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# **Faculty Attitude toward Technology-Assisted Instruction for Introductory Statistics in the Context of Reform**

## **1. INTRODUCTION AND PROBLEM STATEMENT**

There is a rapidly growing body of research evidence that supports technology-assisted instruction as an effective model for introductory statistics at the college-level (West, 2009; Konold & Kazak, 2008; Garfield & Ben-Zvi, 2007; Pratt, Davies, & Connor, 2011; Zieffler, Park, Garfield, delMas, & Bjornsdottir, 2012). The use of technology, however, particularly to promote active learning in statistics, is still relatively innovative. Hence it is reasonable to expect resistance and concerns from potential adopters and users. Moreover, there is an abundance of research evidence indicating that psychological predisposition, including beliefs and attitudes, is a strong and significant determinant of the adoption, use, and maintenance of best instructional practices (Ahmad, Basha, Marzuki, Hisham, & Sahari, 2010; Chuttur, 2009; Keengwe, 2007; Koc, 2005). This underscores the importance of examining the role of such psychological factors as barriers to, and facilitators of, the effective use of technology by instructors. As Valdez, McNabb, Foertsch, Anderson, Hawkes, and Raack (2000) noted, the impact of technology use depends more on “human and contextual factors than on hardware or software” (p.4).

Much of the research on instructors’ use of and attitude toward technology comes from the disciplines of Science, Technology, Engineering, and Mathematics (STEM). There is, however, a dearth of such data for statistics education. The only accessible published work, a report on the status of educational reform efforts, by Garfield, Hogg, Schau, and Whittinghill, noted that “about one-half of the faculty surveyed involve students in using a statistical software program” (2002, p.5), and that the most common change reported by faculty in the past few years was “increased use of technology (70-80%)” (ibid). Apparently, there has been no published follow-up study to date, albeit the use of technology and in particular computers for data analysis, has been a major focus of the statistics education reform movement in the past decade, involving a tremendous amount of financial and other resources.

Indeed, since the Garfield et al. (2002) report there have been many related studies. These are, however, largely surveys of students and qualitative reports of curricular materials, pedagogical strategies, and assessment exercises focused on web resources, such as applets (Dinov, Christou, & Gould, 2009; Al-Aziz, Christou, & Dinov, 2010), the use of clickers (Kaplan, 2011), computer simulations (Mills, 2004; Doane, 2004; Watson & Donne, 2009), as well as calculators, statistical software packages, and multimedia materials (Chance, Ben-Zvi, Garfield, & Medina, 2007). What is not known is the recent or current level of engagement of introductory statistics instructors with technology, and their associated attitudinal predispositions. Such data are necessary for meaningful and objective assessment of reform efforts, regarding the use of technology, as well as the development of appropriate and effective training and other support programs to facilitate technology integration.

## 2. REVIEW OF THE LITERATURE

### 2.1 Overview

Technology-assisted instruction is a core focus of educational reform in most disciplines. This is particularly so for the teaching of introductory statistics at the college level (Garfield et al., 2002; Chance et al., 2007; Kaplan, 2011; Hassad, 2011), for which there is a consensus that the goal should be to foster statistical thinking and literacy by emphasizing concepts and applications rather than mathematical procedures, formulas and calculations (Franklin & Garfield, 2006). This instructional model embodies active learning, and is grounded in constructivism (Cobb, 1994; von Glasersfeld, 1987). A major focus of technology-assisted instruction, in this context, is the integration of statistical and research software packages toward providing students with authentic experiences in collecting, entering, organizing, analyzing, and exploring real-world data. Such activities can facilitate meaningful learning and the acquisition of transferable knowledge and skills. According to Chance et al., such learning outcomes can be achieved by “using pedagogically rich data sets and exploratory activities” (2007, p.7).

