The Science of Sports: Combining Quantitative Analysis and Sports Applications in an Undergraduate Course

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Abstract

I present the development of a one-semester undergraduate course devoted to operations research (O.R.) and statistical methodologies in sports, specifically targeted for first-year collegiate students. In particular, this class explores decision analysis and linear regression using sports as the sole basis of application. Term projects and oral presentations permit student groups the opportunity to investigate specific quantitative applications in this field. Essentially, I endeavor to couple a student's inherent interest in sports with training in basic analytical approaches.

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1. Introduction

For those of us who teach quantitative methods, we may occasionally use a sports example to crystallize a key concept. For example, one could simply determine descriptive statistics and develop histograms for the number of runs a particular team scores in a baseball game. Linear regression can be used, say, to investigate the effectiveness of different summary statistics in predicting golf success (Ketzscher and Ringrose, 2002). Not surprisingly, decision analysis features many potential applications. It could be utilized to address specific crucial in-game decisions, such as a basketball player passing the ball or attempting a shot. Moreover, it could tackle issues in a broad range of sporting and recreational events, such as the choice of the best fishing site (Kangas, 1995). Undeniably, sports provide a solid forum for the application of various operations research (O.R.) and statistical approaches.

For several decades, researchers have explored a variety of interesting topics in a number of sports using a host of analytical approaches. To the best of my knowledge, Mottley (1954) was the earliest contributor to this burgeoning field. Specifically, he surmised "football presents many intriguing possibilities for the talents of the O.R. worker." Noting the applicability of analytical tools in sports decision-making, Bierman (1968) concluded "the day is rapidly approaching when the decision theorist will be sitting on the player's bench." Ladany and Machol (1976, 1977) edited two books devoted to quantitative analysis of sports. Eventually, survey papers were contributed by both Schutz (1980) and Gerchak (1994).

More recently, several notable applications of quantitative analysis within sports have appeared. The Boston Red Sox restructured their bullpen based on the statistical findings of baseball guru Bill James (Antonen, 2003). Several baseball teams are currently placing emphasis on exhaustive quantitative methodologies (Chen, 2004). In particular, teams have hired statistical analysts to help them "beat the market" in an attempt to determine undervalued baseball players. The Dallas Mavericks, a professional basketball franchise, adopted a player-rating system developed by Wayne Winston and Jeff Sagarin (Leonhardt, 2003). In discussing their work, this New York Times article suggested that these models are "part of sports franchises' emerging interest in hard-core quantitative analysis."

Scholarly journals recognize that pursuits of O.R. and statistical methodologies in sports are no longer just

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"academic hobbies"; indeed, considerable rigor is involved in these applications. Recently, several well-respected academic journals have devoted (or are planning to offer) special issues to O.R. and statistics in sports as witnessed by the Journal of the Royal Statistical Society: Series D (Watkins and Wostenholme, 2002), the European Journal of Operational Research (Koning, Sierksma and van de Velde, 2003) and Computers and Operations Research (Hurley, 2004).

Further, interdisciplinary groups within academic disciplines have sprouted to promote the application of quantitative tools in sports. The American Statistical Association (ASA) includes a section called "Statistics in Sports" and offers several sessions at annual meetings[(1)]. The ASA also sponsors the Journal of Statistics Education, an electronic journal that often features articles devoted to interesting statistical analyses in sports, as well as papers illustrating the use of sports in the classroom[(2)]. The Business School at the University of Oxford hosted a one-day symposium on "O.R. in Sport" (Lewis and Potts, 2002). A new INFORMS section, O.R. in Sports, has recently been proposed (Ohlmann, 2004). Further, INFORM-ED is sponsoring three sessions on this topic during the 2004 INFORMS Conference in Denver (Cochran, 2004).

In this paper, I present the development of a one-semester, undergraduate course devoted to statistical methodologies in sports, specifically targeted for first-year collegiate students. A number of O.R. concepts are featured using sports-related examples as the sole basis of application. Essentially, I want to couple a student's interest in sports with training in basic quantitative methodologies.

