Chapter 6
Mathematics, Statistics, and Sports

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Introduction

In *Learning and teaching mathematics in the global village,* Danesi (2016: vii) points out that:

> It cannot be denied that technology today is reshaping the world, including the academy. It has also taken the academy into the world. Math is now a common theme in popular forms of entertainment (in movies, in television programs, and so on) and this incorporation into the popular imagination […] can be turned to the advantage of classroom pedagogy. The extension of the math classroom into the world of pop culture is another example of how the wall-less classroom can unfold.

A sizeable body of literature documents Danesi's assertion (Nuessel 2012). Many of these studies verify the intermingling of popular culture and the academy as an enticing resource for the teaching of mathematics and statistics. The bibliographic references section of several representative studies on this significant matter contains a sizeable list of this type of research.

The first part of this chapter defines and discusses several basic terms related to the topic of teaching mathematics and statistics. These include the following: mathematics, mathematics pedagogy, statistics, statistics pedagogy, mathematics and statistics, mathematics anxiety and statistics anxiety, information, pop culture and its relationship to mathematics and statistics, games, sports, sports wagering, and most popular sports in North America with a brief historical overview of American football, basketball, and major league ball. The second part will discuss how sports information or data can provide the basis for mathematical and statistical problem-solving from the realm of popular culture to create Danesi's (2016: 82–83, 137) "wall-less" academy through the use of the vast amount of information from aspects of everyday life—an approach that will have great appeal to students. This chapter

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will provide selected examples of mathematical and statistical pedagogical problems from American football, baseball, and basketball.

Mathematics

What is mathematics? Berggren et al. (2020) define it as:

> The science of structure, order, and relation that has evolved from elemental practices of counting, measuring, and describing the shape of objects. It deals with logical reasoning, quantitative calculation, and its development has involved an increasing degree of idealization and abstraction of its subject matter. Since the 17th century, mathematics has been an indispensable adjunct to the physical sciences and technology, and in more recent times it has assumed a similar role in the quantitative aspects of the life sciences.

Devlin (2000: 5) describes mathematics simply as *"the science of patterns"* (emphasis in original). He goes on to say that (2000: 8):

> The patterns studied by the mathematician can be either real or imagined, visual, or mental, static or dynamic, qualitative or quantitative, utilitarian or recreational. They arise from the world around us, from the depths of space and time, and from the workings of the human mind. Different kinds of patterns give us different branches of mathematics. For example, number theory studies (and arithmetic uses) the patterns of number and counting; geometry studies the patterns of shape; calculus allows us to handle patterns of motion; logic studies the pattern of reasoning; probability theory deals with patterns of chance; topology studies patterns of closeness and position.

Mathematical Pedagogy

What is mathematical pedagogy? Danesi (2016: 1) provides a historical and informative account of math education from its Greek origins to today, pointing out that *Elements* by Euclid (mid-fourth century BCE to mid-third century BCE) was the first theoretical treatise on mathematics that served as a textbook. In that era, of course, the word "textbook" meant a hand copied document on parchment that required a considerable amount of time and effort by the scribes who reproduced these texts. With the advent of Johannes Gutenberg's printing press, textbooks became available in multiple copies, and, ultimately, facilitated mass education. This world order is what Marshall McLuhan called the Gutenberg Galaxy (McLuhan 1962). Danesi (2016: 52–57) subsequently introduces the term "Digital Galaxy" to refer to electronic media that provides open access to information via the World Wide Web (WWW) developed by Tim Berners-Lee in the early 1990s. This electronic-digital tool has resulted in a resource that provides immense amounts of data and information that can be updated and corrected regularly. In essence, it is an information search tool that permits interactive research communication. The World Wide Web is essentially a massive source of information for the public—one that must be used with care and discrimination in order to avoid false or inaccurate information. This digital tool provides teachers and students with vast data bases that facilitate easy access to a wide array of information, which can serve as stimulating resources that can engage students of mathematics and statistics with tantalizing applications of theory to practice. This virtual space is where the World Wide Web and the classroom converge to enthuse students and teachers alike in a mutually engaging arena for acquiring the knowledge of necessary to understand mathematics.

Statistics

What is statistics? Lexico (2020) defines statistics as "the practice or science of collecting and analyzing numerical data in large quantities, especially for the purpose of inferring proportions in a whole from those in a representative sample." Williams, Anderson, and Sweeney (2020) refer to statistics as "the science of collecting, analyzing, presenting, and interpreting data." The purpose of statistics is to provide meaningful information about specific matters in a particular field. Statistics includes several subdomains, namely, probability and stochastic processes, or random variables.