The literature is replete with justifications for the use of technology. These vary from the behaviorist notion that technology reduces computational burden (Higazi, 2002; Chance et al., 2007) to the constructivist view that it serves as an analytical tool that allows students to explore data and distributions, toward discovery and construction of knowledge, meaning, and conceptual understanding (Garfield & Ben-Zvi, 2007; Pratt, Davies, & Connor, 2011). The behaviorist tends to view the use of technology as a discrete and compartmentalized activity, and statistics as a branch of mathematics; whereas, the constructivist focuses on integration of technology and active learning toward a meaning-making experience for students, by facilitating them to “unlock stories in data” (Pfannkuch, 2008). Furthermore, according to Dede, in the behaviorist teaching context, “knowledge and skills are transferred as learned behaviors” (2008, p.46), with “an emphasis on factual knowledge and recipe-like procedures: material with a few correct ways of accomplishing tasks” (ibid, p.47). This is generally characterized as a top-down or instructor-centered approach with a passive student. In contrast, constructivism is a bottom-up or student-centered approach focused on the construction of knowledge by the active student. As noted by Askew, Rhodes, Brown, William and Johnson (1997), highly effective teachers possess a constructivist or connectionist orientation rather than a behaviorist or transmission orientation.

### 2.2 Integration of Technology

In support of integration of technology, Moore called for “strong synergies among content, pedagogy, and technology” (1997, p.123) if there is to be meaningful change in statistics education. While this notion is often referenced, there is a predominant focus on the technology component separately at the expense of pedagogy and integration, resulting in claims of high levels of use of technology, but learning outcomes that are lacking. Moore’s concept recognizes the need for the instructor to possess adequate knowledge of content, pedagogy, technology, and more importantly, technology literacy, which includes the type of knowledge required for effective integration of technology into teaching (Mishra & Koehler, 2006). It is plausible to assume that for effective teaching, the integration of technology should be informed by pedagogy; the art and

science of teaching. Failing this, the technology becomes a discrete tool used merely for delivery, distribution, automation and presentation of information, with a largely mechanistic and compartmentalized focus, rather than an analytical tool to facilitate active learning and conceptual understanding.

Instructional design should be evidence-based. In other words, information from cognitive science, the study of how people learn, with attention to diversity of learning styles, and concepts such as the theory of multiple intelligences, should inform our teaching. Additionally, there is an emerging body of work (Rubin, 2007) that supports the claim that in order to facilitate meaningful learning, assessment exercises must focus on application of knowledge, critical thinking, and conceptual understanding. This is in contrast to assessments geared toward rote memorization. What students learn, including the extent to which they engage in the material and the use of technology is primarily determined by our assessment approach and philosophy. As psychologist Lauren Resnick puts it: "What we assess is what we value. We get what we assess, and if we don't assess it, we won't get it" (cited in Wiggins, 1992, p.152).

Regarding the use of technology in statistics education, Moore aptly noted that we are "teaching our subject and not the tool" (1997, p.135). Technology is simply a tool, and like any tool, if it is not appropriately and effectively used, there could be far-reaching negative consequences for students, including increased levels of fear, anxiety, failure and attrition, a lack of conceptual understanding, and disillusionment with the field of statistics. Such negative outcomes can result from a lack knowledge and skills regarding creating and managing an active learning environment (Chance et al., 2007; Okojie, Olinzock, & Okojie-Boulder, 2006).

While the synergy of content, pedagogy and technology is important, another domain has emerged as fundamental to the adoption and effective use of technology in teaching, that is, instructors' psychological predisposition, particularly attitudes and beliefs toward technology (Hassad, 2011; Koc, 2005). Much of the research in this area has been guided by the Technology Acceptance Model, TAM (Davis, Bagozzi, & Warshaw, 1989; Davis, 1993), which is based largely on the theories of reasoned action (Fishbein & Ajzen, 1975; Ajzen & Fishbein, 1980), and planned behavior (Ajzen, 1991). The relevant research evidence has consistently identified perceived usefulness, self-efficacy, and level of comfort, as substantive and significant predictors of the use of technology (Ahmad, Basha, Marzuki, Hisham, & Sahari, 2010; Chuttur, 2009). It must be noted, however, that the focus of models such as the TAM, is on the use of a particular technology tool rather than the use and integration of technology for effective teaching and learning.

