BUILDING THE NUMERACY SKILLS OF UNDERGRADUATE AND ELEMENTARY STUDENTS

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This paper will describe a project designed to enhance the numeracy skills of students at two educational levels – elementary and undergraduate. Under the guidance of the university students, students in grades four through six will formulate a research question, gather the appropriate data and summarize the data using graphs. The graphs along with a written summary of the project will be displayed in a poster, which will be sent to the national poster competition sponsored by the American Statistical Association.

Out there, in the streets that we travel, in the offices where we work, and in the newspapers we read and the television programs we watch await forces that would mislead and misinform us, exploiting the enormous public confusion over subjects like percentages, averages, fractions, compounding, and other basic mathematical ideas. This situation has no parallel in illiteracy. Literacy, after all, concerns a translation skill – learning to move easily between written and spoken speech. Numeracy concerns thought itself. You might exploit people's innumeracy through an advertisement, for example, making a claim that seems to be valid but isn't. But how would you exploit their illiteracy through an ad they can't read? (Dewdney 1993, p.2)

The Age of Information has the potential to drown us in a sea of numbers. Johnny's proficiency score is at the 94th percentile. Should a tutor be sought? The experimental drug for your grandmother's illness has a cure rate of more than 50 percent. Can we breathe a sigh of relief? Does it matter that the clinical trials for the drug consisted of men only? The graph in the newspaper shows a decline in the rate of growth in income for physicians. Should the reader be concerned that the time periods portrayed throughout the graph aren't equal? The television commercial tells us that children who eat breakfast earn better grades. Is it prudent to use the excess amount in social security to sponsor breakfast programs? The quality of our personal, professional and community lives depend on our ability to interpret and understand data presented to us in everyday situations. Not only are we tied to data; we are tied to the data-handling machines, computers.

Noss (1998) provides several examples of people relegated to being an "appendage" to their computers. Bank transactions, student records, even grocery shopping are handled by computers with the "humans" merely supplying the necessary input. Although people are "using mathematics to an unprecedented degree, it is hidden in the chips of {the} computer terminal…this mathematics is completely invisible…" (Noss 1998, p.4). Should the computer's algorithms be inappropriate for a situation, the person is at a loss. In order to elevate the human components of this relationship to the functioning level of the computer, people need more than a "consumer-level" education.

The need for this training was documented by the National Center for Higher Education Management Systems (NCHEMS). Through its involvement with business leaders and policymakers, the center is able to keep a pulse on the desired skills and competencies of the labor force. The feedback indicates that citizens need to "acquire a basic understanding of such concepts as sampling, variation, and significant difference" (Ewell 2001,p.48).

Without these skills, this comfort with data, the workforce faces several hurdles. A sample of people born in 1958 has been the focus of a longitudinal study, the National Child Development Study (Bynner & Parsons, 1997). The literacy and numeracy skills of a subset of the original sample were tested when these people reached 37 years old. While the overall performance of the group was appreciatively lower with respect to numeracy skills, the people themselves did not recognize this deficiency. However, the results of poor numeracy skills were felt in the workplace. "We find that numeracy deficits appear to be a significantly bigger problem than literacy deficits" (Bynner & Parsons 1997). When compared to literacy deficits, the lack of

numeracy skills appeared to be a bigger factor in the inability to maintain employment, the preponderance of workers in manual occupations, the lack of opportunity for work-based training, and the earning of low wages. In fact, the opportunity for promotion was the only aspect of the workforce environment where literacy skills seemed to be a more determining factor than numeracy skills.

So, what are numeracy skills? Since numeracy skills evolve from the needs of society, a definition of these skills is fluid. As the needs of society change, the skills to interact with that society necessarily change. In fact, the Quantitative Literacy Design Team wrote in *Mathematics and Democracy : The Case for Quantitative Literacy*, "Quantitative literacy is more a habit of mind, an approach to problems that employs and enhances both statistics and mathematics" (Quantitative Literacy Design Team 2001, p.5).

