

Mathematics and Democracy – Student Reflections on the Case for Quantitative Literacy

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1 Hopes and Goals

One of the wonderful pluses in being at Xavier is that there is no lack of opportunity for growth – expansion outside one’s discipline and comfort zone is a process that continues on. I came into the Ignatian Mentoring Program (IMP) bringing with me my own (limited) expertise in my chosen field of study, with the goal of getting a broader general view from interactions and discussions with colleagues who bring with them their own expertise in their respective disciplines. The hope then is that this widened perspective might translate to a more informed instructorship and a more effective teaching and learning environment in the classroom.

I had always been curious about what output I might have at the end of participation in one of the mission-centered programs of the university. My goal in this IMP participation was to achieve greater awareness of the Jesuit mission of the university, and indeed to find out how I might contribute to this mission as I run my mathematics classes. I have learned a lot from the readings and other resources on Jesuit education and Ignatian pedagogy, but the most learning came from the sharing and discussion with others of their own experiences in incorporating the mission in their classes.

My meetings and discussions with my mentor Thomas Wagner have been invaluable. As a mathematician my classroom goals have mostly focused on “*The Math*”. However Thomas has given me a lot of good insight on how I might be able to reach students who may not be as excited as I am about the exquisiteness(!) of mathematics. For example, during his visit in one of my MATH 150 classes he noted how my illustration of a quadratic function as a model of the number of vehicles parked in a parking lot as a function of the time of day might be improved to something more tangible (or maybe more realistic?).

Although this article focuses on describing the outcomes of a paper requirement for my MATH 150 Honors class in Fall 2012, the broader outcome of my own IMP mentoring this past year goes far and beyond this particular class project.

2 Paper Requirement for Math 150-07H

*“Jesuit Education and Ignatian Pedagogy values the five educational principles comprising the Ignatian pedagogical paradigm: **context** [understanding student life and culture], **experience** [providing intellectual and affective learning opportunities], **reflection of meaning** for self and others, **action** [the external expression of learned content] and **evaluation** of student growth.”*

<http://www.xavier.edu/jesuitresource/>

The goal is to embody these principles in every course that I teach. In particular, I put focus on my MATH 150 course, and as a class project I had my students perform a close look and reflection on a topic that is intimately connected to mathematics – the problem of quantitative illiteracy in today’s society.

MATH 150 is an *informal* introduction to *Calculus*, the mathematics used to describe the process of change. This course is designed for a general audience and fulfills a core mathematics requirement. In this course, a three-fold development of calculus (numerical, graphical and algebraic) replaces the traditional (purely algebraic) approach. Strong emphasis is placed on clearly communicating questions and interpretations of the results obtained, and to provide logical and convincing arguments for the results.

The students in my MATH 150 Honors class in Fall 2012 were given required readings on a collection of essays from *Mathematics and Democracy: The Case for Quantitative Literacy*. This volume, which came out more than a decade ago, consisted of writings and reflections by a variety of professionals both inside and outside of mathematics. These essays address the issue of the disconnect between the mathematics taught in schools and the mathematics that is needed for a citizen to be a functioning member of society. The students were asked to write a paper in response to a list of questions about quantitative literacy. The result was some very thoughtful and enlightening student essays on the subject. Excerpts from these essays are given in Section 3.

2.1 Paper Guidelines

Math 150-07H Fall 2012

Paper Guidelines

Mathematics and Democracy: The Case for Quantitative Literacy

Source: Steen, Lynn Arthur, executive editor, 2001. *Mathematics and Democracy: The Case for Quantitative Literacy*, Princeton, NJ: National Council on Education and the Disciplines. Available at www.maa.org/ql/mathanddemocracy.html.

Read at least the first five essays in this collection, then formulate your paper as a response to the following questions.

1. What does it mean to be quantitatively literate?
2. Why is it important for society to strive towards a quantitatively literate population?
3. According to the authors, mastery of school mathematics concepts does not necessarily imply quantitative literacy. Give some of the evidences that were cited to support this claim.
4. To conclude your paper, give some of your own reflections on quantitative literacy and give your own opinions about the arguments presented in these writings.

3 Student Reflections

The following are excerpts from the papers that the students have written.

3.1 On the meaning of quantitative literacy

“It is clear that “quantitative literacy” means different things to different people. However, a working definition of any type of literacy must evolve with the times. For example, literacy as it was defined in the 1800s would be very different from literacy as it is defined today because of new developments in almost every area of life. If changes in society are not accounted for, a standard for literacy would soon be out of date and inapplicable.

A better term for quantitative literacy may be “numeracy,” which implies a comfort and confidence with communicating using numbers. Numeracy is described as a “habit of mind,” or a way of

looking at situations that come up in everyday life. Numeracy is different from mathematics in that it cannot be separated from context nor taught apart from its real-world applications. In fact, the word numeracy itself refers to an understanding of the most commonly encountered real-world applications of quantitative reasoning. **Quantitative literacy, or numeracy, is “rooted in the connection between mathematics and reason.”** ”

3.2 On the importance of a quantitatively literate population

“In a democracy that stresses independence and free thought, a quantitatively literate population is essential. Today, data is easier to gather and more accessible than ever, and our society is flooded with quantitative information. From advertisements to politics to news stories, we are constantly bombarded with figures. In this type of environment, a quantitatively illiterate person is at a decided disadvantage.

