PERCEIVED USEFULNESS OF THE INTRODUCTORY STATISTICS COURSE AS A CORRELATE OF STUDENT ENGAGEMENT IN STATISTICS

Rossi A. Hassad
Mercy College, New York, USA
Rhassad@mercy.edu

Some non-academic factors, particularly perceived usefulness, are salient determinants of student success, and engagement in a discipline. This study explored the association between college students' ratings of the usefulness of an introductory statistics course, their beliefs about where statistics will be most useful, and their intentions to take another statistics course. A cross-sectional study of 106 students was conducted. The mean rating for usefulness was 4.7 (out of 7), with no significant difference by gender and age. Sixty-four percent reported that they would consider taking another statistics course, and that subgroup rated the course as more useful (p = .01). Thirty-five percent reported that statistics would be most useful for graduate school, 32% research, 14% their job, and 19% were undecided. The "undecided" students rated statistics as less useful (p = .001). Instructors should emphasize practical examples of the use of data in real-world problem-solving and decision-making. Qualitative research methods could help to elucidate these findings.

INTRODUCTION AND RATIONALE

Over the past two decades, there has been a major paradigm shift in the way teaching and learning have been conceptualized and implemented at the college-level (Hassad, 2011; Sabbag & Zieffler, 2015). This is particularly so for the traditionally difficult courses, such as introductory statistics, which are intended to engender core knowledge and skill sets. The change can be characterized as a move from the traditional, behaviorist (instructor-centered) pedagogy to a more reform-based, constructivist (student-centered) approach. In the latter, the student is considered an equal partner in the teaching and learning process, and their course-related beliefs, emotions, and intentions (generally viewed collectively as attitude) are recognized as pivotal to effective teaching and learning (Sproesser, Engel, & Kuntze, 2016). Constructivist pedagogy emphasizes the learning process, including cognitive style, the construction of meaning, and motivation for learning, which, when appropriately and effectively addressed, can facilitate deep and conceptual learning, and hence transferrable knowledge and skills.

In this regard, the introductory statistics course has garnered much attention from the statistics education reform movement, specifically in terms of adapting the curriculum to be more meaningful and practical, by incorporating active learning strategies, including the use of authentic assessments (GAISE, 2016). Moreover, there is consensus among educators that the focus of the introductory course should be to develop statistical literacy, which encompasses statistical reasoning and thinking. Statistical literacy is typically defined as: "*People's ability to interpret and critically evaluate statistical information and data-based arguments appearing in diverse media channels, and their ability to discuss their opinions regarding such statistical information*" (Gal, 2000 as cited in Rumsey, 2002, p. 2). Furthermore, statistical literacy requires an understanding of the data context (Hassad, 2013) as well as "*a feel for how to assess real-life data*" (Watkins, Scheaffer, & Cobb, 2010, p. xvii), and hence a particular mindset or attitude.

Students' attitude toward statistics is well-established as a predictor of academic success (Schau & Emmioglu, 2012). The Survey of Attitudes Toward Statistics (SATS) is considered the foremost instrument for measuring student attitude (Gundlach et al., 2015), and it possesses very good psychometric (reliability and validity) properties. Moreover, this scale has shown that attitude can account for about 14 percent of the variance in student achievement (Nolan et al., 2012), implying that albeit attitude might be necessary, it is not sufficient to explain the variance in student success. While there is much variability in how attitude is conceptualized, operationalized, and interpreted, a salient and consistent component, in this context, is students' perceived value or usefulness of statistics (Nolan

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et al., 2012), which underpins motivation to learn and apply the knowledge and skills acquired, as well as pursue further studies in statistics. And the limited published research shows a tendency for students to be disinclined to use statistics in the field they hope to be employed, or to take another statistics course (Ramirez & Bond, 2014), which can be counterproductive to individual academic and professional achievement, and advancement of the discipline of statistics. The related research in statistics education has focused almost exclusively on the role of attitude in explaining and predicting academic learning outcomes, hence there is a paucity of research evidence on how attitude (particularly perceived usefulness) impacts students' decision-making to use, and stay engaged in statistics beyond the introductory course.

