AC 2010-2044: A TRIPLE PLAY: MATHEMATICS, BASEBALL, AND STORYTELLING

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A Triple Play: Mathematics, Baseball, and Storytelling

Abstract

There are many effective teaching pedagogies. One way we have found to produce results is to combine the use of storytelling about baseball in mathematics classes. This paper will illustrate a positive relationship between the three different subjects of baseball, storytelling and mathematics and explain why teachers may want to explore this triple play combination as part of their pedagogy.

First, there is more to teaching mathematics than solutions to math problems. Mathematics instruction involves thinking skills such as grouping, ordering, pairing, memory, and number related problems, all cognitive capabilities that create the framework for a student's understanding of math. Mathematics also involves ideas such as rotation, magnitude, curves, space, change, spirals, probabilities, equations, roots and other concepts.

Second, many of these same math concepts are also found in the game of baseball which not only lends itself to math problems, but can be developed into stories that become metaphors to assist in the cognitive understanding of mathematical concepts and thinking skills.

Finally, a growing body of research also supports the pedagogy of storytelling in a host of settings including the academic environment. Businesses, hospitals, governmental bodies and schools are discovering the power of stories to shape listeners' understanding and awareness.

This study examines research on mathematical learning and storytelling and uses the action research of baseball umpiring to illustrate how baseball and storytelling can be used effectively in a math classroom. Both have singular benefits. Combined they have even stronger benefits as assessed by student retention numbers, student evaluation, and student feedback. When baseball stories are used, students' cognitive capabilities for the understanding of mathematics will increase.

Mathematics, Baseball, and Storytelling

the home team
math'matically eliminated…
autumn equinox[1]

Baseball is a game that can "make fans catch their breath and pause while the pitcher looks for a sign, the moment a rookie gets picked off first, or the instant the batter lashes a homer into the night sky, just before the crowd explodes onto its feet."[2] Baseball, much like the popular Japanese form of poetry, Haiku, utilizes metaphors and mathematical form to tell its story.

Given recent math trends and headlines stating *Sluggish Results Seen in Math Scores* (New York Times, October 14, 2009), and *Math-Abused Students: Are We Prepared to Teach Them?* (National Council of Teachers of Mathematics, May 1999) we suggest mathematics teachers look

to the sport of baseball and the pedagogy of storytelling for ideas to "decrease emphasis on routine procedural skills and increase emphasis on real-world uses of mathematics and multi-step problem solving."[3] Increasing evidence is starting to emerge that supports this claim.

George Lakoff and Rafael Nunez, in their enlightening 2000 book titled *Where Mathematics Comes From* describe how the embodied mind brings mathematics into being. "Most of the brain is devoted to vision, motion, spatial understanding, interpersonal interaction, coordination, emotions, language, and everyday reasoning."[4] Thus, stories such as baseball stories for mathematics applications can organically assist the brain in learning and students in understanding. Many situations that take place on a baseball field can easily be carried over and analyzed in an academic environment in search of fun, interesting academic goals.[5] Given the natural combination of baseball and mathematics, storytelling is a pedagogy that teachers should consider in order to increase student learning.

In an opening address to the Mediterranean Conference on Mathematics Education, international writer Apostolos Doxiadis stated: "I was a hater of mathematics once. In fact I was a fanatical hater, until age fourteen. It was my teachers who were the culprits. And also, it was a teacher who suddenly, miraculously, made me a passionate lover. His way—though I'm not sure he did it consciously-- was the stories he told me of mathematics."[6]

PRISM magazine has included at least two articles related to storytelling and teaching. David Chesney, University of Michigan, tells how stories enliven his lectures in electrical engineering and computer science in the January 2009 edition *Story Time- A well told yarn holds students' attention and helps them remember what is taught* "They always ask for more."[7] A second PRISM article in February 2007 titled *A Man with Big IDEOS*, profiles Stanford's David Kelly who uses stories to help his engineering students with "design thinking" which helps them come up innovative ideas.[8]

And many university faculty are interested in using storytelling in the classroom, but don't know how, according to Chesney. Following a paper *Big Fish II: The lost Science of Story-telling in the Engineering Classroom*, Chesney said he had "several faculty ask him for advice on how to acquire the necessary skills to become a good story-teller."[9] Chesney also has many requests "from students in end-of semester evaluations to include more stories in subsequent offerings of the course."[10]

Cindy Walters, North Carolina A & T State University, in a 2007 paper titled *Engineering is Life: Storytelling in the Material Science Classroom* presented to the American Society for Engineering Education offers "several examples of the use of storytelling in an introductory Materials Science class. Qualitative responses indicate that students enjoy this mode of presentation."[11]

This paper examines our journey and how mathematical learning and baseball storytelling can be used to enhance learning in the classroom. Both have singular benefits, however when combined they may have even greater advantages. And the combination is increasingly relevant. Google has multiple sites that reference the two combined terms. In short, when baseball stories are used, students' cognitive capability for the understanding of mathematics increases.

