2012; Lewis, 2014). This project analyzed popular blockbuster movies directed by James Cameron in terms of their portrayal of female protagonists' STEM skills and abilities compared to their male protagonist and antagonist counterparts, as well the overall implications for mathematics education. The frequent depictions of lead female protagonists' STEM skills in movies by James Cameron provides a consistent pedagogical message: Having strong STEM skills empowers the movies' heroines to repeatedly achieve success at creative problem solving while under the pressures that accompany some very difficult situations.*

**Key Words:** mathematics education, females in STEM, blockbuster movies.

Representation and communication of abstract ideas is often constricted by the commonplace barriers that exist throughout cultures, such as social norms and personal insecurities (Warren, 2000). Nevertheless, establishing sound lines of communication, as well as a diversity of multiple representations, are both necessary in order to run a mathematics classroom efficiently and effectively (Borisoff & Hahn, 2009; National Council of Teachers of Mathematics [NCTM], 2000). NCTM (2000) has specified in their Process Standards that the quality of communication and representation is instrumental in determining students' learning of mathematics. Educational technologies, particularly those involving media and multimedia, can offer students' opportunities to organize, consolidate, and translate mathematical ideas during interactions with peers and teachers, as well as study visual, physical, and social phenomena. Multimedia can facilitate safe group experiences with narratives portraying fictional characters in exciting and often unrealistic situations (Pinar, 2004). Science fiction movies in particular

have allowed audiences to have communal experiences investigating the potential futures for STEM (Tzuo, 2007).

Movies are an influential popular media, and the narrative contained in movies can help mediate the interactions between students, teachers and parents, while also impacting students' dispositions toward formal school curriculum and future career choices (Horn, 2003). Movies in which STEM skills are displayed by lead characters can help to create role models for students in the mathematics classroom, as well as prompts for learning activities (Barak, Ashkar, & Dori, 2011). Movies can also serve as illustrations for mathematics students unfamiliar with the real-world applications of STEM skills, particularly when characters are shown utilizing mathematical abilities in order to succeed in complex situations. For example, a classical mathematics puzzle was revised and integrated into the movie *Die Hard with a Vengeance* (McTiernan, 1995), in a bomb-diffusion scene where the leading actors were challenged to measure four gallons of water using five-gallon and three-gallon jugs. This problem was later used by mathematics professors to illustrate the use of multiple approaches to solving mathematics problems. Additionally, a website created by Dr. Don Allen provides mathematics questions used in movies for students to solve: <http://www.math.tamu.edu/~dallen/hollywood>.

Using movies with scenarios that shine a positive light on the mathematical skills of prominent characters has the potential to increase student engagement with mathematics instruction (Slattery, 1995). However, a limited number of studies have been conducted which investigate the relationship between movies and mathematics education, from a pedagogical perspective. The focus of this research study is to help address the challenge of how to examine films that portray female role models with mathematics skills succeeding in STEM situations, and how these movies might be better integrated as edutainment tools supporting effective instruction in the math and STEM classroom. Specifically, the catalog of James Cameron's films were chosen to be analyzed because of their broad cultural impact: in a career that has spanned more than three decades, starting with his debut as a student filmmaker and the short movie *Xenogenesis* (1978), Cameron has displayed a consistent knack for producing commercially and critically acclaimed science fiction film franchises, such as *The Terminator* films, as well as directing some of the highest grossing films of all time, like *Titanic* (1997) and *Avatar* (2009). Especially relevant in the context of this study, Cameron is also known for presenting narratives showcasing strong female protagonists tackling STEM-themed challenges throughout his movies.

The purpose of this research study was to examine the representations of female protagonists' STEM skills and abilities within blockbuster movies by James Cameron, and determine the implications for mathematics education. The specific guiding research questions were: (A) What have been the representations of female protagonists' STEM skills and abilities within

blockbuster movies by James Cameron, as compared to his lead male characters, and antagonists? (B) What are the implications for mathematics education resulting from these representations within popular culture, and the usefulness to the mathematics classroom?