Statistical Pedagogy

What is statistical pedagogy? It is a set of procedures that instructors should introduce in their statistics courses to facilitate the organized teaching and learning of this discipline. By following these simple methods and techniques, students will acquire the basic elements of statistics through individual and collaborative approaches. Cobb's (1992: 15–18) detailed overview of the teaching of statistics allows for several observations and recommendations, which continue to be true, and are summarized here.

Recommendation I: Emphasize statistical thinking
The need for data.
The importance of data production
The omnipresence of variability
The quantification and explanation of variability

Recommendation II: More data and concepts: Less theory, fewer recipes

Recommendation III: Foster active learning
Group problem solving and discussion
Lab exercises
Demonstrations based on class-generated data
Written and oral presentations
Projects, either group or individual

Mathematics and Statistics

What is the relationship between mathematics and statistics? Some scholars argue that mathematics is a pure theoretical science while statistics is an applied science. In their essay on the tension between mathematics and statistics, Moore and Cobb (2000: 615) present the following working hypothesis "statistics has cultural strength that might greatly assist mathematics, while mathematics has organizational strengths that provide shelter for academic statistics, shelter that may be essential for its survival."

Cobb and Moore (1997: 801) capture some of the fundamental differences between mathematics and statistics when they state that:

> Statistics is a methodological discipline. It exists not for itself but rather to offer to other fields of study a coherent set of ideas and tools for dealing with data. The need for such a discipline arises from *the omnipresence of variability*. Individuals vary. Repeated measurements of the same individual vary […]. The focus on variability naturally gives statistics a particular content that sets it apart from mathematics. Statistics represents a different *kind* of thinking, because *data are not just numbers, they are numbers in context*. (emphasis in original)

Cobb and Moore (1997: 803) further note the distinctions between mathematicians and statisticians in the following way:

> Although mathematicians often rely on applied context both for motivation and as a source of problems for research, the ultimate focus in mathematical thinking is on abstract patterns: the context is part of the irrelevant detail that must be boiled off over the flame of abstraction in order to reveal the previously hidden crystal of pure structure. *In mathematics, context obscures structure*. Like mathematicians, data analysts also look for patterns, but ultimately, in data analysis whether the patterns have meaning, and whether they have value, depends on how the threads of those patterns interweave with the complementary threads of the story line. *In data analysis, context provides meaning*. (emphasis in original)

Moore and Cobb (2000: 623) point out that "[s]tatistics […] values mathematical understanding as a means to an end, not as an end in itself [. . .] statistics has a subject matter of its own, quite apart from mathematics. These same statisticians argue for a cooperative synergy between the two disciplines for the following reasons:

- Despite intellectual differences, mathematics and statistics both depend on the process of working from the concrete to the abstract, and can learn from each other's successes and failures in teaching this process to undergraduates.
- Statistics can benefit from embracing more openly the importance of mathematical thinking (Moore and Cobb 2000: 625–626).

Mathematics Anxiety and Statistics Anxiety

What is mathematics anxiety and what is statistics anxiety? Phobic reactions to the study of mathematics and statistics are so common that many scholars at various universities have written about this topic and they have provided useful suggestions for overcoming this fear. McCrone (2002: 266) labels it "dyscalculia", i.e. a neurological deficit. Rossman (2006) notes that this type of anxiety occurs in elementary education. In terms of math anxiety, Iossi (2013) cites Richardson and Suinn (1972: 551, Richardson and Woolfolk 1980), who described the phenomenon of math phobia in the following way nearly half a century ago "[m]athematics anxiety involves feelings of tension and anxiety that interfere with the manipulation of numbers and the solving of mathematical problems in a wide variety of ordinary life and academic situations." That now classic article also proposed a Mathematical Anxiety Rating Scale (MARS). In this same vein, Perry (2004) notes that as many as 85% of students enrolled in introductory math classes experience some math phobia. Iossi (2013: 30–31, Bradley 2010) describes some of the strategies for dealing with math phobia. First, there are curricular approaches (retesting, self-paced learning, distance education, single-sex classes, and math anxiety courses). Second, there are instructional approaches (manipulatives, technology, self-regulation techniques, and communication). Finally, there are non-instructional approaches (relaxation therapy, and psychological treatment). To be sure, awareness of math anxiety has received academic attention for at least half a century. The recognition of this phenomenon has resulted in a wide variety of techniques and strategies to address this paranoiac reaction to the study of mathematics.

