Chapter 16

Using Movies and Television Shows as a Mathematics Motivator

Elana Reiser

In recent years, popular culture has joined, perhaps accidentally, the effort to improve the U.S. educational system. More and more television shows and movies have incorporated mathematical topics into their scripts and, by doing so, offer the idea that mathematics is both trendy and functional. Given that students are more interested in learning when the topic is relevant to them, popular culture offers a necessary means for student engagement (Brophy 2004). This article will explore contemporary movies and television shows that include one or more mathematical elements and will suggest how mathematics teachers might use such media to boost student motivation.

Garnering student interest is a long-documented battle. Deci and Ryan (1987) found a correlation between intrinsic motivation and self-reports of interest. Culturally, students of all ages have a significant interest in movies and television; Beckmann, Thompson, and Austin (2004) describe how that interest can motivate students to learn mathematics: "If we can draw the mathematics out of the movies and literature that students find engaging, then we can make mathematics more meaningful and interesting to students" (p. 261).

We will look at several examples of mathematics in movies and television through the lens of the National Council of Teachers of Mathematics (2000) five suggested Content Standards: Number and Operations, Algebra, Geometry, Measurement, and Data Analysis and Probability. I will give examples from movies or television shows for each Content Standard. A suggestion for why you might want to show the clip in your classroom and how you can use it to initiate a discussion or teach or reinforce a lesson will follow each example.

Linking Movies and TV Shows to Number and Operations

We can link the movie *Matilda* to the Number and Operations Standard. The main character, a young girl named Matilda, has a gift for quickly adding and

multiplying numbers in her head, which she exhibits in several scenes. In one such scene, Matilda's dad asks his son to document the prices for which he has sold several used cars and to add them with pen and paper. Matilda can sum the numbers in her head faster than her brother can by hand. When using this movie, you might have students think about how Matilda can add numbers in her head quickly. After this discussion you might examine other interesting mental strategies such as this one for multiplying by 11. One way to mentally multiply 1,784 × 11 is to *first do 1,784 × 10 = 17,840 and then sum 17,840 + 1,784 = 19,624.* Another strategy for multiplying by 11 is to add two consecutive digits from left to right along with completing the required regrouping. With this approach, one finds 1,784 × 11 by placing 4 in the ones place; adding 8 and 4, recording the 2 in the tens place; adding 8, 7, and the 1 from the prior regrouping of 8 and 4, recording the 6 in the hundreds place; adding 1, 7, and the 1 from prior regrouping of 8, 7, and 1, recording the 9 in the thousands place; and placing the 1 in the ten thousands place. Depending on the grade level for which you are using this, discussing and justifying why this method works might be appropriate. Many resources exist for finding additional mental mathematics. You can find some on the Mental Math Power Zone (www.themathlab.com/natural/mental%20math%20tricks/powerzone.htm), and 30 Fast Mental Math Tricks (www.glad2teach.co.uk/fast_maths_calculation_tricks.htm) has videos.

The television show *Futurama* features another example of number and operations. The writers chose 1729 for inclusion in a scene because it is the smallest integer that can be expressed in two different ways as the sum of two cubes (of positive integers): $1^3 + 12^3 = 1 + 1728$ and $9^3 + 10^3 = 729 + 1000$. From that point forward, the writers exclusively chose sums of two cubes whenever referring to numbers. Students may be interested in the conversation between two famous mathematicians, G. H. Hardy and Srinivasa Ramanujan, regarding this number (mathworld.wolfram.com/Hardy-RamanujanNumber.html). After students see 1729 in some episodes, have them come up with more examples of these types of numbers. During lunch or study hall, students can watch episodes of *Futurama* and look for such numbers. Also, have students think about other special numbers, why one might use them, and whether they can invent their own.

If students find the work with cubes interesting, you might ask them to explore relationships that they can notice in the following explorations. You might ask what other patterns they can generate.