### **Theoretical Framework and Background Literature**

The lack of student engagement with mathematics instruction that is framed in typical traditional formats, such as textbooks and worksheets, provides an opportunity to present the instruction in a format that includes edutainment elements, so that students are more likely to become engaged with the subject matter. Bickley-Green (1995) has recommended that it would be pedagogically beneficial to restructure the mathematics curriculum to be better integrated with the arts curriculum, in order to take advantage of the many relationships between congruent elements in the two fields of study. By using cultural references to help maintain effective lines of communication in the classroom, movies can provide positive role models for students, which may help those students to overcome some of the barriers to achieving success in the STEM fields (Tillman, 2015). Grossman and Porche (2013) found that surveyed high school students reported higher STEM aspirations when they perceived that they were supported in those aspirations, particularly when attempting to overcome existing and potential barriers.

Drury, Siy, & Cheryan (2011) examined the importance of differentiating recruitment from retention in STEM, and asked when do female role models benefit women? They reported an experiment that found that female students performed better on math tests after learning about other women's achievements in the STEM fields. This is in keeping with the goal of postmodern pedagogy (Slattery, 1995), which has been described as the effort to "integrate the past and the future into the existential present, meaning that the material students are presented with should expand their conceptual frameworks as opposed to limiting them the way traditional methods of education often do." Since many of the traditional texts that students are exposed to in school are irrelevant in the modern context of their everyday lives, perhaps works of popular culture, such as blockbuster science fiction movies, can allow them to view STEM subject matter in a way that relates to their personal interests (De Gregorio, 2006). Movies that frame STEM skills as a positive and worthwhile personal attribute can thus be employed to encourage students to develop STEM skills (Tillman et al., 2015), and the mathematical thinking fundamental to those skills (Sadler & Tai, 2001).

Edutainment (also sometimes called entertainment-education or E-E) is a pedagogical theory acknowledging that familiar and enjoyable information delivery approaches can play an important role in helping to deliver educational content. Edutainment such as movies using a fictional narrative that highlights characters' situational application of mathematics

skills can assist teachers in generating *immediacy* in the classroom. Immediacy is increased when communication is promptly delivered from the sender to the receiver, which can be achieved by a decreased psychological distance between teachers and students (Gorham, 1988).

As a simplification, immediacy has been described as synonymous with liking (Mehrabian, 1971). The real relationship between the concepts is more complex, and has been articulated as: liking encourages greater immediacy and immediacy produces more liking (Gorham, 1990). Several studies have found a positive relationship between classroom immediacy and affective learning (Gorham & Zakahi, 1990). An early study conducted on this topic found that immediacy accounted for up to 45 percent of the variance in measures of student attitude and behavioral commitment in college classes (Andersen, 1979). If true, this means that students to a large degree, base decisions about their academic careers centered upon their educators' ability to establish classroom immediacy (Kelly 1988; Gorham & Zakahi, 1990).

As discussed earlier, effective communication between teachers and students is crucial to the teaching-learning process, and the degree of immediacy between teacher and students is an important variable in those relationships (Gorham, 1988). When students perceive immediacy, such as while receiving genuine and direct positive feedback from a teacher, students develop affinity for the subject being learned, which helps them to be more successful academically. STEM role models that are presented via examples taken from multimedia are one example of a sustainable way for teachers to help students achieve immediacy in the mathematics classroom.

Communication between students and teachers is vital to the instructional process. The proper integration of educational tools and media by teachers help facilitate the development of channels for communication to occur—which can result in increased student attention, reduced anxiety, improved critical thinking, enhanced concept learning, and a positive classroom environment (Garner, 2003). Edutainment researchers have recommended using movies and other media with strong portrayals demonstrating the value of mathematical skills, in order to serve as educational tools for achieving immediacy in the mathematics classroom. Movie scenes with mathematics-themed situations are easily accessible tools that can be used to break down communication barriers impeding mathematics education. Websites such as [www.math.harvard.edu/~knill/mathmovies](http://www.math.harvard.edu/~knill/mathmovies) have created accessible databases that provide information about movies with situations that highlight mathematics aptitude and achievements.