Statistics also produces anxiety in students, and there is a significant number of studies about this type of angst among students. Nearly thirty years ago, Zeidner (1991: 319) offered the following definition of statistics anxiety:

> Statistics anxiety may be construed as a particular form of performance anxiety characterized by extensive worry, intrusive thoughts, mental disorganization, tension, and physiological arousal. Statistics anxiety arises in people who when exposed to statistics content problems, instructional situations, or evaluative contexts, and is commonly claimed to debilitate performance in a wide variety of academic situations by interfering with the manipulation of statistics data and solution of statistics problems.

Zeidner (1991: 321) developed a Statistics Anxiety Inventory (SAI) to determine issues in four areas: (1) statistical procedures or activities, (2) solving of quantitative problems, (3) situations related to the study of statistics (enrolling in a statistics class, picking up a statistics textbook), and (4) evaluation of performance in statistics (exams, quizzes, and studying for a test in statistics. The content of the SAI sought to elicit information about content and performance in statistics. It was patterned after the MARS instrument (Richardson and Suinn 1972; Richardson and Woolfolk 1980). In his concluding remarks, Zeidner (1991: 327) points out that prior negative experiences with math and a low sense of math-efficacy are antecedents to statistics anxiety. Onwuegbuzie et al. (1997) also provide a detailed examination of statistics anxiety, which offers instructors useful guidelines for dealing with this phobia.

Pan and Tang's (2005: 212–214) list of references and Chew and Dillon's (2014: 205–208) bibliography attest to an anxiety-ridden response to this subject by students enrolled in statistics classes. Pan and Tang (2005: 205) employ Onwuegbuzie, DaRos, and Ryan's (1997) definition of statistics anxiety to describe this experience, namely, "anxiety that occurs as a result of encountering statistics in any form at any level." Pan and Tang (2005: 209) note that there are several factors that lead to statistics anxiety (math phobia, lack of connection to daily life, pace of instruction, instructor's attitude). However, several instructional strategies offer practical ways to address statistics phobia (practical application, real-world example carried through, orientation prior to class, multiple evaluation criteria, flexible availability of assistance). Chew and Dillon (2014: 196) highlight the significance of statistics in daily life by citing Wallman's (1993: 1) call for statistical literacy which she defines as "the ability to understand and critically evaluate statistical results that permeate our daily lives–coupled with the ability to appreciate the contributions that statistical thinking can make in public and private, professional and personal decisions".

Chew and Dillon (2014: 197) hasten to point out that statistics anxiety is not the same as mathematical anxiety. It was widely assumed that they are similar because they are related areas of study. This commonly held belief changed when Cruise, Cash and Bolton (1985) developed their Statistical Anxiety Rating Scale (STARS) to account for the differences between mathematics and statistics and their distinct types of anxiety. Subsequently, Chew and Dillon (2014: 229) provided the following definition of statistics anxiety as:

> a negative state of emotional arousal experienced by individuals as a result of encountering statistics in any form and at any level; this emotional state is preceding by negative attitudes towards statistics and is related to but distinct from mathematics anxiety.

Ultimately, there is a distinction to be made between mathematics anxiety and statistics anxiety. Nevertheless, both academic domains can create discomfort and distress in a significant portion of students who take course work in both subjects. For this reason, it is important to find ways to reduce, or, ideally, eliminate this negative reaction to both areas of inquiry.

One source of math anxiety is its use of language. Freeman and her associates Freeman et al. 2016: 283–284) make the following observations about the differences between formal writing in mathematics and ordinary language:

> Formal writing in mathematics is a precise language that requires accuracy in its expression, especially at higher levels of mathematics study […], though it also constitutes a large part of K-12 education: in the classroom, in textbooks, and on assessments. The language of mathematics contains mathematical statements (hypotheses, conjectures, axioms, and theorems), linguistic forms and properties, grammar (connectors, combinators), and symbols. This language is often information-dense and abstract […]. It is also vastly different than language used in social conversation […], as is the vocabulary of mathematics with mathematical meanings being much more exact and nuanced than their ordinary definitions.

The above statement is equally applicable to the distinct nature of statistical writing and ordinary language, which may lead to statistics anxiety.

One way to accomplish this goal is to make use of what Danesi (2016: 82) calls the "Wall-less" Classroom, i.e.:

> The classroom today is becoming more and more one without walls…It is both individualist (book-based) and communal (social media-based). It thus amplifies learning and retrieves previous modes of pedagogy. This has concrete pedagogical implications, the most important one being that social media are the means through which the walls are being taken down.

