

## INTRODUCING PROBABILITY AND STATISTICS INTO THE ENGLISH STUDIES CURRICULUM

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Introducing probability and statistics into the pre-college English curriculum was the objective of the National Science Foundation Pilot Study on Cross-Discipline Statistics Education. The study, directed by Robert Boruch of Northwestern University, focussed on English studies for various reasons. First, there were already some ongoing projects that were addressing statistical issues in science, social studies, and mathematics (e.g., the NCTM-ASA Quantitative Literacy Project and the Schools' Council Project on Interdisciplinary Statistics Education in England). Second, Boruch had a special interest in statistical issues that appeared both correctly and erroneously in literature (Boruch and Zawojewski, 1986). Many such examples had been collected over the years.

At first it seemed that the selected subject area had the least possibility of requiring statistical reasoning. Further, English and statistics were often seen as involving disparate talents, thereby attracting people who were "good" in one and not the other. However, as the project progressed, support was found for intermingling the skills required for success in English studies with those for reasoning with quantitative material. This support came from three perspectives. First, the many occurrences of statistical ideas in literature (Kruskal, 1978; Boruch and Zawojewski) provided material to be capitalized upon. Such readings presented opportunities for teachers to insert a short lesson to enhance student understanding of statistical ideas. Second, statistics had been used as a tool to analyze literary pieces. For example, analysis of word composition was used to determine authorship (Mosteller and Wallace, 1972; Taylor, 1985; and Swift, 1986), style (Nowakowski, Note 1), and difficulty (Perjil, Note 2). Probability was also used to analyze various assumptions underlying plotlines (Zawojewski, 1986). Third, writing and language arts skills were seen as useful tools for enhancing statistical thinking. Smeeton and Smeeton (1985) stated that students needed to be able to understand numerical data well enough to interpret it into "plain English." The writing to learn concept described by Meyers (1984) used writing as a method to learn mathematics content more thoroughly. He claimed that much of the logic involved in good writing paralleled the processes used in solving math problems. In fact, computer programming was said to accentuate the importance of clear and precise language. In courses on teaching thinking, a longer written response was one of the measures used for evidence of a higher level of understanding of the problem according to Worsham (1986). In the same vein, articles in The Mathematics Teacher (1986) and The Chronicles of Higher Education (1986) cited examples of students using writing in math classes as a tool to help clarify concepts.

Support for the concept of integrating statistical reasoning with English studies was recently found in The Nation's Report Card (1987) where the National Assessment of Educational Progress (NAEP) reported the results of a new literacy test in which the skills being examined overlapped with those currently being tested in the reading, writing, and math assessments. The processes examined turned out to be the same ones used to select and organize information for problem solving. In developing this test NAEP expanded its definition of literacy to encompass three major components: prose literacy, document literacy, and quantitative literacy. Prose literacy involved the knowledge and skills needed to understand and use printed information (editorials, literature, poems, etc.). The document literacy scale measured the knowledge and skills required to locate and use information contained in items such as job applications, payroll forms, schedules, maps, tables, graphs, etc. Quantitative literacy referred to the knowledge and skills needed to apply arithmetic operations to information embedded in printed material. Examples included following directions to reconcile a checkbook and interpreting true interest or discount rates from an advertisement. This expanded definition recognized that measurement of the ability to function in today's world (literacy being an important component) had to include the assessment of the development of complex information processing skills. Finally, in Becoming a Nation of Readers (1985) it was stated that the logical place for reading and thinking strategies was in a content area course, such as science or social studies, because strategies were most useful when students were trying to understand important but unfamiliar content.

The need for the integration of English studies and statistics for students in the United States was demonstrated by the last NAEP results (1983, 1986) where it was found that students were able to read words and numbers but had difficulty reasoning about what they read. Interpretation caused even more difficulty. The Second International Mathematics Study (1987) found that students from the United States were able to do arithmetic computations but could not problem solve as well as children from other nations. Thus, many students found themselves unable to deal with information effectively in a society that increasingly required statistical reasoning with information and data.

### Development of Materials

The vehicle for implementation was a vignette: a short lesson based on topics and literature already addressed in pre-college classes. These vignettes were to be inserted in the pre-college curriculum at the convenience of the teacher. The assumption was that small periodic doses in varied contexts would result

in "good" learning. The criteria that were set when developing the vignettes were:

1. The content would be rich in statistical ideas and involve basic intuitive understandings without the use of complicated computations and formulas.
2. A balance would be established between maintaining the integrity of the mathematical ideas and being non-threatening to language arts teachers.