### 3. STUDY OBJECTIVE AND THEORETICAL FRAMEWORK

The primary objective of this study was to help to fill the gap in evaluation data pertaining to faculty attitude toward technology integration, specifically computers, as well as the level of use of computers with statistical software packages and real-world data, with regard to the teaching of introductory statistics, at the college level. Also, personal and socio-demographic characteristics were examined as possible correlates of attitude. The secondary objective was to explore the data toward developing a

preliminary scale for measuring faculty attitude toward technology integration, again, specifically computers, in this context. Attitude was conceptualized and defined as an evaluative disposition toward some object based on cognitions, affective reactions, and behavioral intentions. In other words, attitude is an informed predisposition to respond. According to the tripartite attitude theory, attitude is composed of three dimensions: the cognitive (beliefs), the affective (feelings), and readiness or intent to act. Additionally, this study was guided by the Theory of Reasoned Action (Fishbein & Ajzen, 1975; Ajzen & Fishbein, 1980), the Theory of Planned Behavior (Ajzen, 1991), and the “Stages of Concern” component of the Concerns Based Adoption Model (Hall & Hord, 1987), with attention to change, innovation, and the attitude-behavior relationship.

## 4. METHODOLOGY

### 4.1 Study Design and Sampling

The data used in this study were collected as part of a cross-sectional study (Hassad, 2011) from which the Teaching of Introductory Statistics Scale (TISS) and the Faculty Attitudes Toward Statistics (FATS) scale were developed. Established standards for psychometric research were followed. The full study methodology has been published elsewhere (Hassad, 2011). While the larger study focused on the broad domain of reform-oriented teaching of introductory statistics, including the technology dimension, development of an attitude toward technology scale was not a specific goal initially.

None of the descriptive statistical data presented in this study for attitude and the level of use of computers and real-world data has been previously reported. However, some of the attitudinal items from the FATS scale reported earlier were used in this study. Their theoretical relevance to technology use helps this study to achieve content validity. Also used in the current study are the previously collected teaching practice data based on the TISS, which consists of two subscales, behaviorist and constructivist, each with five items. All attitude and practice data were obtained using 5-point Likert-type scales.

The study participants were a purposive sample of 227 instructors of introductory statistics from the health and behavioral sciences at four-year regionally accredited, degree-granting institutions in the USA and the equivalent in foreign countries. The determination of the effective sample size is depicted in Table 1. Note that a study response rate was not calculated, as the exact number of targeted potential respondents is not known. Furthermore, the response rate was not directly relevant to this study as the emphasis was on obtaining a maximum variation sample to meaningfully represent the diversity of selected characteristics. Both full-time and adjunct (part-time) instructors who had full responsibility for an introductory statistics course were eligible to participate.

*Table 1. Determination of the effective sample size*

Number of questionnaires returned	258
Number of duplicates	4
Number of unique questionnaires	254
Number of questionnaires disqualified*	27
Effective sample size (N)	227
*Respondents were disqualified because of (1) no teaching experience in the health and behavioral sciences, (2) they taught graduate courses only, or (3) a grossly incomplete questionnaire.	

Purposive sampling has been widely used in major studies to explore teachers' beliefs, attitudes and practices in school reform situations. Specifically, this sampling approach helps to guard against a restricted range in measurement, which can result in attenuated correlations among items (Gorsuch, 1983; Fabrigar, Wegener, & MacCallum, 1999). According to Viswanathan, this sampling design, used instead of probabilistic sampling, is particularly suited for scale development "because the aim is not to establish population estimates, but rather to use correlational analysis to examine relationships between items and measures" (2005, p. 70). Furthermore, given the exploratory nature of this study, purposive sampling was desirable, as it can "maximize discovery of the heterogeneous patterns and problems that occur in the particular context under study" (Erlandson, Harris, Skipper, & Allen, 1993, p. 82).