Several educators have examined using movies to teach mathematical concepts, for instance in the book *Math Goes to the Movies* by Polster and Ross (2012) the authors suggest that using clips from popular movies can help to establish sound communication between teachers and students when trying to address otherwise difficult to understand concepts. As a recent example, a lesson plan is presented describing an activity in which students test how

much weight can be lifted by helium balloons, drawing inspiration from the animated film *Up* (Lewis, 2014). This activity uses the animated scenes from the movie to engage students in the learning activity while they complete the assigned calculations, thus putting mathematics into action.

Using Hollywood movies as their hook, Texas Instruments has performed educational outreach promoting the edutainment approach to getting kids engaged in math and science. The “STEM Behind Hollywood” educational program was developed with assistance from The Science & Entertainment Exchange, a program of the National Academy of Sciences, as well as actress, neuroscientist and STEM education advocate Mayim Bialik. The purpose of “STEM Behind Hollywood” is to get middle and high school students interested in STEM education as well as career paths. By providing a series of classroom activities available online at [www.stemhollywood.com](http://www.stemhollywood.com) that are available for free to teachers, they help provide content for classroom demonstrations examining the real-world STEM concepts behind popular Hollywood movie themes such as zombies and space exploration.

Edutainment media that was intentionally produced for use in the mathematics classroom can be supplemented with entertainment media that was purposefully chosen to encourage academic achievement. While teaching STEM concepts, teachers can use the role models presented in movies to establish productive and engaging lines of communication with students. However, it is important that teachers not inadvertently use media that reinforces negative gender-biased stereotypes portraying only men succeeding in STEM undertakings and professions. So as to facilitate teachers interested in positive STEM portrayals of females, this study analyzed and coded content from eight blockbuster science fiction movies produced between 1978 and 2009 in regards to females and males succeeding in STEM.

### **Research Methods**

This study was designed to determine any trends within the movies examined regarding representations of mathematics skills and abilities in STEM related tasks, as portrayed by the lead female human protagonist, the lead male human protagonist, and the lead antagonist (regardless of gender or species). These trends were plotted and compared over time, along an axis of their production years—1978, 1981, 1984, 1986, 1989, 1991, 1994, 1997, and 2009, respectively. Coded data was employed to determine any trends and/or patterns of the representations of female protagonists' math skills and abilities in STEM driven scenarios within the movies, along with how those trends compared to the lead male protagonist and the lead antagonist.

### **Data Selection**

The data-set for this study consisted of the content from eight feature films produced by James Cameron. The titles of the eight movies are listed

below along with the years of production, along with the character name and actor name for the roles that were coded according to their portrayal of STEM references (i.e., female protagonist, male protagonist, and lead antagonist).

- Piranha 2 (1981). Anne Kimbrough (Tricia O'Neil), Steve Kimbrough (Lance Henriksen), Tyler Sherman (Steve Marachuk).
- The Terminator (1984). Sarah Connor (Linda Hamilton), Kyle Reese (Michael Biehn), T-800 (Arnold Schwarzenegger).
- Aliens (1986). Ellen Ripley (Sigourney Weaver), Dwayne Hicks (Michael Biehn), Carter Burke (Paul Reiser).
- The Abyss (1989). Lindsay Brigman (Elizabeth Mastrantonio), Bud Brigman (Ed Harris), Lt. Coffey (Michael Biehn).
- Terminator 2: Judgment Day (1991). Sarah Connor (Linda Hamilton), John Connor (Edward Furlong), T-1000 (Robert Patrick).
- True Lies (1994). Helen Tasker (Jamie Lee Curtis), Harry Tasker (Arnold Schwarzenegger), Salim Abu Aziz (Art Malik).
- Titanic (1997). Rose DeWitt Bukater (Kate Winslet), Jack Dawson (Leonardo DiCaprio), Cal Hockley (Billy Zane).
- Avatar (2009). Dr. Grace Augustine (Sigourney Weaver), Jake Sully (Sam Worthington), Miles Quaritch (Stephen Lang).