This paper shall investigate several key points regarding this course. In Section 2, I briefly discuss the issues of sports in the classroom. I then provide a background on my course development in Section 3. I subsequently explore course operation in Section 4, after which I illustrate various assignments and projects used to evaluate student performance in Section 5. Section 6 offers student feedback while concluding remarks are provided in Section 7.

2. Sports in the Classroom

Effectively illustrating quantitative concepts through sports applications can enhance our pedagogy. Indeed, if students see a principle demonstrated within an application environment they readily understand and appreciate, they may be more likely to retain awareness of the concept (Cochran, 2004). I note that my course is not the first effort to dedicate an entire class to the study of quantitative tools in sports. For example, Alan Levine has offered a first-year seminar on mathematics and sports at Franklin & Marshall College[(3)].

In a similar vein, Joe Gallian of the University of Minnesota - Duluth offers a freshman mathematics and sports seminar to liberal arts students[(4)]. At Bowling Green State University, Jim Albert teaches an introductory undergraduate statistics class using just baseball examples[(5)] and has published a book on the subject (Albert, 2003).

A need exists to circulate the developmental details of such courses so as to guide others who may opt to deliver a class of this nature. Creatively designing one's pedagogy can augment students' understanding of statistical analysis in sports. By doing so, these students can gain greater insight into the overall process of analytical reasoning and may more fully appreciate the traditional "managerial" application environments within which quantitative methodologies operate. In essence, they can be convinced that O.R. tools matter and that, more importantly, they work.

O.R. concepts do not represent the sole pedagogical area in which sports has had direct application. Perhaps recognizing that sports is big business (Shinn (2003) reported that nearly $200 billion is spent annually on sports-related business, making it one of the ten largest sectors in the U.S. economy), several schools of varying size now provide specialty undergraduate or graduate programs in sports management. Rather than being situated in physical education or kinesiology departments, these programs may be housed within Colleges of Business at some major Division I

(1) http://www.amstat.org/sections/sis
(2) http://www.amstat.org/publications/jse/
(3) http://www.fandm.edu/Departments/Mathematics/A.Levine/ALEVINE.html
(4) http://www.d.umn.edu/math/people/faculty/jgallian.html
(5) http://bayes.bgsu.edu/

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schools in the U.S. Programs ground students in core business skills (for example, strategy and operations) while offering sports-oriented classes in areas like finance, law, technology and marketing. Larger schools include the James Warsaw Center for Sports Marketing at the University of Oregon[6] and the Carey School of Business at Arizona State University[7]. The latter school offers an MBA with a specialization in sports business. The Stillman School of Business at Seton Hall University has a Center for Sport Management[8] while Baylor University offers a graduate program with specialization in sports management and sports pedagogy[9]. Sports management programs are even offered at smaller schools like San Antonio's University of the Incarnate Word[10] and Nichols College[11], located in Dudley, MA. In particular, the sports management program at this latter college is the largest major in the business school. These represent but a few of the several sports management programs available.

3. Course Background

Bucknell University is a private, residential institution that educates about 3,500 (nearly all undergraduate) students. Founded in 1846, its mission is "to provide wide educational opportunities within a collegiate setting to a controlled number of talented men and women."[12]

Historically, Bucknell has followed a very selective admissions policy. For example, over 8,300 persons applied for the class of 2008 with about 900 students being admitted (this comprised about 700 Arts & Sciences students and about 200 in the College of Engineering). Nearly all incoming class members are U.S. citizens, as international students constitute about 6% of the student body[13].

Our school's Common Learning Agenda (CLA[14]) facilitates the educational breadth required of all students enrolled in the College of Arts & Sciences. During their four years of undergraduate education, students will undertake coursework in such areas as natural sciences and mathematics, "Perspectives on Human Diversity," and social sciences. Indeed, the goal of the CLA is " to give students the opportunity to acquire the education they will need in order to live and work successfully in the 21st century."

An important curricular component of the CLA is a first-year experience course called a Foundation Seminar. In March, 2000, I was approached about delivering a Foundation Seminar for the upcoming Fall 2000 semester. As an aside, Bucknell often experiences problems in having to slot an abundance of students into a limited group of seminars. Consequently, faculty members' willingness to teach these courses is certainly appreciated. Being a relatively new faculty member at this institution, I was eager to contribute to its overall wellbeing. I agreed to offer a seminar and thus initiated the task of course design.