## 4.2 Recruitment and Data Collection

In general, the goal of recruitment was to enlist a sample of instructors that represents the broad range of attitude and teaching practice, in the context of reform. This involved targeting instructors of introductory statistics in the health and behavioral sciences at four-year colleges, based on personal knowledge of their teaching practice and involvement in reform-based instruction. Educators were also identified from the membership database of the American Statistical Association (ASA) and in particular, the Sections on Statistics Education, and Teaching of Statistics in the Health Sciences, as well as the ASA directory of minority statisticians. The targeting of instructors was also informed by their publications, research interests, and a review of course outlines. Supplementary contact information was obtained from statistics education journals, conference proceedings, online faculty lists and directories, as well as other professional societies and organizations. Additionally, instructors who self-characterized their teaching as either concept-based or calculation-based in a preliminary mini email survey (Hassad, 2003), were invited to participate.

Awareness of this study was facilitated by departmental chairs, online discussion forums, and listservs. The questionnaire was programmed in Hypertext Markup Language (HTML), and three emails (an invitation to participate, a reminder, and a last call to participate) were sent one week apart with an online link to the questionnaire. Informed consent was obtained online. All data were self-reported. As an incentive to participate, all subjects who completed the instrument were given a chance to win one of three \$100 U.S. awards toward conference registration, journal subscription, continuing education courses or other professional development activities. The study protocol was approved by

the Institutional Review Board of Touro University International (Touro College, New York).

### 4.3 Development of the Attitude Items

The attitude items used in this study were extracted from the final data set of a larger psychometric study as noted above, which examined instructors' attitudes and practices regarding introductory statistics in the health and behavioral sciences in the reform context. The larger study had an initial pool of 64 items pertaining to course content, pedagogy, assessment, and integration of technology. Those items were culled from related studies, as well as formulated by the researcher in consultation with measurement and content specialists. Consistent with other best practices in scale development (Nunnally & Bernstein, 1994; Haynes, Richard, & Kubany, 1995), a detailed qualitative item analysis completed in-person and via email was performed by college instructors from the disciplines of education, health sciences, psychology, and statistics, as well as language and communications. In general, and based on consensus, items were added, rephrased, or removed. All items were assessed for face validity, salience, clarity, readability, theoretical relevance, and redundancy. Following a pilot survey conducted via email with a sample of 30 instructors, each item was evaluated for variability, in particular, the potential to discriminate between groups.

The questionnaire for the larger study was finalized with 45 attitude items, reflecting the domains of course content, pedagogy, assessment, and integration of technology. There were 12 technology-related items; six items focused specifically on computer use and integration, and three each on active learning, and applications. These 12 technology-related items formed the initial pool of attitude items for the current study. Following a detailed qualitative item analysis of these 12 items, seven were retained. In addition to the stated theoretical framework, the selection of these seven items was guided by the principle of compatibility or correspondence (Ajzen & Fishbein, 1977), that is, items specific to computer use and the teaching of statistics in the reform context were selected. The three application items were deemed ambiguous for a technology (specifically, computer use) scale, and were removed. One of the active learning items was kept, as it specifically refers to activities generally requiring the use of computers for data analysis and presentation. Together, seven attitude items were retained for this analysis.

### 4.4 Data Analysis

Given the exploratory nature of this study, emphasis was given to reporting descriptive statistics, specifically, the percent response to each item, for each category of the 5-point Likert-type scale. The internal reliability of these items was assessed using Cronbach's alpha (Cronbach, 1951), which quantifies the degree of internal consistency of a set of items. In general, a Cronbach's alpha of 0.7 is viewed as the minimum acceptable level of reliability (Nunnally, 1978). A prior recommendation, however, that "in the early stages of research ... reliabilities of 0.60 or 0.50 will suffice" (Nunnally, 1967, p. 226) was also considered, since this is an initial exploratory study. Furthermore, Loewenthal (1996) suggests that a reliability level of 0.6 may be considered acceptable for scales with less than ten items. The corrected item-total correlations were also calculated in order to help to determine the relevance and usefulness of each item to the cluster.