Danesi (2016: 83) illustrates how social media are breaking down the classroom walls, namely, by.

1. setting homework assignments or clarifying them outside the classroom
2. exchanging ideas and solutions to classroom problems and tests
3. informing the classroom community of relevant events, such as math competitions
4. writing actual lessons for specific topics that can be shared broadly and modified according to responses–constituting an extended PolyMath Project (the project originated in a blog by Timothy Bowers in 2009 under the pseudonym D. H. J. Polymath to address unsolved mathematical problems through massive collaboration on the Internet; Nielson 2011) applied to math education.

Information

What is information? The *Merriam-Webster Dictionary* (2020) defines it as "knowledge obtained from investigation, study, or instruction." That same dictionary defines it as "a quantitative measure of information."

Gibson (2013: 349) provides a superb overview of the notion of information when she states that:

> *Information* is a concept with ancient roots that translates across multiple fields of inquiry. Use of a general model of information allows scholars to share ideas and describe information phenomena across the spectrum of academic disciplines. Information has often been defined in relation to distinct but related concepts: data, facts, knowledge, and intelligence. Information is organized data presented context, a coherent collection of messages or cues structured in a way that has meaning or use for human beings. Data may be described as a set of discrete, objective facts about events, that become information when assigned meaning or value. Facts involve information that is true, that actually exists, or can be verified according to an established standard of evaluation. Knowledge can be seen as information in context, together with an understanding of how to use that information; it is a mix of information, experience, and values that provides a framework for assessing and incorporating new information. Knowledge can be either explicit (a person is able to make this information available for introspection) or tacit (the person is not able to make the information available for introspection). Intelligence refers to the quality of the information (e.g., information concerning crucial facts, military intelligence, a secret) or the capacity of a sentient being to combine data, facts, information, and knowledge with insight and acuity. Information may therefore be defined as facts and data organized to describe a particular situation or problem and information is what people share with each other when they communicate. (emphasis in original)

In his discussion of "the information society," Danesi (2013: 354, emphasis in original) points out that this term "is used in cyberculture and media studies to refer to the economic system based primarily on the retrieval, processing, and management of information, in opposition to an economic system based on the production of the production of material goods. The latter is known as an *industrial society*." Danesi (2016: 103) further notes that the concept that today's world is the first information society is false, i.e., as he points out, every age is an information society. The dissemination of information in the past has assumed different formats and modes of distribution, e.g., oral communication in non-literate societies, hand written texts, and multiple copies of document with the invention of the printing press. Today, however, information may be stored electronically, thereby, allowing individuals access to and manipulation of vast stores of information through the use of computer programs designed to make those data available to scientists and others to meaning to these vast stores of knowledge. The electronic storage of information or data now facilitates research and teaching by making available enormous amounts of mathematical and statistical facts that can be searched with various computer programs to ascertain trends or glean meaningful information that enhances our knowledge of the world. The ease of access to these data facilitates the ever-expanding wall-less mathematical and statistical classroom.

Pop Culture and Its Relationship to Mathematics and Statistics

What is pop culture? Danesi (2019c: 4) makes the following observations about pop culture:

> There is little doubt that pop culture trends, like commodities, have fleeting value. But it is also true that pop culture constitutes an open social forum in which creativity can be expressed and displayed by virtually anyone. It is empowering, allowing common people to laugh at themselves, to gain recreation through music, dance, stories, and other forms of expression. Before the advent of pop culture as a mass form of entertainment, people sought recreational outlets through carnivals and various other public spectacles, which have typically existed alongside religious feasts since at least the medieval period. Pop culture is also a source of recreation that appeals to our fun-loving side. It is thus a modern-day descendant of carnivals. Admittedly, as most pop culture critics have suggested, most pop culture is a commodity culture. It takes place in a marketplace that is at once economic and artistic, thus appearing in short-lived and era-specific forms.

Danesi (2019c) provides specific examples of popular culture that include print culture (books, newspapers, magazines, comic books), radio culture (radio broadcasting, talk shows, Internet radio), music culture (pop music, rock and roll, hip-hop, independent music), cinema and video culture (motion pictures, video games, HBO®, Netflix®, Hulu®), television culture (sitcoms, reality TV, web TV), advertising culture (ad campaigns, placement, advertising art), pop language culture (slang, spelling style, emoji), and on line pop culture (YouTube®, Facebook®, Twitter®, memes [Danesi 2019b]).