Faculty members have free rein in picking seminar topics. I chose to develop a seminar describing quantitative analysis applications in sports since this subject matter coincided with my teaching (I already used the occasional sports references in my core decision sciences and operations management courses) and scholarship (I had begun a research stream investigating various O.R. and statistical applications in this field). Besides, this material was inherently interesting to me; indeed, I realized that developing a first-year seminar would be much more enjoyable and much less a chore if the particular topic appealed to my personal curiosities. I ended up calling this course "The Science of Sports".

Additional rationale for developing this particular Foundation Seminar involved the anticipated student reaction. I perceived that first-year undergraduates, upon seeing the title and its description in the brochure, would be quite willing to take the course. As a result, I would acquire a student group naturally

(6) http://www.warsawcenter.com/
(7) http://wpcarey.asu.edu/mba/ft_sports/sport_info.cfm
(8) http://business.shu.edu/sports/
(9) http://www3.baylor.edu/HHPR/Graduate
(10) http://www.uiw.edu/snhp/gradsptmgmt.html
(11) http://www.nichols.edu/sportsmanagement.htm
(12) http://www.bucknell.edu/Academics/Course_Catalog/Mission_Statement.html
(13) http://www.bucknell.edu/About_Bucknell/Bucknell_Facts.html
(14) http://www.bucknell.edu/CLA/

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motivated by and innately attracted to the material. Moreover, a vast majority of seminars cover a set of important, but albeit "soft", topics (e.g. courses devoted to the humanities and arts). I thought that by designing a course replete with O.R. and statistical material one could satisfy the intellectual inquisitiveness of those students likely to eventually major in such disciplines as mathematics, computer science and management. First-year undergraduate students could become enthused about collegiate education by learning important concepts from scenarios they appreciate and readily understand.

Bucknell does not require an introductory statistics course of its entire student body, so I was not concerned that my seminar would unnecessarily overlap with a student's later courses. True, there are those students who are obliged to take statistics and decision analysis courses as part of their curricular programs (e.g. Management students). However, my experience in having these students enrolled in my Foundation Seminar, and then witnessing their performance in upper-year quantitative courses I teach in the Department of Management, is that these undergraduates receive a solid foundation in statistical and O.R. tools that serve them well in later courses.

4. Course Operation

I established ambitious seminar goals such as assisting students in their transition from high-school to collegiate learning, introducing them to the process of quantitative reasoning and helping them to appreciate how to use data to make decisions. I endeavored to help students develop abilities in the process of writing (especially as it pertained to the writing of technical material) and to form confidence in their oral presentation skills. Ultimately, this seminar showcased the manner in which insights obtained from model-building and their evaluation cut across disciplinary boundaries.

In order to meet these goals, I needed to determine specific seminar details such as the methodologies to be covered and the pedagogical material I would use in delivering the course. After some reflection, I decided that we would explore, in addition to some introductory material on elementary statistical concepts, two important quantitative methodologies; namely, decision analysis and regression analysis. My choice of decision analysis and regression was driven by a few factors. First, I felt that one could present the fundamental details of these topics in sufficient clarity that they would be readily understood and appreciated by first-year students with limited backgrounds in statistical methodologies. To a certain extent, my methodological choices were constrained by the collective backgrounds of the enrolled students. Secondly, I had a rough idea of the array of interesting papers that had appeared in a variety of academic journals using both regression and decision analysis to investigate sports applications. I initially perceived (which later turned out to be the actual case) that these academic articles could be discussed in a manner that would engage the students and facilitate comprehension.