One Mathematician's Journey to Baseball Stories as Pedagogy for Teaching

Louisville Slugger
the boy's fingertips caress
the trademark[12]

When I first started teaching, I also started umpiring baseball. As a teacher, I did not focus on stories very much and mostly approached the teaching of mathematics more directly. Content mattered most. Today content still matters, however, over the years the culture of umpiring led me into the world of storytelling because I learned when I shared a personal experience in a class, it would spark student interest. Later as I was invited to speak on baseball, umpiring, and mathematics, I learned to gather stories.

In 2006 I experienced an "aha" moment during a University Tilford Diversity Storytelling training event held on the K-State at Salina campus. During this occasion, I realized my teaching pedagogy already included storytelling, the concept that international storyteller Tim Tingle was training and encouraging us to incorporate into the classroom.

As a result, I enrolled in a local storytelling class. I also became a practitioner and started classifying my stories and gathering more stories when umpiring. This was done by creating a written record of past stories and finding and making a record of new stories while umpiring baseball at the collegiate and national level. I have been teaching mathematics at the post secondary level for the last 38 years. I have also been involved in baseball for most of my 67 years, about 40 of those years as a major college baseball umpire where I umpired 20 NCAA Division I regional tournaments, three superregional tournaments and the College World Series two times and at the professional level (National League) a couple of times. Throughout this lengthy career, I gathered numerous stories to share (See Appendix A). Here are three abbreviated sample stories used:

1. The pitching coach at WSU, while objecting to my strike zone, kicked dirt on the entire plate. He proceeded to uncover a two inch space down the middle of the plate and commented that was my strike zone! What percentage of the plate did he uncover?

2. While umpiring a major league game, Davey Johnson the manager of Cincinnati, questioned why a pitch was not called a strike which would have resulted in strike three. The batter hit the next pitch for a home run. Between innings, I asked him if he would agree that the limit of the slope of a secant, as delta x approached zero, was equal to the slope of the tangent. The pitch was close to being a strike and I immediately made a calculus problem out of it. Obviously, he was totally confused. The story goes on!

3. While umpiring a game in California, I called a runner out on a play at first base while the replay showed he was a full step by the bag. When the manager approached me and asked why, I responded that I thought he was coming from the other direction. I immediately made this a "one sided limit problem in calculus." I confused him but

while telling the story in class, I gained the interest of the students and they understood the concept.

There are other approaches to incorporating baseball into mathematics. One can use quotes from stories such as "Yogism's" that relate to mathematics and problem solving skills. For example, when telling the Yogism "it ain't over till it's over", one can share with students how they use mathematics all their lives. Or the Yogism "We make too many wrong mistakes" relates to mathematics because students do many things intuitively that are wrong rather than making decisions based on facts.

Each Yogism is different. Yogi once said "There are some people who, if they don't already know, you can't tell 'em." This applies in mathematics because students sometimes say "Leave me alone. I'll do it my way. This is how I learned it in high school,"[13]

When teaching mathematics, I interject some story, or some event, or some history almost on a daily basis. I allow the subject matter and/or the student's involvement to direct me to something relevant and eventful that I can share that will ultimately capture the interest of the audience and help them remember a concept for future reference. What lies ahead for the students is not what two multiplied by nine is, but rather if a baseball pitcher strikes out two hitters in each inning of a regulation nine inning game, how many did he strike out in the game? This is a very elementary example of how we should be dealing with mathematics; make it relevant!