1. What patterns do you notice?
   a. $1^3 + 2^3 =$
   b. $1^3 + 2^3 + 3^3 =$
   c. $1 + 2^3 + 3^3 + 4^3 =$

2. What patterns do you notice?

   a. 23 + 33 =

   b. 33 + 43 =

   c. 43 + 53 =

Another example that fits into this standard is from *The Da Vinci Code.* French police ask the main character, Robert Langdon, to look at the crime scene where the curator of the Louvre has died. A secret message written in invisible ink is near him. It reads as follows:

13 – 3 – 2 – 21 – 1 – 1 – 8 – 5
O, Draconian devil!
Oh, lame saint!

Although the message at first appears cryptic, Langdon realizes that the numbers are a mixed-up version of the Fibonacci numbers, 1, 1, 2, 3, 5, 8, 13, 21, 34, ... He rearranges the letters and gets "Leonardo Da Vinci the Mona Lisa." Teachers can use this clip to introduce cryptography, the science of analyzing and deciphering codes. Younger students can use a simple coding system such as the Caesar cipher. This system allows for coding and decoding messages by assigning each letter to the one that is three spots away (www.simonsingh.net /The_Black_Chamber/caesar.html). Older students can use more complicated ciphers such as RSA encryption, a method that involves prime numbers and modular arithmetic (mathworld.wolfram.com/RSAEncryption.html). Myerscough et al. (1996) and Gorini (1996) give cryptography examples of all different levels. After students see Langdon solve the riddle, they may become more interested in trying one themselves. Teachers might have students work in pairs. One student chooses a secret message to encode by using the cipher, and the other student decodes the message. After trying this in my classroom, one student told me that he taught the method to his friend so that they could send secret messages to one another.

Teachers can also use this clip to introduce the Fibonacci numbers. Depending on the grade, teachers can find elementary-level (mathforum.org/library /topics/golden ratio) or other age-appropriate activities. The Fibonacci sequence is defined recursively, with each element after the first two defined based on previous elements. The ratio of the consecutive terms, 1/1, 2/1, 3/2, 5/3, 8/5, 13/8, 21/13, . . . converge to a limiting value called the golden ratio, Φ. Teachers can also discuss the idea of recursion or introduce talk about limits. Teachers may ask students to pick any two starting numbers and build a sequence in a manner similar to the Fibonacci sequence. For example, if we start with 5 and 12, we would generate the sequence 5, 12, 17, 29, 46, 75, 121, 196, ... The teacher can

have students investigate the values formed by the ratios of consecutive terms of this or other sequences similarly generated.

Linking Movies and TV Shows to Algebra

Tom Hanks's character in *Big* uses basketball as an analogy to help his friend's son learn algebra: if you score 10 points in the first quarter, how many points would you probably score in a game? Another example is in the movie *Little Big League*, where a 12-year-old baseball team owner makes his players work on this algebra problem: if it takes one man 3 hours to paint a house and a second man needs 5 hours, how long will it take both of them working together? Using such clips in the classroom allows students to see that they are learning material embedded in popular culture.

A book by Chappell and Thompson (2009) gives other examples using algebra. These examples are a little different because they use a movie as the basis for an activity. One movie that the book uses is *Akeelah and the Bee*. Akeelah is studying to be in a spelling bee and must learn to spell many new words. An activity sheet asks students to think about the number of words that she has to learn paired with how much time she has to learn them. Students use algebra to come up with equations relating these two values.

Another algebra example in Chappell and Thompson's book uses the movie *The Pursuit of Happyness*. In this movie the main character, Chris, sells bone density scanner machines, but the original price he charges is unknown. The activity sheet has students use algebra with the possible prices he charges at various parts of the movie. One question asks students to write a piecewise function with the amount that Chris earned as one variable and the number of machines that he sold as another variable.

Linking Movies and TV Shows to Geometry

A situation involving geometry appears in the movie *Death and the Compass*, based on the short story by Jorge Luis Borges. The movie features three murders occurring at locations that form an equilateral triangle (fig. 16.1). Contrary to his police force cronies, the inspector predicts that a fourth murder will occur, at a position that would result in a rhombus if the four locations were joined. Three possible locations will form a rhombus (fig. 16.2).