### Data Analysis

All eight films selected were coded for STEM references accorded to each of the three role categories. STEM references were interpreted to include any appropriately themed dialogue, reasoning or character actions that entailed a relationship to science, technology, engineering, or mathematics. Beyond references to these disciplines as such (which included biology, computer science, and nuclear physics, among others), the films were also coded for characters displaying practical and theoretical knowledge of advanced technologies (such as weapons and vehicles), specialized skills (underwater diving, for example), and improvised problem-solving using logic and STEM knowledge (such as *Titanic*'s main characters creating a makeshift raft, or *Alien*'s characters coming up with a quarantine plan). As the data was tabulated by a researcher watching all eight films, quotes and descriptions of characters' actions were noted, along with their respective actor. The handwritten data was then typed into an Excel spreadsheet, and sorted for each film by character type: (A) lead female protagonist, (B) lead male protagonist, or (C) lead antagonist. Table 1 describes the lead female's role and STEM skills for each of the eight movies included in this study.

*Table 1*  
**Lead Female's Role and STEM Skills Across Movies Analyzed**

<b>MOVIE TITLE</b>	<b>CHARACTER'S NAME</b>	<b>LEAD FEMALE'S ROLE AND STEM SKILLS</b>
<i>Piranha 2</i>	Anne Kimbrough	Diving instructor with a background in marine biology.
<i>The Terminator</i>	Sarah Connor	Waitress with dormant STEM skills that are used to survive.
<i>Aliens</i>	Ellen Ripley	Military background and acquaintance with the STEM knowledge of aliens.
<i>The Abyss</i>	Lindsey Brigman	Scientist/engineer who designed an experimental underwater drilling rig, with extensive medical knowledge, underwater diving experience, and machinery operation including submersible vehicles.
<i>Terminator 2</i>	Sarah Connor	Weapons knowledge, demolitions experience, and reprogramming the T-800.
<i>True Lies</i>	Helen Tasker	Weapons knowledge, and other skills commiserate with pretending to be a spy.
<i>Titanic</i>	Rose DeWitt Bukater	Survival skills and real world problem-solving, such as figuring out that there aren't enough lifeboats on the ship Titanic for all the passengers.
<i>Avatar</i>	Dr. Grace Augustine	Ph.D. scientist with extensive knowledge of planet Pandora's native tribe, the Navi, as well as knowledge of the fauna and flora of Pandora.

## Results

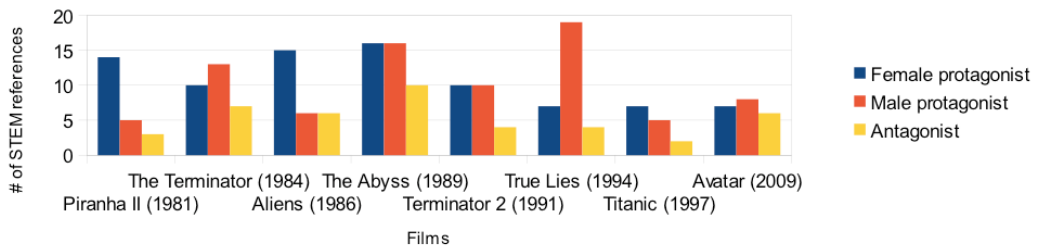
This section will present quantitative and then qualitative findings addressing the two research questions posed. However, if the reader is unfamiliar with Cameron's movies then it is recommended to first read the Qualitative Findings section prior to reading the Quantitative Findings section.

### Quantitative Findings

The quantitative findings from this research study were employed to help address the first research question posed, namely: (A) What have been the representations of female protagonists' STEM skills and abilities within blockbuster movies by James Cameron, as compared to his lead male characters, and antagonists?