It should also be noted that Danesi has written extensively about puzzles and problem-solving, which are forms of recreational mathematics. In one of his earliest books on this topic (Danesi 2002: ix), he talked about the "puzzle instinct," which he describes as a specific trait of *homo sapiens*—a unique propensity to solve puzzles, brain-teasers, and enigmas for the sheer delight in finding a solution. Danesi

(2019a: 115) goes on to state that "[p]erhaps in no other area of human intelligence have puzzles played as large a significant role than in mathematics." He notes that math puzzles can be traced back to the *Ahmes Papyrus*, which contains eighty-four difficult mathematical puzzles, and is one of the earliest sources of ancient mathematics. This type of "recreational mathematics" saw its popularity grow with the publication of Claude-Gaspar Bachet de Mézirac's extensive collection of math puzzles entitled *Problèmes plaisans et délectables qui se font pare les nombres* in 1612 (Bachet de Mézirac 1984). These early examples of mathematics designed to engage and amuse the public may be seen as early efforts to engage the public in the wonders of the science of math.

To this list, I would add the mathematics and statistics inherent in competitive sports. According to Sports in the United States (2020), the three most popular sports in the U.S. in terms of revenue production are: (1) American football (National Football League), (2) basketball (National Basketball Association), and (3) baseball (Major League Baseball). Other popular sports in the US are: Ice hockey, soccer, tennis, golf, wrestling, auto racing, arena football, lacrosse, box lacrosse, and volleyball. The top three professional sports (American football, basketball, major league ball) permeate every aspect of pop culture. We may view these games in person at the various stadia across North America. We listen to them on radio or on the Internet. We purchase sports apparel with the name and number of our favorite player from our favorite team. We also purchase other sports memorabilia (cards, equipment with team logos). We purchase books about our favorite sports heroes and teams and their records since their beginnings. Because of the popularity of sports in North American society by young and old alike, mathematical and statistical activities, exercises, and problems appeal to students enrolled in these classes. In fact, many sports have video games associated with them so that the fan can engage in virtual realistic competition similar to that of the professional athletes in many sports.

Games

What are the essential elements of a game? Palmer and Rodgers (1983: 3) note that games have the following components:

1. Games are *competitive*, i.e., a person competes against another individual, time, personal performance, or a goal.
2. Games are *rule-governed*, i.e., principles determine the acceptable or unacceptable actions or behavior.
3. Games are *goal-defined*, i.e., these activities have their recognized and agreed upon objectives.
4. Games have *closure*. i.e., the participants know when the activity is completed according to pre-determined criteria.

5. Games are *engaging*, i.e., these pastimes are fun and the interactants derive amusement and stimulation from engaging in them. (emphasis in original)

Sports

What is a sport? *The Cambridge English Dictionary* (2020) defines sport as "a game, competition, or similar activity, done for enjoyment or as a job, that takes physical effort and skill and is played or by following particular rules." A sport includes a wide range of games including, but not limited to, baseball, basketball, American football, ice hockey, soccer, and many similar competitive pastimes. To be sure, all of the sports just mentioned follow the principles enumerated in Palmer and Rodgers (1983: 3), i.e., they are competitive, rule-governed, goal-defined, have closure, and they are engaging. These are the attributes that appeal to fans of all sports. Sports enthusiasts love their particular teams and they engage in arguments about which team is the best. Some sports, however, allow ties, which clearly creates a problem for those who wants a definitive winner and loser. Game rules nevertheless, have established ways to address the issue of ties through total wins and losses with another team that seeks to participate in post-season playoffs in an attempt to win a championship.

Sports Wagering

What is sports wagering? According to Wikipedia (Sports Betting 2019), wagering on sports is "the activity of predicting sports results and placing a wager on the outcome." Gambling on the outcome of sports games has a long tradition. In the U.S., it may be legal, i.e., bets are placed with duly licensed companies. At this writing, nineteen states (Arkansas, Colorado, Delaware, Illinois, Indiana, Iowa, Mississippi, Montana, Nevada, New Hampshire, New Jersey, New Mexico, New York, North Carolina, Oregon, Pennsylvania, Rhode Island, Tennessee, and West Virginia) allow legal betting. Sports wagering is also legal in the District of Columbia. As a result of the incipient legalization of sports betting in the U.S., an entire industry has arisen, e.g., FanDuel®, DraftDay®, and PlayOn®.

