Challenging Statistical Claims in the Media: Course and Gender Effects

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Abstract

In today's data driven world, information is readily available and easily obtained. Some of this information may be misleading or inaccurate. Statistical literacy involves critically evaluating and questioning statistics encountered in everyday life. The purpose of this study was to evaluate students' questions (challenges) concerning statistics encountered in everyday life and how these challenges differed before and after taking a course focused on statistical literacy. One hundred forty-four students were given three media articles at the beginning and end of the semester to indicate questions they had concerning statistics cited in the articles and explain why these questions were important to ask. Significant changes in the pattern of topic category responses were observed post-course for each media article, and differences in responses of topic categories by gender were also observed.

Key Words: statistical literacy, gender effects, media claims

1. Introduction

Twenty-four news channels and availability of information worldwide from the Internet have given most people access to a vast amount of information whenever they want. In spite of this, the authenticity of some of this information may be in doubt. Making informed decisions based on available information is an essential skill for success. There is a misconception, though, that if a statistic appears in print or on the news, then it must be true resulting in the mindless belief in everything that is read or heard. As statistics educators, a goal of our courses should be "…to move students from a situation where they automatically believe everything they read in the media to one where they intelligently question data and claims..." (Watson, 1997).

Statistical literacy involves the ability to critically evaluate statistics encountered in everyday life (Wallman, 1993). Being statistical literate enables one to "consume and critically digest the wealth of information being produced in today's society" (Rumsey, 2002, p.33) and involves the ability to know what questions to ask (Snell, 1999) …questions external to the data (Schield, 2004).

Although there are several models for statistical literacy found in the literature including Gal (2004), Watson (2006), and Sanchez (2007), this research was based on The Hierarchical Model (Watson, 1997) of statistical literacy. This model consists of three tiers in which one tier forms a foundation for the next. The first tier involves having a basic understanding of statistical terminology such as mean, median and variance. In the second tier, an understanding of this terminology is needed within a social context in order to make inferences concerning statistics encountered in everyday life. Tier 3

involves a higher level of statistical thinking through the development of a "questioning attitude" that predisposes one to challenge statistical claims. This idea of questioning statistical claims as being a necessary component of statistical literacy was best explained by Milo Schield in "Statistical literacy: Thinking critically about statistics:" "Statistical literacy is more about questions than answers. It doesn't have many answers, but it should help one to ask better questions and thereby make better judgments and decisions…Statistical literacy helps one answer the question asked of most statistics: 'What does this mean?'"

Since questioning challenges presented in everyday life is important for an informed citizenry, then using the media to assess questioning attitudes would be appropriate. According to Watson (1997, p. 107), "If evidence of the need for statistical literacy is found in the media, then the media is also an ideal vehicle to provide initial motivation for the study of statistics, applications of specific topics in the curriculum during instruction, and items for assessment in the final stages of learning."

Statistics in Everyday Life (SIEL), a sophomore level course at Clemson University, was developed in 2005 to promote statistical literacy in response to a University wide initiative for enhancement of general education courses. The course follows a traditional introductory statistics course topic sequence with emphasis on concepts rather than formulas.

The theoretical basis for the development of SIEL was David Ausubel's Meaningful Reception Theory which in essence says that new information is meaningful if it is affixed to prior knowledge (Ausubel, Novak & Hanesian, 1978). An advance organizer is used to form a bridge between prior and new knowledge. This organizer can take many forms such as a book, article, or video.

Based on the Meaningful Reception Theory, the course was structured such that statistical concepts were introduced within "everyday life modules." Course format including everyday life modules and statistical concepts are displayed in Table 1. Background information pertaining to each module was introduced at the beginning of each section before statistical concepts were discussed. For example, an overview of the use of statistics in advertising was presented before a lecture on statistical inference. Using this approach, the advertisement was the advance organizer. To further understand these concepts, activities for each section were conducted in a small group setting during class or assigned to be completed outside class but discussed in class. For further information on SIEL, refer to Martinez-Dawson (2010).