Based upon the data set that was compiled for each of the three character types (i.e., female lead, male lead, and antagonist), a comparison

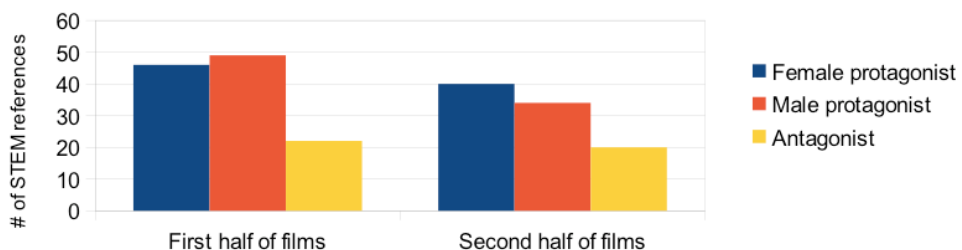
was performed, the first of which was a straight aggregation charting the total STEM references per role type for each film, as shown in Figure 1.



**Figure 1. STEM references per character type.**

Figure 1 shows that, except for *True Lies* (1994), the selected movies employ females in STEM scenarios almost as often, or sometimes more often, than male protagonists. STEM experiences for lead female characters were higher than for characters in the antagonist roles, who were always male in each of the eight movies. In both *Piranha II* and *Aliens* there are female lead characters with substantially more STEM-based experiences in the movie than their male counterparts of either the protagonist or antagonist variety.

In total aggregate, STEM references were roughly evenly spread throughout the movies for the male and female protagonist roles, with fewer STEM references for the antagonist roles (by approximately half). Figure 2 shows STEM references according to when they occurred for each role type—specifically, whether they occurred in the first or second half of the movies.



**Figure 2. Distribution of STEM references in movie narratives.**

Lastly, in regards to the quantitative data, analysis was undertaken to determine the extent to which the data about female protagonists was skewed by plots where the female protagonist had a professional STEM background. In other words, did the lead females that did not have a professional STEM background in the movie display development of any STEM themed skills?

It was determined that narratives where the lead female protagonist did not have a STEM background showed a stronger gulf between STEM references occurring in the first and second halves of the films for these



characters. Figure 3 shows this trend, which implies a relationship between STEM skills acquisition and the lead female characters' narrative arcs.

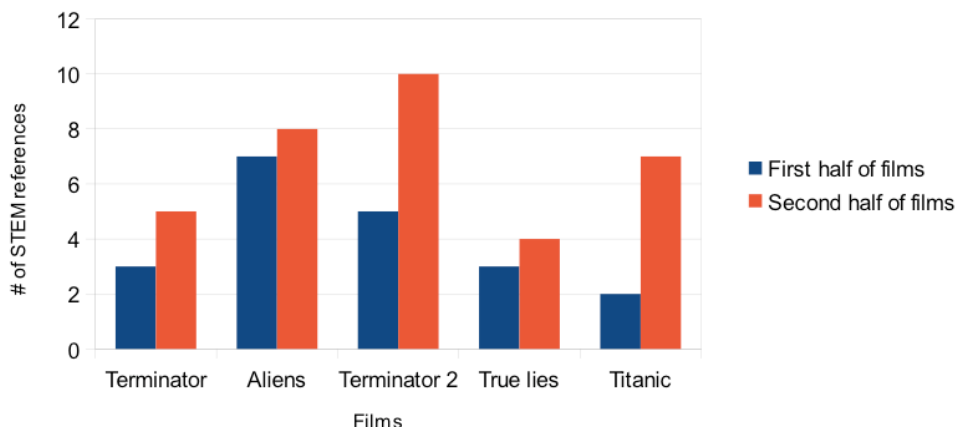


Figure 3. STEM references for female leads without STEM backgrounds.

### Qualitative Findings

The qualitative findings from this research study were employed to help address the second research question posed, namely: (B) What are the implications for mathematics education resulting from these representations within popular culture, and the usefulness to the mathematics classroom?