An initial perusal of reading lists and literature anthologies from several schools in the Chicago area failed to locate a common core of required literature that could be used for developing the vignettes. In light of that discovery, the lists were searched for examples of literature that could be developed into lessons appropriate to the goals of the project. After conversations with Jim Swift (Note 3, 1985) and Peter Barabella (Note 4, 1985), the search was further expanded to include appropriate newspaper articles as well as real life situations. Topics were chosen for their interest value to teachers and students as well as for their statistical applications. More important, examples were chosen that aided in the development of important concepts and skills that were useful for interpreting data in everyday life. The Appendix contains short synopses of the vignettes. The following statistical issues were addressed:

1. simple and conditional probability
2. constructing, reading, and interpreting graphs
3. faulty cause and effect chains
4. necessary and sufficient data
5. insufficient, irrelevant, and faulty data
6. certainty vs. uncertainty
7. sampling and surveying
8. measurements of central tendency
9. some common misconceptions

The vignettes were evaluated by several English and math teachers. Initial responses were enthusiastic. Written evaluations, which included recommendations for specific changes, were generally very positive. Several readers offered to pilot problems or locate others who were interested.

#### The Pilot

The implementation of the pilot ran into difficulty almost immediately. Time constraints were most often given as the rationale for non-participation. One junior high school teacher piloted two of the problems and expressed a willingness to do more the following year. The project staff proceeded to pilot some of the material in a mixed grade group of junior high students at Baker Demonstration School in Evanston. Another problem was piloted in a freshman college class at Northwestern University. All junior high classes were video taped.

The very limited piloting did generate some valuable information. The participating students seemed to find the material interesting and were capable of understanding it as demonstrated by their classroom participation: answering and asking questions; answers on worksheets; general enthusiasm. The positive response of the students prompted the project director to conclude that the vignettes merited

further refinement and piloting.

The difficulties encountered in the implementation of the pilots were also enlightening. Although initial offers to participate came from teachers at both the junior high school and senior high levels, the most co-operation came from a junior high teacher. Promises for future pilots also came from that level. While the sample is admittedly small, some reasons for more junior high co-operation do make intuitive sense and could be worth exploring in the future. In general, the high school curriculum seemed to be very tightly packed with required objectives, therefore not allowing for very much deviation. The junior high curriculum, on the other hand, appeared to be less crowded, thereby giving the teachers the opportunity to be innovative if they so desire. Finally, it was discovered that the vignettes were not the short activities that were originally envisioned. Most take up an entire class period, with several extending over several classes. Thus finding a curriculum with flexible time commitments became more important for future pilots.

The need for some teacher training for even the non-technical, intuitive aspects of statistical reasoning became clear after conversations with teachers and classroom observations. Given the extent of misconceptions held by most lay people (Kahneman, Slovic, and Tversky 1982), it would not be unreasonable to assume that an English teacher, even with the best of intentions, might have some misconceptions about statistical issues. In order to prevent perpetuating misconceptions, some training would need to be considered to help teachers "fine-tune" their vocabulary and address any other issues about needed understandings. It should be noted that this is a discussion of how a teacher thinks about the subject matter, not the techniques for teaching it. Most teacher training has been concerned with the repertoire of teaching strategies a teacher uses (PRISM, The Underachieving Curriculum, etc.). While this is certainly valuable, Thompson (1984) and Silver (1984) both noted the importance of being concerned with the conceptual systems of all parties involved. Teachers are not passive deliverers of dictated curricular materials (Thompson, 1984). Their conceptions influence their perception of any situation and the range of actions they are willing to consider.

#### Evaluation

Evaluation of student learning is a problem because of the difficulty of finding a reasonable measure to demonstrate evidence of higher order thinking. NAEP has developed some open ended items for their literacy assessment. A few examples have been circulated. However more complete sets of sample problems are not yet available and may not be for some time because of the difficulty in developing items (O'Connor, 1987, Note 5). These problems would be worth investigating whenever they are released in light of the expanded definition of literacy noted earlier (NAEP, 1987). A multiple choice questionnaire that dealt with examples of ambiguous information, faulty cause and effect chains, irrelevant information, etc., was

developed by the project staff. It was administered to the junior high pilot by dividing the test in half and giving the first half before any presentation of the statistical materials, with the second given after the sessions were completed. A more thoughtful selection of answers seemed to appear on the second day. The possibility that this group was a little less impulsive after its first experience would be worth exploring. However, even if a change was measured after one or two vignettes, there would be no way of knowing if it was sustained without investigating the students over a period of time. One method of assessment might involve the observation of video tapes of the same class throughout the year. It might be possible to observe an evolution of better question asking and less impulsive answering. Such evidence had been used by Worsham (1986) to indicate the existence of higher level thinking. Access to a class over a longer period of time than originally considered when this project was first conceived would be needed in order to do this.

#### Conclusion

After examining, demonstrating, and evaluating, the concept of encouraging English studies teachers to include basic, intuitive statistical concepts in their classrooms was found to be feasible for student learning. Future investigations need to be conducted on several fronts in order to make this concept a reality for the classroom:

1. More piloting of the vignettes in various settings with different levels of students needs to be done to aid in the refinement of the vignettes as well as to increase understanding of the needs of the various audiences.
2. An investigation of the possibility of using the vignettes as part of a course for gifted junior high students as an alternative to acceleration could prove fruitful.
3. At the high school, because of the tight curriculum, investigation of the possibility of developing a separate course composed of vignette type problems under the rubric of problem solving, literacy as defined by NAEP (1987), or critical thinking might prove to be more feasible.
4. An investigation into the common statistical misconceptions held by teachers from all subject areas would be useful in the development of teacher training workshops.
5. Research into appropriate measures for student evaluation of learning is needed as well as the development of the instrument for the assessment.
6. Because a team structure often already exists in the junior high, investigation into methods of co-operation between English and math teachers for the purpose of introducing these vignettes could prove to be productive.
7. Working with the publishers of literature anthologies to explore the possibility of

inserting assignments of the type in the vignettes at the end of appropriate readings could be worthwhile.