Storytelling and mathematics both involve abstract thoughts. All mathematical equations involve nouns and verbs that put them in action. Through stories, I am able to have students identify the unknowns and list them as variables, identify quantities which become the coefficients and write equations based on information within the stories. Using baseball examples allows students to relate to an interest and immediately transform words into meaningful systems of equations. For example, in 1952 the New York Giants stole eight bases more than the Brooklyn Dodgers. The Dodgers stole four more than twice the number of bases the Cardinals stole. Babe Pirelli while umpiring home plate called Cardinal Stan Musial out while attempting to steal home in the final game of the season which would have resulted in a team record of 114 stolen bases. How many bases did the Giants steal in 1952?

Students on a regular basis in traditional mathematics classes ask: "When will we ever use this stuff?" My solution now is to always attempt to provide an example with a meaningful problem and/or story. This is my challenge. Mathematics is real, fun, and rewarding.

As I approach the twilight of my career, this journey has been a spark of new excitement for my classrooms and has helped me develop professionally because it brings together three passions I have in my life: teaching mathematics, students, and storytelling.

Other mathematics teachers have walked the same path. Marvin Bittinger, lecturer and author of over 170 mathematics textbooks records the memoirs of his professional life in the book *One Man's Journey through Mathematics* which is a mathematics book that emphasizes baseball and storytelling.[14]

The Relationship of Baseball and Mathematics

college ballpark
fungoes one after another
into the blue sky[15]

Recent findings about the nature of the mind, according to Lakoff and Nunez, indicate human beings conceptualize abstract concepts in concrete terms using ideas and modes of learning that are grounded in the sensory motor system. Comprehension occurs through conceptual metaphors. In short, this means there a strong correlation between learning mathematics and the game of baseball. And stories may help students conceptualize different mathematical problems to acquire the connection between the problems and real life situations.

Baseball has many of the same characteristics that Lakoff and Nunez state are characteristics of mathematics: universality, precision, consistency, stability, generalizability, and discoverability.[16]

"One of the great findings of cognitive science is that our ideas are shaped by our bodily experiences—not in any simpleminded one-to-one way but indirectly, through grounding of our entire conceptual system in everyday life. The cognitive perspective forces us to ask: Is the system of mathematical ideas also grounded indirectly in bodily experiences?"[17]

That same understanding is not lost on Dr. Richard Zajac who uses concrete Sudoku-type problems in his classes to help students understand abstract concepts in physics. He says the puzzles "offer certain benefits for novice students. By capitalizing on the present day popularity of these puzzles, this approach has provided a terminology by which students can usefully talk about key problem solving skills in familiar terms."[18]

Indeed, baseball is an ideal topic to use in mathematics instruction, according to mathematics teacher Joseph Prieto, because it gives teachers an opportunity to "find a way to train students to recognize mathematical problems in an everyday situation. This training will allow students to transfer acquired knowledge to the academic environment and approach the solution of the problem from different points of view."[19]

Karl Reid, Associate Dean of Undergraduate Education, Massachusetts Institute of Technology, "searched for years for ways to get inner city boys jazzed about decimals, vectors and other core concepts. When the Red Sox won the 2004 World Series, Reid saw a way to leverage home-team spirit and children's learn by doing nature. The "Science of Baseball" program he developed pairs batting, for example, with classroom lessons on parabolas and physics, which young players practice on MIT's diamond."[20]

Baseball history also provides a comparison of different eras of the game along with the different statistics of each period which can improve understanding of higher order thinking problems.[21]

The game of baseball contains an amazing source of statistics, stories, history, and game situations that give mathematic teachers the opportunity to showcase mathematic problems to students in ways that can make the educational experience memorable and enjoyable.

Mathematic problems can analyze times, distances, speed for running, throwing, and hitting. Baseball can also assist math students in the understanding of spatial reasoning, probabilities, and statistics by giving assignments that ask students to collect and record data, determine possible outcomes or combinations of a situation, and create and interpret graphs.

Using Baseball Problems in Mathematics Classes

Home run trot--
the batter's eye a tape
measuring the distance[22]

There are many ways to incorporate baseball into mathematics. One could show how outfielders catch a fly ball using the linear optical trajectory (LOT) model which received much national attention in 1995. This model uses equations to relate the motion of the fly ball to the motion of the outfielder using a mathematical foundation. The LOT hypothesis determines "the strategy the fielder uses to catch a fly ball by following a path that will keep the optical trajectory projection angle constant, this is equivalent to keeping the ratio (tan cx)/(tan B) constant."[23]

Merrimack College mathematician Michael J. Bradley studies geometry dimensions by focusing on the five sided home base and the baseball "diamond" which is a square, 30 yards on each side, all which offer opportunities for student discovery.[24]