The following section provides an overview of the qualitative data examined for each movie in regards to the usefulness of the representations for the mathematics classroom, specifically in regards to presenting an affirmative portrayal of a female exhibiting STEM skills:

*Piranha 2* (1981) presents a narrative wherein the lead female protagonist is a diving instructor with a background in marine biology, which is an atypical combination of professions in the real world. STEM-themed activities for the female lead protagonist include underwater diving, knowledge of marine species, human biology (including taking pictures in a morgue), radio communications, and setting/detonating of explosives. The male lead protagonist is her ex-husband, a Coast Guard officer whose STEM-themed activities includes understanding/piloting boats and helicopters, criminal forensics, and finding remnants of a piranha fish and thereby surmising they can fly. The villain is a visitor to the island who first courts the lead female, but later betrays the protagonists.

In *The Terminator* (1984) the lead female protagonist, Sarah Connor, is a waitress in her early-twenties, who becomes the target of a Terminator robot sent from the future to kill her. Within the narrative, she is first portrayed as fairly clumsy and naïve about the world. But as the film unfolds, her STEM skills are displayed as a kind of dormant knowledge that is prompted to arise out of her need to survive. She develops competence with

weapons, operating vehicles, and industrial equipment as she struggles to survive the assassination attempts put forth by the Terminator. The lead male protagonist is a human from the future, familiar with guerrilla warfare and survival techniques learned from the machine-ruled future. He also has basic theoretical knowledge of the science and technology responsible for the design and development of the Terminator. The Terminator itself is an assassination-focused robot with extensive weapons knowledge, machinery operation, and the ability to drive all types of vehicles.

*Aliens* (1986) is the sequel to Ridley Scott's (1979) movie *Alien*, which also stars Sigourney Weaver as Ellen Ripley. The movie *Aliens* begins with Ripley being blamed for the destruction of her ship and crew, and then recruited to help the corporation she works for investigate a terraformed outpost that has experienced similar problems. Ripley's STEM skills include familiarity with weapons, industrial machinery and military vehicles, science and biology, and the ability to constructively problem-solve using available STEM resources, particularly advanced technologies. Throughout the movie, Ripley employs a combination of fierce intelligence, quick insight, and STEM skills to be a strong and effective leader, saving the lives of both male and female Marines in several different situations. The lead male protagonist is an enlisted soldier whose STEM knowledge derives mostly from handling of weapons, vehicles, and tactical warfare. The lead antagonist is a representative of the Weyland-Yutani Corporation that wishes to monetize the alien species through corporate research and development, and he has basic familiarity with space travel, androids, and corporate finance.

In *The Abyss* (1989), the lead female protagonist is a scientist and engineer, who designed an experimental underwater drilling rig. Her STEM skills are extensive, and also include medical knowledge, underwater diving, operating machinery including underwater exploration pods, and an accurate analysis of the nature of the unfamiliar life-forms that the characters meet in the abyss. She says many of the movies most iconic lines, such as her retort when wished good luck by another character: "Luck is not a factor." The lead male protagonist is her husband, the chief operator of the oil rig. His STEM skillset is less widespread than his wife's professional and academic training, although he has practical knowledge operating the equipment that she designs. The competitive nature between the two spouses, as they each try to control the fate of the experimental underwater drilling rig, is a chief theme of the movie's narrative. Eventually, they both team up against a Navy SEAL who is trying to take over the drilling rig himself, and whose STEM skill set is highly developed in relation to his tremendous training with weapons, including familiarity with nuclear weapons and submarines. Of all the movies analyzed, this film perhaps best exemplifies the competition, and collaboration, that occurs between different factions and interests within the STEM community (i.e., the interactions between research, corporate, and military interests).