Six items formed a meaningful cluster, and were used as a preliminary Attitude Toward Technology Integration Scale (ATTIS). An attitude score was obtained by summing the scores of these six items. Possible variation in the attitude score was examined based on gender, age, ethnicity, duration of teaching, teaching area, location/country, highest academic degree concentration, employment status, and membership status in professional organizations, using the independent samples t-test, one-way ANOVA, chi-squared analysis, and Pearson's and Spearman's correlation. Additionally, the relationship between the ATTIS score and the subscale scores for the behaviorist and constructivist dimensions of the TISS was examined as a measure of criterion, or more specifically, concurrent validity of the preliminary attitude scale. Regarding the TISS, behaviorist refers to the traditional, mathematical or teacher-centered approach, whereas constructivist refers to the reform-based, concept-based or student-centered approach. An alpha level of .05 was used for all tests of significance. Also, where applicable, assumptions underlying the statistical methods were checked, and post-hoc analyses with Bonferroni correction were performed. SPSS versions 19.0 and 20.0 were used for data entry and analysis.

## 5. RESULTS

### 5.1 Respondents' Background Characteristics

Of the 227 participants, 222 provided country information: 165 (74%) were from the U.S. and 57 (26%) were from international locations, primarily the UK, Netherlands, Canada, and Australia. In all, the participants represented 24 countries and 133 academic institutions. The median age category was 41–50 years, and median duration of teaching was 10 years. The majority (139 or 61%) of participants were male, and from the U.S. sub-sample, 135 (82%) identified as Caucasian. There were 94 (41%) instructors from the health sciences, 102 (45%) from the behavioral sciences, and 31 (14%) who taught both in the health and behavioral sciences. The modal category for highest academic degree concentration was statistics, 92 (41%), followed by psychology, social, and behavioral sciences, 71(31%), health sciences, public health, epidemiology, and biostatistics, 28 (12%), education, business, and operations research, 19(8%), and mathematics and engineering, 17 (8%).

### 5.2 Attitude Toward Technology and Reported Level of Use

Table 2 illustrates the responses to the questionnaire items pertaining to attitude and use of computers. Ninety-seven percent of the instructors reported some level of use of a computer program to explore and analyze data, with 171 (76%) reporting always or usually; whereas all reported using real-world data for class demonstrations and assignments, with 178 (79%) always or usually doing so. Moreover, intention to avoid using computers was low, 14 (6%). The majority, 161 (72%) believed that using computers to teach introductory statistics makes learning fun, and 204 (90%) felt comfortable using computer applications. However, considerable proportions either perceived difficulty or were undecided regarding the use of active learning strategies, 111 (49%), and integrating hands-on computer analysis into the introductory statistics course, 85 (37%). Additionally, 63 (28%) reported being hesitant or undecided about using computers without the help of a teaching assistant, and a similar proportion, 58 (26%)

perceived a need for training or was undecided on how to integrate hands-on computer exercises.

The attitudinal items were subjected to reliability analysis and items 1 through 6 (Table 2) formed a plausible and internally consistent cluster with a Cronbach's alpha of 0.68 with no meaningful change if any item was deleted. Additionally, the corrected item-total correlations ranged between 0.3 and 0.5. Items were reverse-coded where necessary so that higher values represent more favorable levels of attitudinal predisposition toward computer use and integration. These six items encompass cognition (belief), affect (feeling) and intentionality, which are the recognized components of attitude, in accordance with the tripartite attitude theory. Also, the six attitudinal items reflect core underpinnings of reform-based teaching of introductory statistics, namely: active learning, integration of technology, self-efficacy, perceived usefulness, and perceived comfort. Accordingly, this cluster of items (Table 3) was considered to possess adequate content validity for measuring attitude toward computers, in this context.