In selecting articles for class discussion, I used sports-related pieces that were published in several journals; however, my main sources of material involved articles from Chance[15] and Interfaces[16]

Further, I incorporated some shorter articles that were published in the books by Ladany and Machol (1976, 1977). In fact, I have now compiled a list[17] of over 200 articles covering a wide range of sports and associated quantitative methodologies (click on the "list" hyperlink to access this file). This spreadsheet file permits sorting of material by several parameters, including specific methodology or sport. Obviously, this extensive compilation is more than any one instructor could possibly cover in a single semester course. In addition, many of these articles are at an advanced undergraduate or even graduate level, thus precluding their use in a first-year seminar. Nonetheless, this list of relevant articles can provide a body of material for those instructors wishing to design an "O.R. in sports" offering. There exists considerable leeway in the selection of specific articles. Conceivably, one could customize a course offering to an instructor's personal tastes by selecting only those articles that are more advanced in nature (for an advanced undergraduate or graduate offering). Or, one could choose those articles featuring a specific sport or those that use a particular methodology.

[15] http://www.stat.duke.edu/chance/
[16] http://www.interfaces.smeal.psu.edu/
[17] http://archive.ite.journal.informs.org/Vol5No1/Willoughby/sports_articles_list.xls

This course is structured in that we begin with a set of basic concepts and progress towards more elaborate statistical approaches. I felt that such an approach would effectively contribute to student learning. By beginning with basic statistical tools before launching into particular quantitative methodologies (and starting the specific methodologies with simpler, more straight-forward pieces), these first-year students would not become quickly overwhelmed. Having said that, we do examine a number of applications within each conceptual area, so students ought to be able to appreciate a particular methodology from a variety of perspectives. In each of these cases, the treatment is at such a level that students were challenged to gain an understanding of the application and its significance, without it becoming an impossible task. Frequent discussion during class sessions also helped students appreciate the applications, and gain confidence in their abilities to speak in class.

In each of the three offerings (Fall 2000, 2001 and 2002 semesters), the course met thrice weekly (Monday, Wednesday, Friday) for approximately 50 minutes each session. Admittedly, this is not the only feasible scheduling scheme. This course could be delivered in two 75-minute sessions each week. However, we doubt that a single 2.5-hour block each week would be desirable for this course. Any student, especially those in their first-year of collegiate studies, requires breaks (both in and out of class) in order to digest new material (Powell, 2004). No matter the innate pedagogical appeal of our material, students may have difficulty maintaining focus for an extended period of time.

I began the course with an introduction to mathematical concepts (including the notion of probability distributions) in order to establish the groundwork for applications that would soon follow. Our initial sports paper explored the informative Golden and Wasil (1987) article, "Ranking Outstanding Sports Records". I used this article since the authors carefully outlined various career, season and single-game records, and the reasons why certain achievements ought to be ranked as outstanding triumphs. Although the students did not receive an in-depth treatment of the analytical hierarchy process (AHP) methodology - I only gave it a "hand-waving" overview - my class participants could readily appreciate exceptional sports accomplishments. As the students and I discussed this article, great class debate ensued and students contested for the overall ranking of particular records. I ensured that students backed up their responses with some degree of quantitative logic. Permitting students to freely express opinions was important to me since much of the course centered on active participation, and I wanted students to feel comfortable contributing in class from the outset.

Building on the initial foundation of basic statistical concepts, I then explored additional sports applications. The class examined, in turn, the riskiest sports as assessed by participant injury rates (Collins and Gubernick, 2001), variation in team records from year to year (Saltzman, 2000 and Berry, 2002), and where to aim the ball when attempting a soccer penalty-kick (Brimberg and Hurley, 1999). Subsequently, we discussed the sequencing of golfers on the final day of Ryder Cup matches (Hurley, 2002), the suitability of a 9^{th} -inning intentional walk in baseball (Steinsaltz, 1999) and a statistical analysis of collegiate football scores (Mosteller, 1970).

Now into the 5^{th} week of a 15-week semester, I devoted attention to decision analysis, one of the major O.R. methodologies covered in the seminar. I initially covered the basic mathematical concepts of expected values and probability distributions so students would be sufficiently prepared for its treatment.