The four major U.S. sports leagues (American football, baseball, basketball, and ice hockey) had held a position against sports gambling. However, the National Basketball Association (NBA) and Major League Ball (MLB) have advocated for a change in their previous stance against this practice. The National Hockey League (NHL) has not taken a position. At this juncture, only the National Football League (NFL) continues its oppositions to sports betting.

Sports scandals have occurred in various sports over the years, in part, because gambling was illegal. As a result, there have been various scandals caused by criminals who sought to influence the outcome of a game. One infamous case of such a crime occurred in Major League Baseball a little over a century ago. It involved the World Series of 1919 (Chicago White Sox versus the Cincinnati Reds). Because it damaged the reputation of what some have called America's sport, it came to be known as the "Black Sox Scandal" in which the White Sox deliberately lost 5 games in a nine games series. This scandal became a famous 1988 movie *Eight Men Out* based on a book by Eliot Asinof's *Eight Men Out: The Black Sox Scandal and the 1919 World Series* (1963) Another film, *The Field of Dreams* (1989) based on the novel *Shoeless Joe* by W. P. Kinsella (1982), also deals with this scandal.

Most Popular Sports in North America

What are the most popular sports in North America? According to Sports in the United States (2020), the three most popular sports in the U.S. in terms of revenue production are: (1) American football (National Football League), (2) basketball (National Basketball Association), and (3) baseball (Major League Baseball). Other popular sports in the US are: Ice hockey, soccer, tennis, golf, wrestling, auto racing, arena football, lacrosse, box lacrosse, and volleyball. The top three sports are also the most lucrative in terms of revenue through a variety of venues (ticket sales, products with specific logos, television and radio broadcast rights, and so forth).

American Football

American football has its origins in rugby football. Walter Camp (1859–1925) is widely regarded as the father of American football. Its early period, when it was developing rules and procedures, was 1869–1875. The intercollegiate period occurred from 1876 to 1893. The creation of a rules committee and athletic conferences (groups of colleges that participate regularly in intercollegiate games) dates from 1892 to 1934. The modernization of the game took place from 1933 to 1969. Modern intercollegiate football started in 1970.

Professional American football began in 1892 and various cities developed their own teams. The National Football League began in 1920 with organized and regular schedules. From 1933 to 1969, there was a period of stability and slow but steady growth. The development of a rival and competitive league, the American Football League in 1959. Ultimately, there was a merger of the two leagues in 1970, and the two leagues (NFL, AFL) compete annually in the Super Bowl to determine the winner for a given season.

Basketball

The game of basketball was invented in Springfield, Massachusetts by the Canadian James Naismith (1861–1939). He authored the first rule book for basketball on December 21, 1891. The first known intercollegiate basketball game took place on February 9, 1895 between Hamline University and Minnesota AandM. Naismith subsequently created the University of Kansas basketball team, and became its head coach (1898–1907).

The Basketball Association of American became the National Basketball Association was founded on June 6, 1946 in New York. In 1949, it merged with the National Basketball League. Subsequently, the American Basketball Association was founded in 1967. By 1976, it merged with the NBA.

Baseball

The origins of baseball derive from various games played in Europe. Immigrants brought early versions of the game to the US. In 1871, the National Association of Professional Base Ball Players was founded. In 1876, the National League was founded. In 1901, the American League came into being. Shortly thereafter, a World Series between the two leagues started in 1903. By 1905, the series became an annual event. It is known as the national sport of the US.

American Football, Basketball, and Major League Ball: Their Use as a Pedagogical Resource for Mathematical and Statistical Problems

In part II of this paper, the three most popular professional sports in North America (American football, basketball, and major league baseball) will be used to illustrate selected exemplary mathematical and statistical problems in each sport to demonstrate how these pop cultural sports manifestations may serve to provide a useful and engaging resource for teaching mathematics and statistics. All three sports (American football, basketball, and major league ball) maintain precise information about every game and every player in sports. All of these data are easily available on the Internet, so access is at one’s finger tips. The examples provided in the following three sections involve the arithmetical functions of addition, multiplication, and division. To be sure, these are simple operations. Nevertheless, more complex mathematical procedures are required for certain types of information gleaned from the three sports discussed in this paper.