For example, an American citizen could not make informed decisions on how to vote on tax policies, entitlement programs, or health care if he or she cannot interpret the graphs and statistics provided in support of and in opposition to these measures. Also, jobs are becoming increasingly competitive and employers are looking to hire candidates with a solid background in data analysis and interpretation. In this type of job market, the odds are clearly against the quantitatively illiterate person. Furthermore, quantitatively illiterate persons in America experience a profound lack of social power because they lack the skills to “think for themselves,” “ask intelligent questions,” and “confront authority confidently.” **In a democracy such as our own, it is important that no one group becomes marginalized, and any group that lacks the aforementioned quantitative skills would face a much greater risk of marginalization.”**

“Leaders – government officials, scientific experts, health agencies, and media organizations – all use statistics to educate, persuade, and control the public. Without quantitative literacy and an understanding of how to analyze numbers and their context, people are left without the confidence or the ability to question or confront these authority figures... **If we cannot understand numbers, we are relinquishing our control to those who can and allowing them to exercise that control over us.”**

3.3 On school mathematics versus quantitative literacy

“Quantitative literacy is much different than statistics and mathematics. It is an empowering tool that moves away from the uncertainty and abstract nature of mathematics into a certainty rooted in real data and real situations. **While mathematics teaches skills that are typically associated with success in the educational world, quantitative literacy involves tools that allow success in life.”**

“Mastery of school mathematics does not necessarily mean quantitative literacy. Quantitative literacy is an extension of subjects in understanding. Numerate students are created by using mathematics in everything they do. Quantitative students are created by learning that “content is inseparable from pedagogy and context is inseparable from content,” and applying it to their everyday life and professions... **Quantitative literacy is not isolated to one subject; instead, it is about applying all the information learned from different subjects and applying them to one’s life. Quantitative literacy expands from numeracy and reason.”**

3.4 Further reflections

“Reading these chapters really opened my eyes to the issues that the United States faces. I agree with the authors of the chapters that quantitative literacy is important and needs to be taught in schools. It was not until this class that I actually began to catch a glimpse of how math is actually important to everyday life and how it can be applied to certain situations... I have never been interested in numbers and have never understood how the math I was doing in high school would

ever be used when I was older... **Throughout high school and middle school I always excelled in math. I memorized the formulas and did well on the test. After the test the information left my head as quickly as I had learned it."**

"Although I still do not see any clear-cut solution to the problem of quantitative illiteracy, I certainly can identify with feeling quantitatively illiterate. Even before reading "Math and Democracy," I knew that I am probably innumerate in quite a few ways. **I can watch a math problem be solved in front of me and then spit it out back on a test, but when it comes to looking at a situation and figuring out how to use math to solve the problem, I end up confused and frustrated every time. "**

"**I was never shown the importance of quantitative literacy**, and thus should not be expected to recognize that importance on my own. I assume that many other students, like myself, also lacked education that stressed this literacy, which explains why there is a lack of public concern for innumeracy, unlike the large concern for illiteracy; we are taught the importance of reading and writing at an early age."

"**I do not believe that quantitative literacy should be improved in the classroom** despite the fact that countless acts of legislation has put priority on science and mathematics. It is unfair to subject the majority of the populace to advanced courses for the needs of a few. Furthermore, as technology continues to advance and quantitative literacy is needed, technology can act as a simplifying aspect, instead of becoming quantitatively literate, technology can act as a translator in order to understand the world around us, instead of individuals being forced to become quantitatively literate."

"As a student who was taught the same "school mathematics" that Schoenfeld experienced during high school, I am new to the concept of quantitative literacy. I have always seen mathematics as a discipline that did not apply to me... required mathematics were frustrating and seemed unnecessary. However, **after reading these articles I am actually embarrassed by my lack of interest or concern with skills that affect my everyday life."**

"While arguments could arise exponentially for the various sides of quantitative literacy, and I do see benefits of advocating for greater stress of it study, I think there is a broader idea to approach society's intellect from. As far as I have observed in my life thus far, as a student and American citizen, I believe our society is becoming lazy. One characteristic of laziness is exhibited by people's lack of analytic skills and hands-on problem solving with data, as discussed with this case study. But another aspect is people's seemingly lack of interest in anything that has to do with their minds instead of having a computer do it for them... For these reasons, **I believe a greater emphasis needs to be put on "thinking" in general.** Yes, much of that thought is numeracy, but I see its growth in conjunction with philosophical and scientific thinking growth."

4 Conclusion

Overall I am happy with the papers that the students have produced. It is encouraging to see from the writings (and subsequent class discussions) how the students' viewpoints about their own mathematics education (and education in general) have been affected by the readings from *Mathematics and Democracy*. It is interesting how the subject of grades has come up in these papers, and that good grades, even excellent grades, do not ultimately translate to true learning. I found the student essays to be very enlightening and these will certainly guide me in the years to come in my capacity as mathematics educator. My hope is that these too have contributed to the students' growth and that these have truly reflected the five principles of Jesuit education and Ignatian pedagogy mentioned at the beginning of section 2: context, experience, reflection of meaning for self and others, action, and evaluation of student growth.