Table 2. Percent response to technology-related items

Attitude items	Strongly Agree %	Agree %	Undecided %	Disagree %	Strongly Disagree %
1. Using active learning strategies (such as projects, group discussions, oral and written presentations) in the introductory statistics course can make classroom management difficult. (N = 227)	7	30	12	42	9
2. Integrating hands-on computer analysis into the introductory statistics course is not a difficult task. (N = 227)	19	44	8	24	5
3. I will need training on how to integrate hands-on computer exercises into the introductory statistics course. (N = 226)	2	16	8	41	33
4. I am hesitant to use computers in my introductory statistics class without the help of a teaching assistant. (N = 227)	27	45	20	6	1
5. Using computers to teach introductory statistics makes learning fun. (N = 226)	14	10	39	34	4
6. I am not comfortable using computer applications to teach introductory statistics. (N = 227)	3	4	4	36	54
7. I will avoid using computers in my introductory statistics course. (N = 226)	3	4	7	31	55
Use of computers and real-world data	Always	Usually	Sometimes	Rarely	Never
8. Students use a computer program to explore and analyze data. (N = 226)	41	35	13	8	4
9. I use real-life data for class demonstrations and assignments. (N = 226)	29	50	19	2	0

Note: Percentages may not add up to one hundred due to rounding.

A composite attitude toward technology integration score (ATTIS) was obtained by summing the equally weighted scores of the six attitude items (Table 3). There was no

significant variability in attitude score based on gender, age, ethnicity, teaching area, location/country, highest academic degree concentration, employment status, or membership status in professional organizations. Duration of teaching was weakly but significantly correlated with attitude, that is, as years of experience increased, attitude toward technology integration was more positive ( $r = .18$ ,  $df = 218$ ,  $p = .007$ ).

### 5.3 Correlation Between Attitude and Teaching Practice (Constructivist and Behaviorist)

Attitude toward technology integration was moderately, positively and significantly correlated with constructivist teaching ( $r = .4$ ,  $df = 217$ ,  $p = .001$ ). That is, a higher attitude score, or a more favorable predisposition toward technology use and integration, was associated with a higher level of constructivist teaching. This is theoretically and empirically plausible (Nanjappa & Grant, 2003; Walker, 2000), and consistent with major attitude-behavior research (Ajzen & Fishbein, 2004; Schwartz, 2007), thereby establishing acceptable evidence of concurrent validity of the preliminary attitude toward technology integration scale. On the other hand, attitude toward technology was orthogonal to behaviorist teaching practice ( $r = -.02$ ,  $df = 220$ ,  $p = .80$ ). This indicates that these two constructs are independent of each other, and that the level of attitude toward technology use and integration is not directly helpful in determining the degree of behaviorist teaching practice.

Table 3. Attitude toward technology integration scale (ATTIS)

Attitude Items	Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree
1. Using active learning strategies (such as projects, group discussions, oral and written presentations) in the introductory statistics course can make classroom management difficult	1	2	3	4	5
2. Integrating hands-on computer analysis into the introductory statistics course is not a difficult task.*	5	4	3	2	1
3. I will need training on how to integrate hands-on computer exercises into the introductory statistics course.	1	2	3	4	5
4. I am hesitant to use computers in my introductory statistics class without the help of a teaching assistant.	1	2	3	4	5
5. Using computers to teach introductory statistics makes learning fun.*	5	4	3	2	1
6. I am not comfortable using computer applications to teach introductory statistics.	1	2	3	4	5

Note: The items with the asterisk were reverse-coded so that higher scores represent more favorable levels of attitude toward technology integration. The composite score ranges from 6 to 30.

## 6. DISCUSSION

This study identified attitudinal characteristics pertaining to integration of technology, in particular, computers for the teaching of introductory statistics at the college level. Technology integration was conceptualized in the context of constructivist or reform-based teaching, with emphasis on the use of active and authentic learning strategies including the use of computers and real-world data. Attitude is recognized as a potential barrier to, and facilitator of, such teaching practice. Compared to the last published study on technology use, in this context, which reported about 50% of instructors “involving students in using a statistical software program” (Garfield et al., 2002, p.5), the current study almost one decade later, notes widespread use of computers with almost all faculty (96%) reporting some degree of computer use and 76% reporting always or usually doing so. Similar findings were noted for the use of real-world data.

