American Honda Foundation
UNM Grant Proposal: Statistical Literacy

1. Proposed Project:
Funding the first confounder-based statistical literacy course offered by a major university.

2. Description: The goal of the course is to help students understand and evaluate the statistics they encounter in the everyday media: to see the story behind the story. The goal of the grant is to fund the delivery and assessment of this course at the University of New Mexico and at two other colleges.

2A. Executive Summary:

A civilized society is a peaceful society: a society where citizens argue with words rather than with force or threat of force. In today's civilized societies, most arguments involve social statistics. These statistics are typically dismissed in a traditional statistics course by saying "Association is not causation." But most of our knowledge starts by observing an association. Educated citizens and decision-makers need a broader course – a modern course focused on social statistics. A course that will help them evaluate everyday statistics so they can make better personal, business and social decisions.

This project proposes a large-scale test of a new course focused on statistical literacy: critical thinking about statistics as evidence in arguments. This course focuses on "Seeing the story behind the story." This grant will be used to trial this new course at the UNM ABQ and at two other colleges. Some of the sections at UNM will be taught by teaching assistants who have no prior background in this area. The results of this trial will be assessed and the results will be disseminated at a national conference. The goal is to produce future citizens who can raise the quality of questions and arguments that involve statistics as evidence – and hopefully improve the quality of political and social debate worldwide.

2B. Course Elements and Activities:

This course is a confounder-based statistical literacy course. Confounders are factors that are found with (tangled up with) an association. For example, city hospitals typically have a higher patient death-rate than rural hospitals. This disparity may indicate an incompetent administration or staff. But it may be due to a difference in the mix of patients. City hospitals tend to have a higher proportion of patients in poor condition than do rural hospitals. The original disparity is a mixed-fruit comparison. We need to compare city and rural hospitals on the same mix of patients for an apples and apples comparison.

Hypothetical thinking: This is a key element in this critical thinking course. How groups could have been formed, how measurements could have been made, how the observed results might be influenced by confounders (unmeasured or measured but not included).

Precise use of ordinary English with guidelines. This course uses ordinary English to distinguish association from causation (Eating nuts cuts cancer risk), to form arithmetic comparisons (three times as much as versus three times more than), to form ratios (30% of college students are business majors versus the percentage of business majors among college students is 30%), and to form comparisons of these ratios (accounting majors are more 20% more likely to be female than are management majors). This grammar indicates what was taken into account in forming the statistic.

A medical test with 99% accuracy does not mean that "99% of those that test positive have the disease". It means "99% of those with the disease test positive". Accuracy in confirmation is not the same as accuracy in prediction. Understanding the confusion of the inverse is a major part of this course.

Statistical significance is introduced via a lack of overlap in confidence intervals. In observational studies, students see how taking into account a third factor can transform a statistically-significant

association into one that is statistically insignificant – and vice versa. Students do this using simple proportional reasoning. This result that is not taught in any other introductory statistics course.

Courses that stress critical thinking are much harder to teach than courses that focus on calculation. A major goal of this project is to develop, test and disseminate good teacher-training materials.

3. General Long Term Goals:

To help students

- read, interpret and evaluate the statistics in statements, tables and graphs
- read, interpret and evaluate the statistics in news stories, press releases and journal articles
- become sensitive to the various kinds of influence on a social statistic
- think hypothetically about how a statistic might have been constructed or influenced
- appreciate the need and the value of being educated in each of the above activities

To help math-stat teachers:

- get better at teaching statistical sensitivity to a variety of influences
- teach critical thinking involving statistics and strength of evidence
- see that confounding is more important for most students than randomness
- see value in teaching confounder-based statistical literacy

4. Data Collection and Evaluation

This project will collect student data from student exercises: multiple choice exercises, one-line descriptions and comparisons of statistics, critiques of news stories. It will use a nationally validated SATS assessment to compare students' attitudes before and after taking this course. In traditional statistics courses, students see less value in the subject after taking the course than they did before. This project will also collect data from those teaching this course. This data will be disseminated at a national conference and published in a peer-reviewed journal.