Table 1: A summary of statistical concepts covered in everyday life modules in SIEL (Martinez-Dawson, 2010, p.5)

Everyday Life Module	Producing Data	Basic Probability	Descriptive Statistics	Inferential Statistics
Society	X			
Government	X		X	
Survey & Polls	X		X	X
Lottery		X		
Sports		X	X	
Education	X		X	X
Liberal Arts	X		X	
Environment	X	X	X	X
Court room	X	X	X	
Advertising	X		X	X
Medicine	X		X	

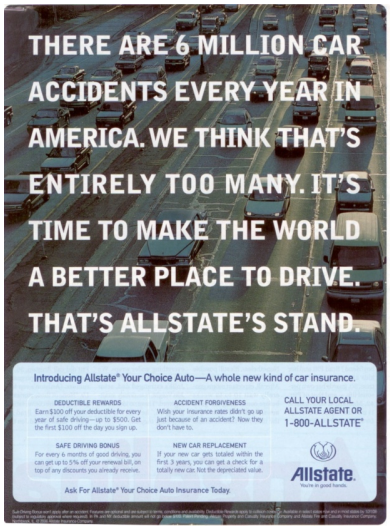
Since the goal of SIEL was to promote statistical literacy, this course provided an appropriate vehicle for this research. In order to assess the questioning attitude of statistical literacy, this research attempted to answer the overall research question: What areas of concern did students raise when viewing media that make statistical claims? In particular, were there course and gender effects? The four research questions were:

1. Before taking the course focused on statistical literacy, what topic categories were observed?
2. After taking the course focused on statistical literacy, what topic categories were observed?
3. Was there a change in topic categories observed from pre-course to post-course?
4. Were these topic categories and response patterns different for males and females?

2. Method

On the second day of class and on the final exam during the spring 2009 semester, students enrolled in SIEL were asked to provide questions concerning claims made in two advertisements and a short article and to explain why these claims were important to ask. Each student was given the media articles in a random order and this same order was used pre-course and post-course. In addition, pre-course and post-course challenges were matched by student.

The media articles were selected because they represented real-world experiences and included examples of quantitative and categorical data. This paper addresses the results from one of the advertisements which is shown in Figure 1. For results concerning the other advertisement and article, refer to Martinez-Dawson (2010). An open-ended format to obtain students' challenges was chosen over a guided approach using prompts so as to assess understanding at a higher level (Watson & Moritz, 2000).



What questions might you have concerning Allstate's claim that there are "6 million car accidents every year in America." Explain why each question is important to ask.

Figure 1: Allstate advertisement used to assess students' challenges

One hundred and forty-four students completed both the pre-course and post-course assignment with 58.33% being female and 41.67% being male. The distribution of classifications for participants included 41.67% freshmen, 36.11% sophomores, 13.89% juniors and 8.33% seniors. The average student-reported SAT score was 1246.

Since the overall research question focused on determining what challenges students made concerning statistical claims in an advertisement, students' responses were grouped based on similar topics using QSR Nvivo 8, and matrix coding resulted in an Excel file that included each student's name and the presence or absence of a response in each topic category indicated by a "1" for presence or a" 0" for absence. Students' pre-course and post-course responses were coded in this manner and matched by student.

Descriptive statistics were performed on the data and results were analyzed using Chi-square tests or Fishers exact tests and McNemar's test using the Statistical Analysis System version 9.2. Statistical significance was determined at the 5% level.

3. Results and Discussion

3.1 Course effects

Table 2 provides a summary of the five most common (based on percentages) challenges students made concerning the Allstate advertisement both prior to and after SIEL. All pre-course challenges in Table 1, except for factors affecting accidents and effect of definition of car accident on 6 million, showed an increase in percentage of students who had these challenges after SIEL. The largest percentage increase in challenges from pre-course to post-course was observed for "definition or type of accident" and "how was information obtained."

Table 2: Common pre-course and post-course challenges before and after SIEL

Pre-course challenge	Percentage	Post-course challenge	Percentage
Definition or type of accident?	58.33%	Definition or type of accident?	84.72%
Source of 6 million?	29.17%	How was information obtained?	60.42%
How was information obtained?	20.14%	Source of 6 million?	39.58%
Factors affecting accidents?	18.06%	Unreported accidents included?	30.56%
Unreported accidents included?	15.97%	Which years was study conducted?	15.28%
Effect of definition of car accident on 6 million?	15.97%	Location of accidents?	15.28%

Significant changes in response patterns after SIEL were observed for challenges listed in Table 3. Of these challenges, four were related to definition issues. Several challenges pertained to issues concerning data collection. Two statistical concepts, MOE or confidence interval and lurking variables, were also found to have a significant response pattern change after SIEL.

Table 3: Significant* response pattern changes in challenges after SIEL

Challenges with significant response pattern changes
Definition or type of accident?
How was information obtained?
MOE or confidence interval included?
Effect of definition of car accident on 6 million?
Unreported accidents included?
Definition of "car"?
Lurking variable?
"Too many" definition?
Source of 6 million?
Location of accidents?