After introducing the topic of decision analysis, I designed an innovative approach to capture their attention, facilitate team-building and promote deliberation of decision problems. I provided the students a sports problem consisting of specific alternatives and a host of future outcomes. Assigning the class participants into groups of 2-3 students, I gave them a box of multicolored "sidewalk chalk" and informed them that we were to reconvene in the parking lot adjacent to our classroom building. I then had the students use the chalk to draw a life-size decision tree of the particular problem. They continually collaborated while building their trees, only stopping when class members requested my advice (or they had to permit a vehicle to exit or enter the parking lot!). At times, the completed decision trees exceed 30 feet in size. They became topics of discussion throughout the class period as students would explain their rationale about probabilities and payoffs to other class members, either within or outside their specific group. Being able to walk around the perimeter of a tree, gazing at the uncertainties and possible payoffs provided them with a unique sense of decision tree development. These trees also became

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topics of discussion among faculty members and other college students.

Returning to the classroom for subsequent sessions, the students and I explored two pressing decisions in football; namely, fourth-down decision-making (Hurley, 1998) and point(s)-after-touchdown attempts (Porter, 1967). The class also discussed critical decisions in the sport of curling (Willoughby and Kostuk, 2004). A highly interesting dialogue occurred as we analyzed the drug-testing of student-athletes (Feinstein, 1990). Based on actual events at Santa Clara University, this article clearly articulated the costs, uncertainties and alternatives associated in implementing proposed drug-testing programs. To a very real extent, students were captivated. They realized that O.R. stuff is actually used. Further, they could readily extend this application to the drug-testing issues continually plaguing professional and amateur sports throughout the world.

Given that this was a first-year seminar, I was somewhat limited in the decision analysis concepts I could present in class. For instance, I restricted treatment to single-stage decision problems, as opposed to their more complex multi-stage counterparts. I also chose to exclude discussion of the expected value of perfect information. I only provided a superficial coverage of Bayes' theorem, sufficiently deep to help the students understand its role in Feinstein's (1990) drug-testing case study.

Beginning in about the semester's 9th week, I initiated our exploration of regression analysis. Although I was unable to develop a suitably innovative procedure to introduce the topic (as in the decision analysis "chalk talk"!), I did want them to "hit the ground running" with a motivating regression example. The National Football League (NFL) season, fully underway during this part of the semester, captures the attention of several course participants. I took various box-score statistics from a previous weekend's set of games (e.g. winning team's rushing yardage and margin of victory) and had the students develop a linear regression model using Excel's data analysis feature. We met in a computer lab for this class period, thus allowing the students to gain hands-on experience in using the software. Prior to setting up their spreadsheets, I asked the students to provide intuitive rationale for the anticipated statistical relationships. This helped to cement their understanding of model results; simply, it became less of a black box for them.

The students and I treated several application papers in this topic area. In particular, we explored whether particular Super Bowl winners could somehow influence financial market movements (Sommers, 2000) and the modeling of player performance in both basketball (Price and Rao, 1977) and baseball (Berry, 2000a). Further, we investigated regression analyses of Ivy League collegiate football scores (Haberman, 1977) and the rate of improvement in some Olympic Games winning performances (Stefani, 2000). We concluded our study of regression by examining the return of the missed field goal in Canadian football (Willoughby, 2001) as well as several studies to predict winners in collegiate basketball's "March Madness" tournament (Carlin (1996), Schwertman, Schenk and Holbrook (1996), Stern and Mock (1998), Berry (2000b). Owing to the significant popularity of this event among U.S. collegiate students, this topic provided a high level of in-class participation.

As with decision analysis, there existed a few concepts within the realm of regression studies that I could not explore during the seminar. Specifically, I did not include any discussion of stepwise regression, multicollinearity, F tests and violations of particular regression assumptions. I provided brief coverage of outliers in regression problems, but the class did not discuss any statistical approaches for dealing with them.

Generally, I could cover one application case study within a single class period. The exceptions involved such topics as "March Madness" modeling and student-athlete drug-testing, wherein the extent of class discussion meant that additional sessions were required to complete treatment of the material. For each statistical topic or sports application, I prepared a set of PowerPoint slides covering the relevant ideas. I found that having the PowerPoint slides helped to crystallize many of the salient points during classes (in order to "get my message across", I opted for this approach instead of standing in front of the class without PowerPoint material and simply talking about the applications). The slides permitted students the opportunity to follow (and participate!) in course discussions without the interference of excessive note-taking. I wanted students to become active learners, not silent followers.