5. Plan for growth

This new course will be piloted at UNM in a few sections during the first year. It would be expanded in future years depending on the feedback from the teachers, and the buy-in from other departments at the university. At this point the ABQ campus of the UNM offers some 20 sections of introductory statistics with 40-50 students per section. The long-term goal would be to convert most of these sections to statistical literacy. We would expect some majors to continue requiring traditional statistical inference. We expect that many others will to allow their students to choose between statistical literacy and traditional statistical inference. Once this project has been successful at the UNM main campus, it could be extended to the branch campuses. Based on the experience at other colleges, the course will be in a good position to be adopted by a wide variety of colleges and universities throughout the US. Achieving this goal would mark one of the most important changes in higher education in decades.

6. Description of communities served by this program and benefits to those communities

Two communities of students are served by this program: ESL students in particular and all students in general as citizens, personal decision makers and future social leaders.

ESL students need guidelines on how to use ordinary English to form and critique arguments using statistics as evidence. Traditional statistics is formula based (algebra); this course is language based

(ordinary English). This course provides guidelines for ESL students and for native speakers that are not accustomed to using ordinary English with such precision.

All students will be faced with social problems, health solutions and environmental issues. Many – if not most – of these will involve statistical data. In each case, reading, interpreting and evaluating the associated statistics is essential in order to make good decisions as individuals, social leaders and citizens. Being able to read, interpret and evaluate social statistics should raise the level of discourse and result in arguments that may be more socially productive.

7. How does this project match the five 'soft' characteristics identified by Honda?

- Creative. This course uses a textbook that is extremely creative. It focuses more on Wired Magazine (Oct 2010) named statistical literacy as the most important course students should have taken in college. "Statistical literacy has risen to the top of my advocacy list, right alongside numeracy, and perhaps even ahead of 'algebra for all'." M.Shaughnessy, NCTM President.
- Innovative: it involves hypothetical thinking. Hypothetical thinking is a new method of thinking. How might a group or measurement have been defined? What might have been taken into account?
- Youthful: Today's youth get information from a wide variety of sources. Detecting fake news is a skill they need to navigate the deep waters of misinformation. This course gives some characteristics of fake news that students can readily identify.
- Forward thinking: Today's students want everything to be web accessible. This course has been taught in both a hybrid and online modes.
- Imaginative: Using math-stat teachers to teach critical thinking about numbers is certainly imaginative. These teachers may not want to teach statistical literacy, but they can see the need and value. They need help and training. This course will develop and evaluate useful methods.

8. How does this project address Honda's other priorities?

- Funding Priority: (1) Youth education (2) STEM focus, (3) Literacy: This is a college course offered by a Math-Stat department with a literacy focus. Literacy is what this course is all about.
- Youth-focused: Parts of this course can be offered at the secondary level. Schield (2008) argued this course could be an alternative to Algebra 2 for college-bound students in non-quantitative majors.
- Impact: Most college graduates take a statistics or research-methods course. If half of those who take traditional statistics would take statistical literacy instead, the impact would be huge!
- High potential for success with minimal duplication of effort. This project had initial funding of $500,000 from the W. M. Keck Foundation. The course and the associated teaching materials have been student tested extensively by the textbook author in small classes at Augsburg University. Schield (2004). This project will test this course in large classes taught by TAs without a background in this area to see if they can be successful as teachers. This course is unique. It is the only statistical literacy course that focuses on statistics in arguments, confounding and the use of ordinary English.
- Dedicated to improving the human condition of all mankind. Improving the quality of political debate – much less the quality of critical thinking – would be highly welcomed by many citizens.
- Financial and administrative soundness. The University of New Mexico has the administrative and financial controls needed. The project PI has the experience needed to manage this project.
- Relative importance to the public. The sooner this project is field-tested, the sooner it can be adopted by other colleges and universities, and the sooner students will be able to take a statistics course they see as being useful and valuable regardless of their major.