American Football

The famed Chicago Bears Super Bowl XX team is considered one of the best National Football squads of all time. They dominated in every area. That team produced five NFL Hall of Fame players (Richard Dent, Dan Hampton, Walter Payton, Mike Singletary, and head coach Mike Ditka). The Super Bowl itself was played in New Orleans, Louisiana at the Louisiana Superdome on January 26, 1986. Their opponent was the New England Patriots. The final score was 46–10. The time of possession (TOP) of the football for Chicago was 39.15 min while New England had the ball for 20.45 min (Super Bowl XX, 2020). This statistic is significant because it means that the team with the greatest time of possession has the best opportunity to score points and achieve more points than the opposing team.

A regulation football game lasts 1 h (60 min). One minute has 60 s. The simple formula for determining the total number of seconds in a regulation football game is:

$$60\,\mathrm{min} \times 60\,\mathrm{s} = 3600\,\mathrm{s}$$

In Super Bowl XX, the Bears had possession of the football for 39.15 min. To determine the total number of seconds, it is necessary to multiply 39 × 60 equals 2340 s and add 15 s. The total time of possession was 2355. Based on that equation, the New England Patriots had possession for 20.45 min. The same arithmetic operation involves multiplying 20 min × 60, which equals 1200 s. Then the additional 45 s must be added for the total (= 1245 s). The final step to determine total percentage of time of possession by the Bears is to divide 3600 by 2340, which equals 65.41666%. The New England Patriots had possession for 1245 s. By using the same arithmetical operations, the Patriots had possession of the ball 34.58333% of the time. This is a substantial percentage, and it explains the lopsided final score (46–10). Three arithmetical calculations are necessary to determine the per cent time of possession of the football by the Bears in Super Bowl XX: addition, multiplication, and division.

Basketball

Michael Jordan, known by his initials "MJ" and his nickname "Air Jordan", played for the Chicago Bulls from 1984 to 1993 and 1995–1998. After a three-year retirement, he played two more years for the Washington Wizards (2001–2003). He played in a total of 1072 games over 15 seasons. During his career, he scored 32,292 points (Jordan 2020). Many people consider him to be the greatest basketball player of all time. This assertion, of course, can lead to disputes among those who believe that another player is the best. These disagreements can be resolved through mathematics and statistics. In terms of scoring, Michael Jordan's average was 30.123134 per game. The next best in that category was Wilt Chamberlain, whose nickname was “Wilt the Stilt” because of his height (7 feet, 1 inch). Jordan was a scoring guard and a small forward, while Chamberlain was a center. He played 16 seasons for several different teams including his final five seasons for the Los Angeles Lakers. He participated in 1045 games during his career with a point total of 31,419. His scoring average was 30.066028 rounded out to the next highest number, i.e., 31.1 (Chamberlain 2020).

To determine the scoring average of a basketball player, the following formula must be used:

$$\text{SA}\left(\text{Scoring Average}\right) = \text{PTS}\left(\text{Total Career Points}\right) \div \text{G}\left(\text{Total Games Played}\right)$$

Arriving at this particular statistic requires two arithmetical operations: addition and division. First, it is necessary to add up all of the games played by each player. Then, that number must be divided by the total number of points scored by each player. Because the scores of each player are rounded off to the next highest number, it would appear that each player had the same number of points (30.1) over their respective careers. However, if the two players are compared numerically through arithmetic, it is clear that Michael Jordan had a slightly better scoring percentage based on the formula use to determine this type of statistical information.

The use of scoring average, however, is just one way to compare two players. Thus, it is possible to compare two players based on very specific aspects of the game, e.g., field goals per game (FG), field goal attempts (FGA), field goal percentage (FG%), three point goals per game (3P), three point field goal attempts per game (3P%), two point field goals per game (2P), two point attempts per game (2PA), two point percentage (2P%), effective field goal percentage (eFG%), free throws per game (FT), free throw attempts per game (FTA), free throw percentage (FT%), offensive rebounds per game (ORB), defensive rebounds per game (DRB), total rebounds per game (TRB), assists per game (AST), steals per game (STL), blocks per game (BLK), turnovers per game (TOV), personal fouls per game (PF), and points per game (PTS). Thus, a comparison of two players can result in multiple statistics. Each of these statistics requires a formula to determine with precision a given player’s actual performance based on at least two dozen parameters. Each one of these provides subtle insights into an individual’s strengths and weakness. As a result, students of mathematics and statistics can fine tune their arithmetic skills as well as make arguments for and against the quality of a specific player.

Major League Baseball

Baseball aficionados love to assess their favorite players by comparing their numbers or stats. This type of information includes batting average, homeruns scored, runs batted in, runs scored, stolen bases. While it is quite easy to memorize these bits of information. A determination of the mathematical and statistical processes employed to arrive at these data requires some knowledge of the procedures required to arrive at these facts and figures (Martin and Guengerich 2004; Ross 2007).