In 2007, when Barry Bonds broke the home run record of Hank Aarons with his 756th home run, many mathematicians used the event in class room studies by following the trajectory of the fly ball which can be calculated given the initial conditions (location, velocity, and spin) and a model for the forces acting on the ball. These forces include gravity, air resistance, and the Magnus force on a spinning baseball.[25]

Even the leather or vinyl cover of the baseball itself which "consists of two identical pieces, stitched together, then stretched to cover cork, rubber, or yam-wound core of the ball" is a design piece that, from a mathematical viewpoint, can be thought of as "a simple closed curve on the surface of a sphere." The curve serves as a boundary between two congruent identical regions which can be an interesting study for mathematics students.[26]

Problems used in a traditional algebra class with baseball applications can easily be developed like this short list used by one of the authors of this paper:

1. Use the official rule book and the Pythagorean Theorem to calculate the width of the home plate. Where is the error in the book?

2. Find the exact distance from home plate to second base. Why is the rule book not correct?

3. Use a professional rule book (field dimensions section) and comment about the distance between bases.

4. If you have a 40 inch strike zone from the knees to the top of the zone and the umpire extends the strike zone one inch in and one inch out, what percentage has he increased your strike zone?

5. If a baseball stadium is symmetric and it is 340 feet down the left field line, what is the distance between the foul poles?

6. In a major league season there are 162 games in a season. If Boston has a record of 80-60 and New York has a record of 77-63, what is the magic number for Boston to clinch the title?

7. If you look at a box score how can you determine the number of people who batted in the game. There are 3 mutually exclusive categories you must consider. What are they?

8. If a manager lists nine players on a line-up card, how many different line ups could he make?

9. A baseball batted during a game followed the path of a parabola. The path can be modeled by the function: $d(t) = 2t^2 + 12t + 1$, where 't' is the number of seconds which have elapsed since the baseball was struck, and d(t) is the number of meters above the ground after 't' seconds.

    a. At what times was the baseball 11 meters above the ground?
    b. What is the maximum height reached by the baseball? What relation does this have to the parabola?
    c. How many seconds elapsed when the baseball reached maximum height?
    d. The baseball is not fielded before it hits the ground. How many seconds did it take for the baseball to hit the ground?

Benefits of Storytelling as a Pedagogical Tool

fireflies…
the smallest boy hits
the game winning home[27]

Each classroom instructor has their own story to tell. Yet many university instructors are ambivalent about the idea of storytelling as a teaching method. One mathematics professor the author knows believes that everyone knows baseball stories and can make the same associations, so stories are not that important. Another faculty the author knows is not convinced that baseball and storytelling is directly related to teaching mathematics nor is significant in teaching of mathematics, although he agrees that students are eager to enroll in the author's classes and speak highly of their learning experiences.

Nevertheless, storytelling is catching on in a significant way as a re-discovered teaching pedagogy. Storytelling was once thought to be mostly for children or for use in library programs.

Recently Robin Adams, Purdue Unhiversity; Cheryl Allendoerfer, University of Washington; Tori Rhoulac Smith, Howard University; David Socha, University of Washington; Dawn Williams, Howard University; and Ken Yasuhara, University of Washington conducted a research project supported by the National Science Foundation to explore storytelling in engineering education. They found storytelling can provide an important instructional method for engineering educators and they encourage taking storytelling research forward so others can build on their ideas. "Simply put- our stories matter—and storytelling provides a vehicle for scholarly discourse that makes explicit knowledge, promotes reflective practice, and provides entry points into a community of practice."[28]

Storytelling is also now being applied in the business, industrial, and corporate world by managers and human relations specialists for employee training, knowledge transfer, and cultural change and by faculty in academic settings as a pedagogical tool for effective teaching.

> "One reason storytelling is making a comeback is because of the estimated 60 million to 74 million millennial generation students and employees born from around 1977 to 1995 who are flooding colleges and entering the workplace with learning styles favorable to storytelling. Another reason is the value of stories in a learning setting."[29]

Howe and Strauss, widely acclaimed for advancing the idea of the millennial generation, suggest that these students actually like and accept authority figures (at the risk of diminished critical thinking). [30] A 2002 Harris Poll lists teachers in the top six groups that influence today's generation of students which gives support to why stories can be important in teaching mathematics today:[31]

- 59% -- my mother
- 43% -- my father
- 22% -- my grandparent
- 19% -- a teacher or coach
- 18% -- an entertainer

While the Harris poll shows that authority figures such as parents and grandparents have the most influence on the millennial generation, it is also true that teachers and coaches are more respected by millennials than by the boomer generation, thus creating an opportunity for teachers to use stories to enhance learning.