In *Terminator 2* (1991), the lead female protagonist is again Sarah Connor, though she has matured by almost a decade of experience fighting against the machine uprising that will occur. Her STEM skills in this movie reprise the ones she developed in the first volume of the series, but now she has taken her training and knowledge to an advanced level. Although she is in an encumbered position at the beginning of the film (i.e., an involuntary detainee trapped inside a mental asylum), her STEM skills allow her to display an array of survival skills, including improvising weapons with household objects, and thereby escaping. The rest of the narrative continues to showcase her widespread weapons knowledge, including handling military grade guns as well as setting/detonating explosives. She also uses her STEM skills in this movie to help others medically, including her son and some of the people she has injured. The lead male protagonist in this movie is her son John Connor, who she has trained since early childhood to be skilled with STEM-themed challenges such as fixing vehicles, and cracking ATM PINs. The nemesis in this movie is a more advanced assassination-focused robot, designated the T-1000, with even more fearsome STEM skills than the T-800 in the first film. As a seemingly unstoppable force of improvisation, the T-1000's STEM skills include being able to modify its own body to form almost any non-mechanical shape or mimic any person, and ability to modify its voice to imitate any sounds that it hears. The T-1000 also has knowledge of weapons, and the ability to drive all types of vehicles.

The lead female protagonist in *True Lies* (1994) begins the movie as a character with a clerical job. As the plot evolves, she learns to handle weapons and eventually acts as a full-fledged spy of her own. The narrative portrays her as someone fully capable of stepping up to a challenge, using her STEM skills that were previously ignored or underutilized. The male lead protagonist is her husband, who has been secretly working as a spy while pretending to be at a less interesting job. His STEM skills are extensive, and include knowledge of weapons, underwater diving, setting up explosives, computer hacking, chemistry, and vehicle operating. The antagonist is an anti-America terrorist whose STEM skills are primarily illustrated through knowledge of weapons, including nuclear bombs, and vehicle handling.

*Titanic* (1997) differs from all the other movies in this study in that the narrative is contextualized within an actual historical event. The female lead protagonist is wealthy and highly educated, with extensive knowledge of the works of Sigmund Freud, and her STEM skills are first displayed when she figures out that there aren't enough lifeboats on the ship. As the story develops, she employs STEM skills and basic survival abilities to problem solve how best to escape from a sinking ship. The lead male protagonist is courting her throughout most of the movie, with his lowly social status as they primary impediment. His STEM skills are first illustrated in a poker game, and then later when he solves several real world problems to help save himself

and the female lead from being drowned inside a sinking ship. The antagonist is the female lead's fiancé, and his STEM skills include guns and finances.

*Avatar's* (2009) lead female protagonist, Dr. Grace Augustine, is a Ph.D. scientist with extensive extraterrestrial species knowledge, and the author of several textbooks on that same subject. Of all the characters in James Cameron's movies, Dr. Augustine, played by Sigourney Weaver, perhaps best personifies a female STEM role model for encouraging female students to foster their STEM skills. The male lead is a wheelchair-bound former Marine, with STEM skills pertaining to weapons and equipment handling. The antagonist is a soldier bent on acquiring planet Pandora's natural resources, using any means available. This film has many of the same dynamics as *The Abyss* in showing how different types of STEM knowledge are essential in dealing with alien worlds and species. Like in many of Cameron's movies, the plot explicitly highlights how the scientific/theoretical framework competes with the militaristic/corporate approach.

Lastly, regarding James Cameron's earliest production, *Xenogenesis* (1978), although this short film was not included in the quantitative data set because it was not a feature length movie, an analysis of the story's content is helpful when considering the historical arch of Cameron's portrayal of STEM skills for female protagonists. In *Xenogenesis*, which runs for 12 minutes, the lead female protagonist displays STEM skills by operating advanced machinery and problem solving while attempting to rescue her male partner from an assassination-focused robot. Meanwhile, her partner, who is the lead male protagonist, displays similar STEM skills as he also tries to fight off the robot which is attempting to exterminate them. The antagonist is a robot that attacks our protagonists while they are exploring what they originally thought was an abandoned space outpost. This short film is the earliest portrayal of Cameron's long-standing affinity for presenting strong female characters that employ their STEM skills and problem solving abilities to forward the plot of the story—it is not by mere happenstance that in *Xenogenesis* it is the female that is helping to rescue the male from out-of-control technology, as this is a theme that occurs repeatedly throughout Cameron's movies.