8. A method must be found to ensure teacher commitment to the cross-curricular approach. Without this commitment, the requisite time to prepare and understand will not be spent.

In conclusion, the literature and limited experiences of this pilot project indicate the need and the feasibility to end the dichotomy between statistical reasoning and English studies. The vignettes, as written, represent a beginning inventory of prototypical problems that can provide meaningful learning experiences in both areas. The solid background in statistical reasoning would give students tools to be better readers and analyzers. At the same time, their improved abilities to express and explain what they have learned would enhance their mathematical understanding.

#### Reference Notes

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Appendix: Synopsis of Vignettes  
Developed for Cross-Discipline  
Statistics Education.

TITLE: The Unknown Citizen  
ACTIVITY BY: Judith Zawojewski and Jeri Nowakowski  
MATERIAL: A poem, "The Unknown Citizen" by W. H. Auden.  
STATISTICAL ISSUES: measures of central tendency, surveys, sampling, interpreting results of surveys  
LITERACY ISSUES: reading for understanding, writing effective survey questions, writing interpretations of survey results

TITLE: A Study of Time Management  
ACTIVITY BY: Judith Zawojewski and Jeri Nowakowski  
MATERIAL: A poem, "Mr. Artesian's Conscientiousness" by Ogden Nash.  
STATISTICAL ISSUES: estimating, measures of central tendency, units of measure, circle graphs, practicality of information  
LITERACY ISSUES: reading, interpreting, applying concepts to real life

TITLE: Cause and Effect  
ACTIVITY BY: Eunice Goldberg  
MATERIAL: Newspaper articles from the New York Times ("If you understand pizza, you understand subway fares"), the Chicago Tribune ("Dear Abby") and a short story, "The Monkey's Paw" by W. W. Jacobs.  
STATISTICAL ISSUES: faulty cause and effect chains, correlation, coincidence  
LITERACY ISSUES: reading, interpreting, evaluating arguments, extending arguments to consider alternate interpretations of events

TITLE: Romeo and Juliet: Fate, Chance, or Choice?  
ACTIVITY BY: Judith Zawojewski and Jeri Nowakowski  
MATERIAL: "Romeo and Juliet" by William Shakespeare  
STATISTICAL ISSUES: probability of outcomes, altering probabilities, probability trees  
LITERACY ISSUES: reading, understanding possible implications from alterations in plot, expressing changes with the use of charts and words

TITLE: The Death Penalty  
ACTIVITY BY: Eunice Goldberg  
MATERIAL: Newspaper articles from the New York Times: two letters to the editor expressing opposing views, using the same numbers to support their arguments.  
STATISTICAL ISSUES: ambiguities, insufficient information, reliability, definition of terms  
LITERACY ISSUES: reading, evaluating arguments, writing a statement defining the problem, clarifying issues, noting alternative interpretations, recognizing the need for more and better information

TITLE: "The Lady or the Tiger"  
ACTIVITY BY: Judith Zawojewski and Jeri Nowakowski  
MATERIAL: A short story "The Lady or the Tiger" by Frank Stockton  
STATISTICAL ISSUES: certainty vs. uncertainty, simple probability, conditional probability  
LITERACY ISSUES: reading, reasoning and analyzing beyond the material presented in the story

TITLE: Risk to Health  
ACTIVITY BY: Eunice Goldberg  
MATERIAL: Newspaper article from the Chicago Tribune, "Knowing the odds may lessen the risk" with supporting charts

STATISTICAL ISSUES: interpreting charts, graphing, units of measure, resolving contradictory information, probability, reliability, risk, central tendency, reasonableness of numbers, meaningful representations

LITERACY ISSUES: reading, obtaining meaning from several sources, writing information gleaned from charts, writing about flawed information, evaluating, recognizing, and describing needed information

TITLE: Starting a Cookie Company

ACTIVITY BY: Eunice Goldberg

MATERIAL: recipe, newspaper ads, personal experience

STATISTICAL ISSUES: components of cost, price setting, target markets, time, finding meaning in data from different sources, budgeting, etc.

LITERACY ISSUES: reading, interpreting generated information and expressing it in a useful manner, consolidating meaning from several sources

TITLE: Estimating Phone Bills

ACTIVITY BY: Eunice Goldberg

MATERIAL: Cost analysis data supplied by the phone company. Compares present bills with what they would have been under the new price structure for a four month period.

STATISTICAL ISSUES: central tendency, sample size, reading data from tables, constructing charts

LITERACY ISSUES: ability to read and interpret information, write reasoned conclusions

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