THEORETICAL AND CONCEPTUAL FRAMEWORK

The expectancy-value theory (Wigfield, Tonks, & Eccles, 2004), and the self-determination theory (Ryan & Deci, 2000) are conceptual models that provide insight into the role of beliefs, emotions, and attitude in the motivational underpinning of learning. Specifically, the expectancy-value theory posits that students' expectancies or beliefs regarding usefulness of the course and their likelihood of being successful will determine how much value or importance they attribute to the course, their interest in the material, and the extent to which they engage in the discipline. As well, with reference to the self-determination theory, perceived competence or self-efficacy (the belief in one's capability to be successful) is a key determinant of motivation to learn. Together, these models can help to explain and predict the quality of learning outcomes, and the likelihood that students will use and expand the knowledge and skills acquired from the introductory course. As noted by Schau and Emmioglu (2012, p. 92) "*students will not employ statistics in life, in their work, or in other courses unless they believe it is useful. They will use statistics only if they believe that they can do statistics"*. For the purpose of this paper, perceived usefulness (represented by a rating) refers to beliefs about the benefits, relevance, and value of statistics in personal and professional life.

OBJECTIVE

This study explored the association between college students' ratings of the usefulness of an introductory statistics course, their beliefs about where statistics will be most useful, and their intentions to take another statistics course. Variability was examined with respect to age and gender.

METHODOLOGY

This cross-sectional study was conducted by administering a brief in-class questionnaire to 106 undergraduate students from the humanities and behavioral sciences, including psychology. The students came from three different Colleges, and were taught by the same instructor in the Fall 2016 semester. The questionnaire was administered to all students at the end of the introductory statistics course, and before the final examination, and ascertained the following in addition to age and gender: (1) *How would you rate the usefulness of this course*? (2) *Where do you believe the statistics knowledge and skills acquired from this course will be most useful*? (3) *Would you consider taking another statistics course*? A single-item measure (with a 7-point response scale) was used for a global rating of the usefulness of the course.

The introductory statistics course was designed and administered in accordance with the American Statistical Association Guidelines for Assessment and Instruction in Statistics Education (GAISE, 2016). The course material encompasses common statistical methods and their applications within the disciplines, and covers (in this sequence) descriptive and inferential statistics; including types of data, levels of measurement, frequency distributions, graphs, measures of central tendency, measures of variability, cross-tabulation, sampling, z-score and the normal distribution, as well as tests of hypothesis such as: t-tests, ANOVA, linear correlation and regression, and chi-square. Effect size, study designs (observational and experimental) and research concepts (including association, causation, confounding, and interaction) are also addressed, and the IBM-SPSS software is used for data analysis. While the mathematical underpinning of each statistical method is addressed, the course emphasizes

concepts over calculations, and characterizes statistics as a language, with a focus on telling the story of the data by way of oral presentations and written narratives. Critiquing of quantitative research articles is also included, and in order to further demonstrate the integration and application of knowledge and skills, students are required to complete a small-group project in which they explore and analyze primary or secondary data, and submit a structured written report.

Data entry and analysis for this study were conducted using SPSS version 24, and both descriptive and inferential statistical analyses were performed. Specifically, the independent samples t-test and one-way ANOVA (with post-hoc analysis and Bonferroni correction), and an alpha level of .05 were used to check for subgroup differences regarding the ratings of usefulness. Consistent with ethical guidelines, the analysis was limited to the combined sample, so as to protect the identity of the institutions.