In an attempt to shed light on the components of numeracy, Steen describes five kinds of numeracy: practical, civic, professional, leisure, and cultural (Steen, 1990). Practical applications of numeracy skills are everywhere. Interest rates are a facet of everyone's existence. With the goal of being debt free, some folks would rather use extra money to pay off an 8% mortgage than to consider an investment with a 10% rate of return. Other examples of practical uses for numeracy include: an educated skepticism regarding advertisements, an understanding of standardized tests results, the ability to recognize the valid information obtained on the Internet, and the ability to interpret data presented in tabled form.

The interpretation and understanding of community issues rely on civic numeracy. Historically, a select group of property owners made the nation's decisions. As information began to be disseminated, additional people earned voices. With the vast amount of information currently available to us, we need to be able to assimilate that information to make educated decisions regarding tax issues, health care issues, drug testing, etc.

Specific examples of professional numeracy are, by nature, tied to specific occupations. As corporations replace "Mom and Pop" stores, the relationship between data interpretation and the maintaining of a competitive edge becomes increasingly apparent. The ability to forecast sales demand in order to properly monitor inventories and work schedules become necessary.

Educators who collect data from proficiency tests are employing professional numeracy. The percent of the local elementary students who score at the 75^{th} percentile on the proficiency test becomes an important number for curricular decisions.

Steen's categories of leisure and cultural numeracy refer to the mere pleasure of mathematics. Games of strategy and the patterns of math are included in these categories.

In order for future citizens to take advantage of the deluge of data, students need to be exposed to numeracy skills. As stated by Hughes-Hallet (2001, p.93-94), "A careful study likely would show some correlation between mathematical achievement and quantitative literacy because some mathematical skills are a necessary part of quantitative literacy. But there are many examples of students with sophisticated mathematics course work in their backgrounds who possess minimal quantitative literacy."

Although courses in mathematics build the foundation for numeracy, students need additional opportunities to interact with real data. This is similar to the process of becoming literate. A person can distinguish an adverb from an adjective. Even though that mastery helps to build a foundation for literacy, that skill or a combination of such skills doesn't define a literate person. One has to be given the opportunity to understand nuances and interpret the meaning of language to be literate. In a similar manner, a person becomes numerate. The person must be immersed in situations where data are encountered and interpreted; students need to be provided with opportunities to hypothesize, collect data, and evaluate that data.

This is the philosophy behind the sponsorship of the Statistics Poster Competition by the Center for Statistics Education and the Section on Statistical Graphics of the American Statistical Association. The event encourages students in grades K-12 in the United States and Canada to interact with data. Students are encouraged to formulate a question, collect the relevant data and display the summary of that data on a poster. The poster is then submitted to the national competition.

The purpose of this paper is to describe an activity designed to enhance the numeracy skills of students at two levels of educational achievement – elementary students in grades four through six and undergraduate students at Ohio University.

PARTICIPANTS

Students enrolled in an introductory sophomore level, statistics class at Ohio University (Quantitative Business Analysis) will be given the opportunity to participate in the study. Students will be chosen based upon their desire to participate and a minimum grade point average of 3.3. All elementary students in grades four through six will be invited to participate in the numeracy activity.

METHOD

During the ten-week program, the university students will assist the elementary students in conducting a research project. The elementary students will formulate a question, gather the appropriate data, and summarize the data using Excel. They will present their findings using a Power Point presentation.

For example, suppose the students want to know their fellow students' procedure for eating an Oreo cookie. Do they twist the cookie and eat the middle first? The "student researchers" would gather the data by actually watching students eat an Oreo cookie and recording the results. The data would then be summarized using graphs created by Excel. The graphs, along with a written description of their research, would be used to construct a poster. In addition, the students would create a Power Point presentation to explain their results to parents and teachers in an evening assembly.

As part of the project, the elementary students will create a poster displaying their results. This poster will be entered into the Statistics Poster Contest sponsored by the Center for Statistics Education and the Section on Statistical Graphics of the American Statistical Association. A team of experts representing the American Statistical Association evaluates the entries to this national competition.

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