*p-value < 0.05

3.2 Gender effects

There was a significant difference in the proportion of males and females who made challenges about correlation prior to SIEL with there being a higher proportion of females who made this challenge. After SIEL, gender effects were observed for the definition of "America" and question if could count all accidents. A higher proportion of males asked about definition of "America" while females questioned more than males if all accidents could be counted.

Significant changes in response patterns pre-course and post-course by gender were observed (Table 4). Although significant changes in response patterns were observed for both genders, females had twice as many challenges with response pattern change after SIEL in comparison to males.

Table 4: Significant* change in response pattern of challenges by sex

Both Male and Female	**Male**	**Female**
Definition or type of accident?	Definition of "America"?	Dark figure?
MOE or confidence interval?	Location of accidents?	Effect of definition of car accident on 6 million?
		How was information obtained?
		Population or population size?
		Question if could count all accidents?
		Source of 6 million?
		"Too many" definition?
		Unreported accidents included?

* p-value < 0.05

Although significant course and gender effects were observed, this observational study cannot make cause and effect conclusions. The sample in this study was non-

random which can lead to issues of bias. In addition, the results applied to students at one University and one course, and the specific media articles may have had an effect on the results. The results may have been influenced by the nature in which the results were obtained. Students were asked to express their challenges in writing and this may have created problems for those who have difficulty expressing their opinions in words. With this approach to data collection, there could be a link between literacy and statistical literacy. Since students were asked to give challenges to three media articles during a class period the results could have been affected by writing fatigue. Finally, the open ended format of data collection may have influenced the results whereas using prompts may have produced different results.

4. Conclusions and Implications of Research

After taking SIEL an increase in percentage of responses to important topic categories and significant changes in response patterns were observed. Gender differences were observed not only in the percentage of topic categories but in significant changes in response patterns of topic categories after SIEL.

The results from this study provide insight into statistical literacy of a certain group of college students. It may provide a building block for other research concerning statistical literacy and the development of courses on statistical literacy through the use of media articles and everyday life modules to promote questioning attitudes. Although there were increases in the proportion of responses regarding important challenges, it was hoped that more changes would have been observed. Based on these results, it appears that statistical literacy, like general literacy, takes time to develop and more than one course is needed. In order to have a statistically literate citizenry, statistical literacy should be integrated into education from elementary school through college in order to promote a culture of questioning.

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References

Ausubel, D.P., Novak, J.D., & Hanesian, H. (1978). *Educational Psychology: A Cognitive View* (2nd ed.). New York: Holt, Rinehart, and Winston, Inc.

Gal, I. (2004). Statistical literacy: Meanings, components, responsibilities. In D. Ben-Zvi & J. Garfield (Eds.), *The Challenge of Developing Statistical Literacy, Reasoning and Thinking* (pp.47-78). Dordrecht: Kluwer Academic Publishers.

Martinez-Dawson, R. (2010). The effects of a course on statistical literacy upon students' challenges to statistical claims made in the media. (Dissertation) Clemson University, Clemson, SC.

Rumsey, D.J. (2002) Statistical literacy as a goal for introductory statistics courses. *Journal of Statistics Education*, 10, 3 [Online] www.amstat.org/publications/jse/v10n3/rumsey2.html

Sanchez, J. (2007). Building statistical literacy assessment tools with the IASE/ISLP. Retrieved from http://www.stat.auckland.ac.nz/~iase/publications/sat07/Sanchez.pdf

Schield, M. "Statistical literacy: Thinking critically about statistics" http://www.augsburg.edu/ppages/schield

Schield, M. (2004). Statistical literacy curriculum design. *Curricular Development in Statistics Education*, 54-74.

Snell, L. (1999). Using *Chance* media to promote statistical literacy. Paper presented at the 1999 Joint Statistical Meetings, Dallas, TX.

Wallman, K.K. (1993). Enhancing statistical literacy: Enriching our society. *Journal of the American Statistical Association*, 88, 1-8.

Watson, J.M. (1997). Assessing statistical thinking using the media. In The Assessment Challenge in Statistics Education, IOS Press.

Watson, J.M. (2006). Statistical literacy-A global goal. In A.H. Schoenfeld (Ed.), *Statistical Literacy at School: Growths and Goals* (pp.247-272). Mahwah, New Jersey: Lawrence Erlbaum Associates.

Watson, J.M. & Moritz, J.B. (2000). Development of understanding of sampling for statistical literacy. *Journal of Mathematical Behavior*, 19, 109-136.