Frank Thomas (1968-), whose nickname was "The Big Hurt", played for the Chicago White Sox for most of his career (1990–2005) and for two other teams during his last three seasons (Thomas 2020). He was elected to the Baseball Hall of Fame on his initial year of eligibility in 2014. His batting average and his slugging percentage provide an excellent way to teach some basic arithmetic concepts, namely, addition and division. To determine a baseball player's batting average, the following formula is used:

$$\text{Batting Average} = \left(\text{Hits} \div \text{At Bats}\right)$$

Frank Thomas had 8199 at bats and 2468 hits. It is necessary to divide his total number of at bats by his total hits. This produces a batting average of .3010123. On the other hand, to calculate a baseball player's slugging percentage (SLG) involves the following formula: TB (Total Bases) = 1B (First Base) + 2 × 2B (Second Base) + 3 × 3B (Third Base) + 4 × HR (Home Runs). This may be formulated as follows. The World Wide Web now has a Slugging Percentage Calculator (2020), but its use would not allow a student to engage in the necessary mathematical calculations to internalize the procedures to carry out the SLG.

$$\text{SLG} = \frac{(1\text{B}) + (2 \times 2\text{B}) + (3 \times 3\text{B}) + (4 \times \text{HR})}{\text{AB}}$$

The translation of this formula is Total Number of Bases = 1B (the number of singles) + 2 × 2B (the number of doubles) + 3 × 3B (the number of triples) + 4 × HR (the number of home runs). Thus, the slugging percentage (SLG) is as follows.

$$\text{SLG} = (\text{TB} \div \text{AB}).$$

In the case of Frank Thomas, he had 2468 total bases during his career. Likewise, he had 1440 singles, 495 doubles, 12 triples, and 521 home runs. It is necessary to multiply the singles by 1 (= 1440) + two times the number of doubles (= 990) + three times the number of triples (= 36) + four times the number of home runs (= 2084). This totals 4550. Next, this sum must be divided by the total number of at bats (= 8199). The slugging percentage (SLG) is .5549457. The SLG measures the quality of a batter's hits, while the batting average measures the number of times on base. Frank Thomas's SLG of .554 is outstanding.

Frank Thomas's batting average and slugging percentage represent only a small part of any baseball player's total skill. Other factors include runs batted in (RBI), stolen bases (SB), caught stealing (CS), bases on bats/walks (BB), strikeouts (SO), times hit by a pitch (HPB), sacrifice hits/bunts (SH), sacrifice flies (SF), and intentional bases on balls (IBB). All of these game dynamics play a part in the assessment of the total value of an individual baseball player. The arithmetical computations needed to ascertain Frank Thomas's batting average requires a knowledge of addition and division. Likewise, his slugging percentage requires a knowledge of addition, multiplication, and division. Danesi (2008: 40–77) offers a very useful semiotic perspective to teach these basic arithmetical operations.

Furthermore, the example of selected numbers related to Frank Thomas's batting performance demonstrates how baseball managers make decisions based on statistical information. In the cases of hits and at bats, batting average is less important than slugging percentage because the latter clearly measures the quality of the hits versus the number of on base hits made. It must be remembered that a winning team in baseball must have more home runs than the opponent. This fact accounts for the significance of certain statistics in this sport.

Concluding Remarks

This chapter has addressed the significance of a popular cultural phenomenon (professional sports) and how they can be used to engage students in learning about mathematics and statistics by means of bringing mathematics and statistics into the world and bringing the world into the classroom. Danesi (2016: 137) points out that the "wall-less classroom [...] can now be defined not as a replacement of, but as an extension of, the traditional classroom–that is why the critical components of the latter are still in the picture (so to speak). The main feature of education is still the teacher-student relationship."

The first part provided definitions and discussions of key concepts (mathematics, mathematics pedagogy, statistics, statistics pedagogy, mathematics and statistics, mathematics anxiety and statistics anxiety, information, pop culture and its relationship to mathematics and statistics, games, sports, sports wagering, and sports in North America). The second part provided selected examples of the use of mathematics and statistics to in the three most popular sports in North America (American football, basketball, major league baseball). Particular examples from these sports demonstrated how the use of these popular cultural manifestations can teach students how to apply basic mathematical and statistical notions from real world data located on the Internet. The latter is a cornucopia of information, i.e., big data, which, in sports provides reliable data gathered over a player's career.

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