RESULTS

The sample (N = 106) was predominantly female (80%) and younger, with 90% being 18-25 years of age, consistent with the demographic trend in the general college population in the USA. The mean rating for usefulness of the introductory statistics course was 4.7 on a 7-point scale where higher scores are more favorable (Table 2), with no statistically significant difference based on gender and age. Sixty-four percent reported "yes" to whether they would consider taking another statistics course (Table 1), and that group was more likely than those who reported "no", to rate the statistics course as more useful (Table 3). Regarding the areas in which students believed that statistics will be most useful (Table 1), almost equal proportions reported research (32%) and graduate school (35%), whereas 14% indicated their job, and 19% were undecided. The "undecided" students had the lowest rating for usefulness of the statistics course, which was significantly different from the ratings for the other response categories (Table 2).

Table 1: Percent response to survey questions (N = 106)

Where do you believe statistics will be most useful?		**Would you consider taking another statistics course?**	
Response	**n (%)**	**Response**	**n (%)**
Graduate School	37 (35)	Yes	68 (64)
My Job	15 (14)	No	38 (36)
Research	34 (32)		
Undecided	20 (19)		

Table 2: Comparison of students' rating of the usefulness of the introductory statistics course by their response to where statistics will be most useful (N = 106)

Where do you believe statistics will be most useful?	**Rating of the usefulness of the statistics course**		
	n	**Mean***	**SD**
Graduate School	37	5.08	1.26
My Job	15	5.13	1.19
Research	33	4.70	1.24
Undecided	20	3.50	1.28
Total	105	4.67	1.36

Usefulness was rated using a single item with a 7-point response scale, where higher ratings are more favorable. *F (3, 101) = 7.93, p = .001; Tukey's HSD was used for multiple pairwise comparisons.

Table 3: Comparison of students' rating of the usefulness of the introductory statistics course by their intent to take another course (N = 105)			
Would you consider taking another statistics course?	**Rating of usefulness of the statistics course**		
	n	**Mean***	**SD**
Yes	67	4.94	1.15
No	38	4.18	1.57
*t (103) = 2.6, p = .012 (based on Welch's adjustment for unequal variances). N varies due to item non-response.			

DISCUSSION AND IMPLICATIONS

This study explored the association between college students' ratings of the usefulness of an introductory statistics course, their beliefs about where statistics will be most useful, and their intentions to take another statistics course. In general, students rated the course as moderately useful, with a mean of 4.67 (based on a single item with a 7-point response scale), which is comparable to a mean score of 4.72 (for perceived value) reported by Schau and Emmioglu (2012) using the multi-item SATS (Survey of Attitudes toward Statistics) scale. Other studies have noted considerable lower levels of perceived usefulness or value. For example, Ramirez & Bond (2014) reported that only 20% of students (35 out of 175) who completed an introductory statistics course were neutral or expressed some degree of usefulness for the course. One plausible explanation for these mixed reports is the lack of consistency in how attitude and its components (including perceived usefulness) are measured and interpreted; and this could limit comparability across studies (Nolan, Beran, & Hecker, 2012).

Notably, favorable levels of perceived usefulness (and attitude, in general), are usually associated with active-learning (or student-centered) pedagogical approaches, involving the use of real-world applications (Carlson & Winquist, 2011; Evans, 2007; Hassad, 2015). While the statistics course that was rated in the current study used a predominantly active-learning approach, the research design was cross-sectional, that is, information was obtained at one point in time only (at the end of the course). Accordingly, albeit it seems plausible to attribute the positive ratings of usefulness to this pedagogical approach, the evidence does not allow for a conclusive determination, given the absence of baseline (or pre-test) data, or evidence from a parallel group of students (who received traditional pedagogy) for comparison.

Additionally, it is not surprising that in response to the question "*where do you believe statistics will be most useful*", the highest proportions were graduate school (35%) and research (32%). The former is usually a natural preoccupation and next step for most undergraduate students, at this stage, and both areas are generally emphasized in a constructivist-based or active-learning course (in terms of value and real-world applications). Of concern, however, is that 19% of the students were "undecided" about where they believe statistics would be most useful, and this subgroup was more likely to give lower ratings for the usefulness of the introductory statistics course, compared to the other three subgroups (those who reported, graduate school, research, and their job). This does not necessarily mean that these "undecided" students were lacking in their understanding of the course material. Rather, it could be that they did not consider statistics to be relevant and useful to their future. Indeed, this needs to be further explored, noting that an overarching goal of the introductory statistics course should be to facilitate students to recognize and appreciate the usefulness of statistics, in particular, how it relates to everyone, in terms of everyday problem-solving and decision-making, toward informed and effective citizenship.