Besides the methodological discussions and sports applications, I devoted a few classes each semester to general issues. Early in the semester, I scheduled a

session at the library so class participants could be introduced to the respective research tools available. This would serve them well during preparation of their written term projects, an entire semester activity that culminated with group presentations during the final two weeks of the semester. Undoubtedly, awareness of on-line research accessibility would prove beneficial in remaining courses throughout their undergraduate education. Prior to the end-of-semester presentations, I set up an in-class workshop in which students received instruction in some of the particulars of successful presentations. I gave them my expectations for their eventual oral reports.

Finally, a certain vitality has been brought to the course by the use of guest speakers. I used this opportunity to highlight current quantitative applications in sports. Speakers were careful to address their comments at a level that my first-year students could readily understand and appreciate. So far, Michael Trick from Carnegie-Mellon University[18] addressed scheduling in collegiate basketball (Nemhauser and Trick, 1998) and Oklahoma State University's Rick Wilson[19] explored collegiate football ranking systems (Wilson, 1995). This latter application was especially relevant to the class since it showcased how quantitative methodologies, based on the input data considered, could arrive at differing outcomes.

5. Course Evaluation

Bucknell University places emphasis on developing and enhancing the writing skills of its students. Indeed, students are required to enroll in at least three writing-focused courses during their undergraduate education. One of these courses must be at the introductory level (signified by W1), while two are intermediate course offerings (denoted by W2). To capitalize on the opportunity to develop undergraduate writing skills, I pursued (and received) W1 status for the "Science of Sports" Foundation Seminar. This meant that a portion of performance evaluation, as well as course instruction, would need to center on writing skills development. The various seminar assignments provide students the opportunity to cultivate writing skills in the technical material area. The students and I explore methods of succinctly delineating the key findings of quantitatively-oriented information. At the beginning of the semester, a session is scheduled with support staff from the University's Writing Center in an effort to demonstrate how these individuals can work with particular students in any writing assignment, not just those from this seminar.

In our first assignment, students watch a recording of "Sports Images of the 20 th Century", a video that highlights the most dramatic and amazing sports performances of the past century. Students then prepare a short paper describing examples from the video that illustrate teamwork as well as positive and negative instances of leadership. We discuss their particular examples in the following class period. Although not a statistical paper, this assignment does "gear up" the students for the sports applications considered during the remainder of the semester. The scenes in this video also generate a considerable amount of class discussion.

In the second assignment, students prepare a paper on their favorite sports record (since we would have just completed the discussion of the "Ranking Outstanding Sports Records" article, this topic would be fresh on their minds). Students are asked to determine how they could statistically evaluate the "greatness" of their selected record. The third and fourth assignments involve students preparing a decision tree and regression analysis, respectively, of particular situations in sports.

In the fifth assignment, students peer-review a classmate's copy of the regression analysis assignment. This task permits class participants to evaluate the efficacy of another student's regression model. Often, the students indicate how their classmate's regression model could be improved.

Exams represent an additional opportunity for evaluating student performance. I provide both a midterm examination and a (non-cumulative) final examination. Usually, these exams feature a combination of both quantitative problems and written questions. Besides evaluating a student's quantitative skills, we want to assess their ability to coherently write material that is technical in nature. Examples of written questions could include: "How does logistic regression differ from linear regression?", "How were payoff matrices used in the "Soccer Penalty Kick" article?", "What are the limitations of using expected value as a criteria for assessing best alternatives in decision analysis?" and

[18] http://mat.gsia.cmu.edu/trick/
[19] http://faculty.mstm.okstate.edu/~rlwilsn/

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"How does one assess the performance of linear regression models?".

In pairs, students are required to prepare a written term project (10 pages in length) on any quantitative application in sports. Student groups select their own particular topics. Newspapers, academic journal articles, or Internet sources are frequently used to search for topics and associated data. The term project enhances their writing skills. The statistical findings from their projects are then presented to the rest of the class; this serves to develop their oral presentation skills. Indeed, the term projects have been a highlight of the Foundation Seminar. Based on my initial three offerings of this course, I have witnessed a varied set of project topics. Some of them include "Decision Analysis in Volleyball", "Who's Better: The New York Giants or New York Jets?", "Starting Position and Winning at the Kentucky Derby: A Regression Analysis", "Why Do the LA Clippers Suck?", "What's the Deal with Cricket?", "Riding in the Sport of Lacrosse" and "The Demise of NFL Dynasties". Besides PowerPoint material, some student groups have incorporated video technology into their project presentations. These creative presentations dealing with innovative topics represent a truly enjoyable way of wrapping up the semester.