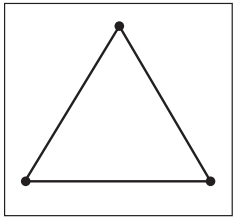

Fig. 16.1. Equilateral triangle

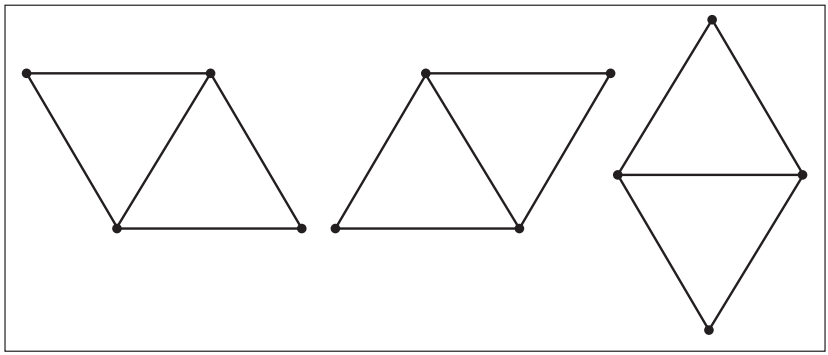

Fig. 16.2. Rhombuses formed from an equilateral triangle

The clues supplied suggested that since the first three crimes occurred in the north, east, and west, the remaining crime would occur in the south. Therefore, the inspector knew that the rhombus in figure 16.3 would be the correct one.

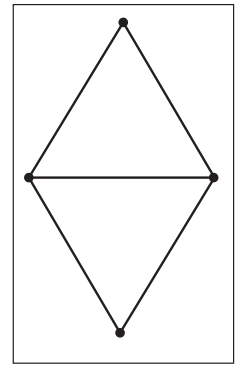

Fig. 16.3. The rhombus that accurately predicts the fourth murder

Chuck, the protagonist in *Cast Away,* is another character who illustrates using geometry as well as measurement. Chuck figures out how many square miles rescuers would have to search to rescue him after his plane crashes. He first estimates the distance from where the plane was supposed to be and where it ended up. He then multiplied the square of this value by π to find the area of the circle that needs to be searched.

After showing students this clip, teachers can encourage them to consider why using the circle that Chuck selected made sense.

Linking Movies and TV Shows to Measurement

Though examples of the Measurement Standard are rare, *Die Hard: With A Vengeance* provides a good one. Bruce Willis and Samuel L. Jackson's characters hunt a criminal by solving riddles. In one scene, they use a five-gallon jug and a three-gallon jug to measure exactly four gallons of water. During class, you can first show the clip where the criminal explains the riddle and sets forth the rules. After viewing, have students work out the solution and discuss their findings. Show the rest of the clip where the characters solve the riddle.

I used this example with a group of nonmathematics majors on the first day

of a college class that I taught. The topic was problem solving, and normally I would have explained Polya's methods and then had students work in groups to solve various word problems. When I showed them this movie clip, the students got excited about finding the solution. Once they solved the problem, I showed the clip where the characters in the movie solved it. The students were gratified knowing that through their own hard work they could solve a riddle worthy enough to be in a movie. One student even said, "I have seen this movie a bunch of times, but I never stopped to think about how they solved that riddle." It seemed that using the movie clip for the first example excited my students about the topic and that they enjoyed solving the other problems—a welcome motivator, especially since these students took the course only to fulfill their mathematics requirement.