Another concern is the relatively high proportion of students (36%) who reported that they would not consider taking another statistics course; and this subgroup rated the usefulness of the course significantly lower than those who reported "yes". This is a complex issue, as although it is hoped that students will further their knowledge and skills in statistics, and contribute to the discipline, this will quite likely be influenced by their future plans and intentions in terms of work, graduate school, etc. Accordingly, these students may be satisfied with the introductory statistics course, but do not see the need for another statistics course, or may be ambivalent about the relevance and usefulness of formal

statistics to their future. And of course, it could quite likely reflect that these students were not satisfied with the course material, did not have a positive experience, and were therefore less inclined to recognize and appreciate the usefulness of statistics, and consider pursuing another statistics course. Notwithstanding, other studies have reported much less favorable findings, in this regard.

For example, Ramirez & Bond (2014) reported that 66% (N = 64), and 65% (N = 111) of students who took a project-based course (where the project was 20 percent of the final grade), and a hybrid course (traditional lecture and online) respectively, were not likely to take another statistics course. It is worth observing that these two course formats seem intended to compare different pedagogical approaches (active learning versus traditional). However while a project-based course usually implies an active-learning course - with just 20% of the course assessment focused on active-learning - this could amount to both formats being similar, and more akin to traditional pedagogy. Accordingly, these less favorable reports (Ramirez & Bond, 2014) could be supporting that students who pursue an introductory statistics course based on traditional pedagogy, are less likely to appreciate the value of statistics, and hence be less inclined to consider taking another statistics course. Indeed, the results from the wider published literature are quite varied, in this regard, and in some instances, counterintuitive, which could be attributed to inconsistency in instrumentation across studies, and curricular design, particularly regarding what constitutes the core elements of an active-learning introductory statistics course (Carlson & Winquist, 2011).

The results of this study suggest that perceived usefulness (represented herein by ratings of the course) could play a salient role in students' decision-making regarding where statistics can be useful, and plans to pursue further studies in the discipline. Additionally, a constructivist-based (or active-learning) introductory statistics course rather than the behaviorist (or traditional) instructional model may be more beneficial to students, in terms of fostering a greater sense of value for statistics. Accordingly, pedagogical approaches, particularly for assessment, should emphasize the use of real, relevant, and interesting data, in the context of real-world problem-solving and decision-making, so that students can better appreciate the usefulness and practicality of statistics. This can facilitate deep and conceptual understanding as well as transferrable knowledge and skills. Moreover, the introductory course should emphasize concepts over calculations and should include multiple forms of authentic assessments.

Further research, in particular, qualitative methods such as case studies and focus groups, could prove helpful in further exploring and elucidating students' beliefs about the usefulness of the introductory statistics course as well as their intentionality and decision-making regarding taking another course. While the use of a single-item measure for rating usefulness (as a proxy for perceived usefulness) may be viewed as lacking reliability and validity, it must be noted that the focus of this study was on a global rating of usefulness, given that students were asked separately about where they believe statistics will be most useful. Moreover, there is an emerging body of research supporting the use of single-item measures as having *"superior predictive validity"* when compared to established multi-item scales (Hoeppner, Kelly, Urbanoski, & Slaymaker, 2011, p. 9). Not to mention, the single-item measure used in the current study produced results comparable to the SATS, considered the most psychometrically sound instrument for measuring student attitudes toward statistics. Finally, this study used a convenience (non-probability) sample which could limit the external validity of these findings, however, the sample was comparable by age and gender to the general student population in the USA. Also, the sample was comprised of students from three four-year colleges, and this could have helped to maximize variability in terms of student characteristics. Bias associated with self-reported data must also be considered.

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