6. Student Feedback

My experience with this seminar has been most gratifying. As far as I am able to determine, students have gained an appreciation of the applicability of quantitative methodologies in sports. They have performed admirably on assignments and examinations. Further, the variety of term projects serves as testament to their initiative in discovering topics and analyzing data sets. Almost without exception, their presentations have been innovative and imaginative. Despite being enrolled in just their first semester of college, they have gained skills that may serve them well the remainder of their collegiate education. I feel that the course objectives have been satisfied.

Widespread interest exists for this particular seminar. From informal conversations with personnel in the Registrar's Office, we learned that nearly 100 students would annually select this course as their top choice for Foundation Seminars during first-year pre-registration. Lamentably, the seminar is capped at relatively small numbers.

After taking this course, students have inquired about an upper-year seminar in this area. Those who have not been able to take the course have suggested the need for alternative sections! Further, a student who took the course in the Fall 2000 semester later served as a sports reporter with our college newspaper. To a certain extent, she took the writing, statistical and sports skills developed during this course and parlayed it into collegiate service.

The following comments are representative of those included on student evaluations:

"I was so excited to take this course, and it lived up to my expectations. It was fun and informative. I'd love to take a course like this in the future!"

"I really enjoyed the class. It helped me think about sports from another, more scientific view."

"This course was very interesting, and provides an opportunity to learn a subject matter that is not usually available."

"Personally, I thought this course was very interesting. I've never had a course like this and I absolutely loved it!"

"Very informative/interesting. For all students, not just sports fans."

"Learning about some new sports broadened my horizons."

"Very interesting, it was a new approach of sports."

"This course allowed me to look into aspects of sports I never realized were there. It gives me new perspectives about sports and a deeper understanding."

7. Conclusions

This paper has addressed the development of a one-semester, first-year undergraduate course entitled "The Science of Sports". This innovative seminar combines quantitative methodologies and sports applications. Course objectives have been satisfied, student interest remains high, term projects are continually unique and refreshing, and I look forward to each semester's offering of the seminar.

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Statistics and sports? Isn't this just an excuse for football-jocks to get together and discuss their favorite teams, players and games during the past week? Well, No. The particular applications, although captivating, do involve a certain amount of rigor. Moreover, my classes were not completely dominated by males. Although I admit I was likely to draw more males than females into the class, I have had 16 females take the seminar (representing nearly 30% of my entire 3-semester enrollments). Further, I have taught a host of student-athletes in several collegiate sports in this class. Although football represented my largest contingency (6 students), I have had 4 lacrosse players and 3 each in soccer and rugby. I even had 2 cheerleaders (one male, one female) in the course in addition to a pair of members of the water-polo team.

My goal is to expand this pedagogy by eventually offering a senior elective course tentatively entitled "Advanced Quantitative Methodologies in Sports." I envision the exploration of such topics as Markov decision processes (Bukiet, Harold and Palacios, 1997), simulation (Koning et al, 2003) and linear optimization (Zappe, Webster and Horowitz, 1993) and their application in the field of sports. The rigor of these methodologies precluded their illustration in our current Foundation Seminar.

Transferability is a key principle with any curricular offering. It is my belief that instructors at any undergraduate institution could deliver such a course (indeed, as described earlier in the paper, other instructors have developed "sports and statistics" classes in the past). An appropriate delivery method for an instructor may be to offer this course as a "Special Topics" seminar. The particular topics I investigate are those that any undergraduate statistics or quantitative analysis course would cover. The key is amassing a sufficient number of sports-based applications. I envision that instructors could take the applications provided in my list[20] and modify it corresponding to their own interests.

[20] http://archive.ite.journal.informs.org/Vol5No1/Willoughby/sports_articles_list.xls

  ISSN: 1532-0545

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