## Discussion

The numerous portrayals of lead female protagonists' STEM skills in movies by James Cameron provide a consistent pedagogical message: Having strong STEM skills empowers the movies' heroines to repeatedly achieve success at creative problem solving while under the pressure of very difficult circumstances. In contrast, the STEM skills demonstrated by the movies' antagonists were consistently destructive in nature, and pertained primarily to weapons, combat, and other technologies related to warfare. Each of Cameron's movies has a narrative arc that is primarily focused upon a female character's journey towards some type of emancipation. For Anne Kimbrough

(*Piranha 2*), Lindsay Brigman (*The Abyss*), and Rose Bukater (*Titanic*) the challenge is confronting the ocean's depths and dangers. For Ellen Ripley (*Aliens*), Sarah Connor (*The Terminator*, *Terminator 2*) and Dr. Grace Augustine (*Avatar*) the challenge is escaping from an enemy hell-bent on causing destruction. None of these lead female protagonists face an antagonist that can be reasoned with or expected to grant leniency. Instead, each of these women must rely upon their own wits and skills to survive and overcome the obstacles they face. These journeys of emancipation are often undertaken with considerable consternation from the male-dominated, patriarchal society—the rivalry between Lindsay and Bud Brigman for control of an oil rig perhaps most crisply illustrates this type of dynamic.

Science fiction movies that portray visions of the future can assist STEM students in reflecting upon how their present life is connected with their career aspirations. The catalog of James Cameron produced movies provides a wide variety of illustrations showing STEM skills employed by both female and male protagonists, often in situations where their very lives are at stake. Within Cameron's movies, the lead female protagonists are often particularly adept at employing several kinds of STEM skills to solve life-threatening problems. These movies viscerally demonstrate the application of a much broader range and versatility of STEM abilities on the parts of the female protagonists than is traditionally expected in most Hollywood fare, wherein creative decision making is often relegated to the male protagonists. Further, compared with the antagonists whose STEM skills are often variations on magnified destructive behavior in Cameron's movies, the female protagonists' roles and STEM skills were considerably more multi-dimensional. If properly contextualized, these fictional narratives can help STEM educators encourage their students to establish connections between what they are studying in school and their out-of-school interests.

## Conclusions

Before proceeding to the concluding remarks regarding this research study, some design limitations should be noted. First and foremost, this study did not explore any direct educational impacts resulting from students watching movies; therefore future research in this line of inquiry will examine the impacts science fiction movies have upon students' mathematics learning outcomes as well as attitudes toward STEM careers. Second, only eight feature-length movies were analyzed and these movies were all selected from a single director; though consistent themes were found, other movies not analyzed during this study might display different findings. Third, the data analysis was conducted by the research team, and although we endeavored for objectivity, it is feasible that another research team would advance other emergent subthemes, or vary in their precise coding of discrete numerical references in the data, and therefore research replicability is a concern.

Nevertheless, the present examination of the selected movies helped clarify the representations of female protagonists' STEM skills and abilities in science fiction movies as groundwork for future research on encouraging positive STEM attitudes amongst female mathematics students. In the current digital era, the boundaries between traditional schoolhouse curricula and out-of-school learning are increasingly getting blurred (Slattery, 1995). This situation calls for innovative STEM education wherein we reconsider the values and meanings behind the "hidden curriculum" contained with popular media such as movies, and better employ these resources for teaching STEM content in a manner that encourages students to understand mathematics as a thriving academic discipline, through which any student that applies themselves can learn STEM content and enjoy a rewarding career.

Pinar (2004) suggested that educators should strive to take advantage of available technologies to promote shaping students' attitudes, beliefs, and careers goals. In Pinar's perspective, technology—especially movies—can play an important role in education, by promoting intellectual judgment, critical thinking, ethics, and self-reflexivity. Movies, along with other types of screen media, often appear to have more influence on students' development of personal values than the school's official curriculum. The role models presented in popular media are often the frameworks upon which students attempt to mold themselves. Through movie watching, students witness possible realities, and sometimes even potential futures. The appeal of the medium for students makes it a potential edutainment tool, wherein engaging presentations can lead to the elimination of barriers impeding the communication necessary for STEM instruction to be successful.

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