Storytelling has been around for thousands of years as a means for exchanging information and generating understanding.[32] It is now emerging as an important learning method, today, in the study of history, sciences, philosophy, religion, social sciences, business, and medicine because it is found to be a significant factor in bringing people together in families, schools, and businesses to create a common bond and learning environment.[33] Personal communication and storytelling is found in all institutions in society because stories greatly reduce depersonalization and narratives are increasingly being used in higher education because they help students think critically and understand factual content.[34]

Eastern Tennessee State University is one of the first universities to develop an advanced degree in storytelling. David Kolb in *Experiential Learning: Experience as the Source of Learning and*

Development said learning comes from a sequence of experience, reflection, abstraction, and active testing. Storytelling in higher education supports this type of deep learning.[35]

This trend has a logical basis too. Artificial intelligence visionary, Roger Shank, explains in *Tell Me a Story: Narrative and Intelligence* that stories enhance deep learning because of how they impact the brain. He says stories aid recall and creativity because they engage all parts of the brain and which assists deep learning, so teachers and students should create, tell and repeat stories.[36]

Another international recognized expert on brain development looking at the relationship between stories and the brain is Dr. Bruce Perry, who states:

> "Neural systems fatigue quickly, actually within minutes. With three to five minutes of sustained activities, neurons become less responsive; they need a rest (not unlike your muscles when you lift weights). They can recover in minutes too. But when they are stimulated in a sustained way, they are just as not efficient. Think about a piano and organ, if you put your finger on the organ key and hold it down it will keep making a noise, but the piano key makes one short note, and keeping your finger there produces no more sound. Neurons are like pianos, not organs. They respond to patterned and repetitive, not sustained, continuous stimulation."[37]

This information suggests that students can only sustain about four to eight minutes of factual information before the brain seeks other stimuli. Perry says the way to counter this learning process is through the "Bob and Weave" lecture, meaning the most effective presentation must move back and forth through these interrelated neural systems weaving them together. This is done best through stories because human beings are storytelling primates.[38]

Michael Schiro and Doris Lawson's book *Oral Storytelling & Teaching Mathematics* is "largely about how mathematics and oral storytelling can be woven together to provide an exciting method of teaching mathematics. It contains two case studies of teachers telling stories to teach mathematics. Oral storytelling transforms the abstract, objective, deductive mathematics we have all experienced in school into a subject surrounded by imagination, myth, and subjective meanings and feelings."[39]

Our Case for Storytelling: Methodology and Results

distant thunder
the home run hitter
drops a bunt[40]

In 2006, a team of six K-State at Salina faculty received a Tilford Diversity grant to explore storytelling as a pedagogical tool for faculty, staff, and administrative leaders. Their project included storytelling as the technique for diversity awareness. Nearly 50% of the faculty, staff, and administrative personnel attended this voluntary training.

Tim Tingle, international storyteller and member of the Choctaw Nation, seriously addressed the subject of storytelling with several examples of entertaining and cajoling diversity stories.

Prior to the training, a pre-survey was administered to 98 faculty, staff, and administrative personnel. A post-survey was conducted after the training to determine storytelling's impact. Fifty one of the surveys were completed and results from the survey indicated:[41]

- Classified staff (secretaries and facilities personnel), minority, and females felt storytelling was more important to their work they attended the workshop. They also recognized they already used storytelling. Males and unclassified staff (professional administrative personnel) who attended felt storytelling was less important after the workshop. However, males and unclassified staff who did not attend felt storytelling was more important and females not attending felt it was less important.

- All male groups including faculty said they didn't use storytelling as much as they thought as a teaching tool or to provide customer service after they attended the workshop. Minority attendees felt very positive about their use of storytelling as a teaching tool or to provide customer service after they attended the workshop. Females also felt more positive about it.

- Classified staff, unclassified staff, faculty, males, and minorities felt they had more experience after the training and they were more confident about using storytelling after the event.