Schield, Milo (2004). Statistical Literacy and Liberal Education at Augsburg College. AAC&U Peer Review. Copy at www.statlit.org/pdf/2004SchieldAACU.pdf

Schield, Milo (2008). Quantitative Literacy and School Mathematics: Percentages and Fractions. *MAA Calculation vs Context*. Mathematical Assoc of America. www.statlit.org/pdf/2008SchieldMAA.pdf

Milo Schield
Adjunct Research Professor, UNM

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Academic History: Iowa State University (B.S. Physics); University of Illinois, Urbana (MS. Physics); Rice University (PhD. Space Physics).

Professional Experience:

- Business experience: Consultant with a national CPA firm; Sr. Operations Research Analyst with a large national property-casualty company. President of two start-up ventures.
- Academic experience: Full-time in the Dept. of Business and MIS at Augsburg University since 1985. Tenured in 1991. Full-Professor in 1998. Taught critical thinking for ten years. Taught statistics for 30 years. Taught Statistical Literacy for 20 years.

Books:

- Wiley (John Wiley & Sons) has contracted to publish my textbook: *Statistical Literacy for Decision Makers*. Final copy is due to Wiley January 2020.

Publications:

- Over 70 statistics publications. These have received over 950 citations per Google Scholar. List available at www.StatLit.org/Schield-pubs.htm

Qualification and Skills:

- Editor of www.StatLit.org: Google rated as the largest website dedicated to statistical literacy with 340,000 visits and 460,000 downloads in 2018.
- 38 talks outside the United States in 18 countries on six continents (all except Antarctica)
- Organized 16 sessions on statistical literacy at the annual meetings of the ASA.
- Past-Chair of the Department of Business Administration at Augsburg University.
- Conducted teacher training in Statistical Literacy at Palomar CC and Keene State College.

Awards and Honors

- 1998: Created first argument-based (confounder-based) Statistical Literacy course.
- 2001: Principal investigator on a $500,000 grant from the W. M. Keck Foundation "to support the development of statistical literacy as an interdisciplinary curriculum in the liberal arts".
- 2003: Named the "leading voice" of the Statistical Literacy movement by Dr. Joel Best in his book, *More Damned Lies and Statistics*.
- 2004: Invited to submit a paper, "Statistical Literacy and Liberal Education at Augsburg College", for publication in 2004 issue of the AAC&U journal: *Peer Review*.
- 2014: Named the US Representative of the International Statistical Literacy Project (ISLP)
- 2015: Elected member of the International Statistical Institute (ISI)
- 2016: Invited to give a Statistical Literacy workshop at the IASE Invited Roundtable in Berlin.
- 2017: Invited to contribute a paper to a special issue on Statistical Literacy in the *Statistics Education Research Journal* (SERJ).
- 2018: Invited to present at the International Conference on Teaching Statistics (ICOTS) in Japan.
- 2018: Named a Fellow in the American Statistical Association (ASA)
- 2019: Elected president of the National Numeracy Network (NNN)

$75,000	**Total Budget**		
$9,000	UNM Overhead	12%	Dean Peceny
$66,000	**Net after Overhead**		

Project Activities ($46k):

$6,000 Coordination and Internal Review: Dr. Erik B. Erhardt (UNM)

$6,000 TA Training: UNM ABQ (Three TAs per semester): $1,000 each

$12,000 PI travel to and housing in Albuquerque: $1,000/mo for 12 months

$22,000 External review stipend (Other schools/campuses)
- $10,000 Dr. Larry Lesser (Univ. Texas El Paso)
- $6,000 Professor Marc Isaacson (Augsburg University)
- $6,000 Augsburg offers MIS 264 during Schield's sabbatical

Dissemination: ($20k)

$9,000 Marketing Video: Statistical Literacy: An Introduction
No interaction; no flash; no database; no professional actors
- $6,000 10 minute
- $2,000 6 minute
- $1,000 3 minute

$4,000 2020 Meeting of the National Numeracy Network at Augsburg University

$4,000 2021 Meeting of the National Numeracy Network at UNM ABQ

$3,000 Instructor presentations at NNN in 2021: $500 each

$0 Net Remaining