Linking Movies and TV Shows to Data Analysis and Probability

The Da Vinci Code also presents an example of the Data Analysis and Probability Standard. Teachers can use this clip best when students are first learning permutations. One character, Sophie, describes how many permutations are possible on a *cryptex*, a term that Dan Brown coined for the novel. A cryptex is a device that holds a scroll with a secret message. It is similar to a combination lock with five wheels that each contain the twenty-six letters of the alphabet. Knowing that it was a five-letter code, a teacher might have students think about how Sophie could solve the problem, before sharing that she computed the answer, 11,881,376, by multiplying $26 \times 26 \times 26 \times 26 \times 26$. A teacher can then give similar problems to stretch the exercise further.

The television show *Monk* offers another example of using probability. In one episode, two female victims have the same first and last names. The characters want to know how likely a coincidence it is. One detective tries to explain why this finding isn't as unlikely as one might think, but he botches his explanation after getting flustered. You can have students think about the detective's answer and how they might calculate the probability. According to the U.S. Census Bureau (1990), 88,799 last names and 4,275 female first names are possible. With this information, have students calculate the probability of two females having the same first and last names. [Answers will be estimates only because the census information (*a*) is rough and (*b*) doesn't take into account that certain first and last names more commonly go together.]

Teachers can lead this discussion to other types of probability problems such as the Monty Hall problem from television. The Monty Hall problem is as follows: "On a game show, there are three doors. Behind one is a car; the others have goats. The contestant picks a door, and the host, who knows what's behind

each, opens one of the doors the contestant did not pick. Behind it is a goat. The host offers the contestant the option to switch the current choice for the remaining unopened door. Should the contestant switch?"

In the movie *21*, a mathematics professor posed the Monty Hall problem to his students to find out who was smart so that he could recruit them to count cards in blackjack. The question also appeared in *Parade* magazine's "Ask Marilyn" column, which features Marilyn vos Savant, the *Guinness Book of World Records* titleholder for highest IQ. A *New York Times* article (Tierney 1991) documents her experience. When vos Savant answered that the contestant should switch doors, she received a flurry of letters from all over the globe, many from mathematics professors, saying that she was wrong. But she was right, which shows students that probability is sometimes counterintuitive, even to professors, and that problems from mathematics can be of interest to the general public.

Summary

The preceding are a few examples that teachers might use if they want to bring mathematics from movies or television to their students. However, many others also exist. The "Math in the Movies" Web page (world.std.com/~reinhold /mathmovies.html) is an excellent resource. Teachers can also find other examples in published articles. For example, Takis (1999) explains how she used the movie *Titanic* to teach statistics; Wood (1992) discusses different games from *The Price is Right* to teach probability and problem solving; Appelbaum (1995) uses *Wheel of Fortune* to teach problem solving; Beckmann, Thompson, and Austin (2004) use movies such as *The Perfect Storm* and *Harry Potter* to teach proportional reasoning; and Chappell and Thompson (2009) draw from movies such as *The Pursuit of Happyness* in a book aimed at tying mathematics into popular culture. Using mathematics to solve crimes is a popular concept in television shows such as *Law & Order* and *CSI*. Teachers can find a plethora of activities to complement episodes of *NUMB3RS* on Texas Instruments's activity exchange Web site (education.ti.com/educationportal). Teachers can also make up a fake crime for students to solve or have students develop their own and switch with a classmate for solving.

Another great option is to ask students to be on the lookout for mathematics in the movies and television shows that they watch. When students see such an example, they will be more likely to discuss it with their friends and family and, in turn, better understand it themselves. Incorporating these media clips into lessons will not require much extra time. Most of the clips in this chapter are less than five minutes long, and some are even shorter than one minute.

The primary purpose of the preceding examples is to show the potential for entertainment as a means of motivation. The examples show that mathematics

can be relevant to a student's life by highlighting math's pervasive presence in the entertainment that they frequently watch.

If our challenge as teachers is, as Deitte and Howe (2003) suggest, motivating students to feel responsible for their educational development, we need to understand what drives them. "This goal," Deitte and Howe continue, "is most effectively accomplished if students convince themselves that mathematics is interesting and useful" (p. 278). Equating mathematics with popular culture serves that precise purpose.

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