- All demographic groups surveyed said storytelling was more important in their lives after they attended. Those not attending noted no increased change in attitude.

- All demographic groups surveyed had a significant improvement in awareness between the relationship of storytelling and diversity. Those not attending did not recognize or understand the importance and relationship between storytelling and diversity.

- All groups in attendance had an increased interest in learning more about storytelling as a tool to engage students in learning. With the exception of the minority group and one other group based on age, all groups not in attendance were less interested in learning more about storytelling.

The results of this non-scientific survey indicate the training created a more positive understanding of storytelling and its impact on diversity awareness and culture change. The event also was the catalyst for one of the authors to start using stories as a pedagogical tool for mathematics instruction.

In the past two years both authors of this paper, from different disciplines, have made a planned effort to utilize stories as part of their teaching pedagogy. The results of polls taken in two business classes (Introduction to Business and Supervisory Management) during the 2008 fall semester repeated in the fall 2009 semester indicate that students at K-State in Salina like stories as a

pedagogical tool. The poll asked students to rank ten different presentation/learning methods utilized in class based on the student's order of importance. Ten different teaching tools were listed on a single page and here is how students ranked the items:

1. Class Discussion
2. Stories Ranked #2
3. Class Lectures
4. PowerPoint
5. Handouts
6. Group Projects
7. Videos/DVD's
8. Textbook(s)
9. KSU Online (Classroom program like Blackboard, WebCt, etc)
10. Homework.

Business students ranked stories as #2 in the fall 2008 and as #3 in the 2009 for the business courses. Mathematics students were polled at the end of the fall 2009 semester and stories were listed between #2 and #3 (2.6 on a scale of 10). These polls indicate there may be reason to believe that students like story pedagogy.

There is also evidence that retention and grades may be positively enhanced in the mathematics classes. Eighty-eight per cent of intermediate algebra students who enrolled in college algebra were successful in 2009 using a series of problems for each concept and including "baseball" problems and stories.

In the fall 2008 semester 55% of the students received a 'B' or better with three "F's" and three incompletes. In the fall 2009 semester, using a more focused approach with baseball stories, 75% of the students received a 'B' or better with one "F" and four incompletes.

In the mathematics classes each student was also given an opportunity to share their own story or write a short paper and give an 'oral report' for extra credit. This was followed by class feedback on the discussion and presentation.

Finally, student class evaluations in mathematics classes include very strong and supportive comments about stories and baseball. (See Appendix B).

Conclusion

the umpire with raised arms!
a trail of dust still circling
the infield[42]

In a June 2000 article, Robin Wilson suggested more real world focus in *The Chronicle of Higher Education* article titled The Remaking of Math.[43] Perhaps now is the time to remake

mathematics with the use of stories that engage learners in a way that helps them relate and understand abstract concepts with concrete examples.

Ken Burns sums up baseball's potential to bridge mathematics in his PBS documentary on baseball which included this segment from Bob Costas:

> "….and this is one of the great things about baseball, where you calculate so many things simultaneously. A ball is hit into the gap…How good is the fielders' arms? …Where is the cut-off man? …A quick look and a glance…The runner is between first and second…How fast is that runner? …How many outs? …Should he try for third?...Is his history that he is daring? …Will he try for third?...What is the third base coach doing?... You take all of these things with depth perception…You try to calculate fleeting seconds…What are the possibilities?"[44]

As teachers who have been exploring innovative ideas and methods for over three decades, we highly recommend more research into this approach. If the evidence shows that millennial generation students enthusiastically favor personal relationships, technology, multitasking, and learning, the almost forgotten soft technology-storytelling may offer pedagogy value for mathematics instructors. Harvard professor Dr. *Howard Gardner,* author of *Changing Minds* stated **"**Storytelling is the single most powerful tool in a leader's toolkit."[45] Our experience concurs.

entering
the batter's box
afternoon shadows[46]

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Appendix A

This a list of stories I use in my mathematics classes and for public presentations:

1. Coming from other direction
2. It took too long to get here
3. Chinese Olympic Team
4. Trig problems, Pig, USA
5. Street People Alaska
6. Man on bench Alaska The future ain't what it used to be
7. Learn math and think at the same time
8. People who already know and you can't tell them
9. Largest number
10. 3 2 pitch
11. 99 cent whopper
12. Yogisms
13. We make too many wrong mistakes
14. Cut pizza in four pieces because I am not hungry enough to eat six
15. I didn't really say everything I said
16. It ain't over till it's over
17. Wefald story
18. Athletic director Still be my friend
19. Snyder broken arm
20. Quigley
21. Early umpires Villains
22. Top Hat vs. Pugilists
23. Go someplace where I can't see you
24. Small comb first base Anchorage
25. Travesty
26. Quick sand bride
27. Dummy Hay
28. Lord Byron Singing ump
29. Bob Emslie nervous baldness
30. Ashford First Black
31. Rodriguez – First Latino
32. Bernie Gexa First Woman
33. Sosniak Fly out Do over
34. Billy Evan Youngest
35. First Full Female Crew N Y Mets vs. U of Michigan
36. OSU Home Run
37. Nebraska Home Run
38. Ed Moriarty Spell Name
39. Frank OSU Yell
40. James Duo
41. Nomo
42. Dave Johnson - Held mine to a single
43. Bill Conners Rick Sutcliffe cannon 3
44. 1995 Yankee Texas playoff Hershbrock
45. 1997 Baltimore Cleveland camera
46. Coors Field Colorado
47. St. Louis 20,000 cushions
48. Blind Boy
49. Wade Boggs
50. Dick Stuart
51. Steve Spurrier Library
52. Metcalf Grades A & M
53. Lee, Minnesota
54. Bum Phillips
55. Umpire Mental and Physical Care
56. Making friends Psychiatrist take serious
57. Eat properly
58. Turn the other chin
59. Hurts push
60. Walk grandma
61. Box of apples
62. Parrott
63. Shirts laundry
64. Eyes/Moon
65. Golf story
66. Curb gutter
67. Appeal strike call to Supreme Court Wright vs. Deckman
68. Point fair, safe, out, safe
69. Home plate square root 289
70. T.D. play 12, play 13, play 24
71. 10 strokes off
72. One will have to leave
73. Black and white
74. Winston Churchhill and Lady Astor
75. Flight 40000 ft. engine blew up
76. Sam's exam/ same score me either

Appendix B

Student Feedback: Mathematics Teaching Evaluations

"The thing that interested me in the class was the baseball applications part of the class".

"As a former player, the thought of math in baseball was nothing new, considering that all stats are mathematical, but the application problems were quite interesting."

"I would have never known about the irrational measurement of second base or how home plate measurements are incorrect because of irrational numbers."

"Your class sparked a nice conversation between my dad and me, because he is a baseball coach and math teacher."

"While using the baseball rule book and calculating the actual distance a runner travels between bases, I will be teaching my son how to bat left-handed."

"Parabolas have been shoved down my throat in math classes, but now after the "flight of the baseball" problem, I will never forget how to do those."

"Probability and combination problems were made interesting with the number of possible line card a baseball manager has available."

"Overall I enjoyed your class very much. Putting simple math in applications that are interesting to common people is often very hard, but you accomplished that very well with your stories and baseball problems."

"It was a relief to finally be able to understand math because it was always something I struggled with."

"I had a great time in your class and I will use the applications when I tutor people from now on."

Appendix C

The Society for American Baseball Research (http://www.sabr.org/), established in Cooperstown, New York in 1971, offers multiple resources for teachers on the long tradition of detailed records on a variety of offensive and defensive aspects of the sport. Online resources include a classified section to assist researchers, links to other baseball resources and over 200,000 documents indexed by subject, title, or persons referenced. Local chapters are in Des Moines (http://chapters.sabr.org/fieldofdreams/) and Kansas City (http://sports.groups.yahoo.com/group/SABRmonarchs/)

and legitimacy in the smart city market. Drawing on actor-network theory and critical plan-. ning theory, the paper analyzes IBMâ€™s smarter city campaign and finds it to be storytelling, aimed at making the company an â€˜obligatory passage pointâ€™ in the implementation of urban. technologies. Our argument unfolds in three parts. We first trace the emergence of the term. â€˜smart cityâ€™ in the public sphere. Secondly, we show that IBMâ€™s influential story about smart. Triple Play Baseball, Palermo, Maine. 73 likes. We're a small local business offering lessons and mentoring to ballplayers of all ages. We help players...Â See more of Triple Play Baseball on Facebook. Log In. or. Create New Account. See more of Triple Play Baseball on Facebook. Log In. Forgotten account?Â Page created â€“ 10 April 2010. People. 73 likes.