These findings are not surprising, as computer use and the use of statistical software packages along with the use of real-world data, have been the major thrust of the statistics education reform movement, especially over the past decade, as evidenced by the widely used and publicized blueprint of the reform movement, the GAISE report (Franklin & Garfield, 2006). Indeed, the finding of such a high level of computer use may be directly related to the nature of statistics, which is largely numerical analysis, and hence a natural fit with computers and software packages. Unlike instructors of introductory statistics, Georgina and Olson (2008), reported that a lower proportion (71%) of general faculty, used some type of technology tool in their teaching.

Consistent with the overall high level of reported use of computers and real-world data, is the level of favorable predisposition or attitude toward use and integration of technology, particularly computers. Most important in this regard is the low level of avoidance toward computers, 14 (6%), the high level of comfort with computers, 204 (90%), and the report by the majority, 163 (72%), that the use of computers to teach statistics makes learning fun. Together, these findings suggest a meaningful embrace or acceptance of computer use, in this context. The perceived benefit or usefulness by instructors that computer use makes learning fun, is particularly reassuring, as this can facilitate the use of pedagogical strategies that can foster deep and meaningful learning including conceptual understanding, and transferrable knowledge and skills. Moreover, this attitude is helpful for a subject that is generally known to evoke high levels of anxiety and fear among students, which can be a barrier to effective learning (Chance et al., 2007; Okojie et al., 2006).

Notwithstanding these favorable attitudinal elements, there are other dispositional components that warrant attention. Specifically, facilitating active learning is the intended goal of the use of computers and real-world data. Sizable proportions of instructors in this study, however, perceived difficulty or were undecided regarding the use of active learning strategies, 111 (49%), and integrating hands-on computer analysis, 85 (37%). In view of the general high level of reported use of computers, these findings could imply that a considerable proportion of instructors may not be using computers effectively or as frequently as they would like. This clearly suggests the need for training programs and support services for instructors, by way of workshops, modeling of best practices, possibly through team teaching and mentoring, and other targeted professional development programs.

Providing training and support for faculty should be a priority, in order to build on the gains achieved thus far, in particular, the general favorable level of readiness of instructors to use computers to facilitate active learning. Regarding training and support programs, the responses to two attitudinal items are particularly instructive. These are, 63 (28%) being hesitant to use computers without a teaching assistant, and 58 (26%) perceiving a need or being undecided regarding training on how to integrate hands-on computers into the introductory statistics course. These reports seem to underscore concerns about integration of technology, and perceived self-efficacy, that is, belief in one's capability to successfully accomplish a task. Therefore, it would be wise to address these domains; self-efficacy and integration, in training, with attention to contextual factors, class size, and diversity including learning styles, students' academic preparation, and majors.

## 6.1 Correlation Between Attitude Toward Technology and Teaching Practice (Constructivist and Behaviorist)

The moderate positive relationship between attitude toward technology integration and constructivist teaching can suggest a level of specificity between these two constructs, and indicate that technology integration is a necessary and salient component of constructivist teaching (of introductory statistics). In other words, the relationship between attitude toward technology and constructivist teaching can be viewed as complementary, synergistic and bi-directional. The effective use of technology (as cognitive tools), can serve as a vehicle for creating a constructivist environment and facilitating active learning. And, a constructivist-minded instructor is inclined to view technology integration as salient to teaching.

However, as Nanjappa and Grant (2003) observed, the mere use of technology is no assurance of constructivist teaching, as some instructors tend to focus primarily on "drill and practice type of software" (p.6), or technology for presentational purposes only – an approach that is consistent with behaviorist (or instructor-centered) pedagogy, which is counter-productive to educational reform. The orthogonal relationship between attitude toward technology integration and behaviorist teaching can support this view. That is, a high level of favorable attitude toward technology integration can be associated with either a high or low level of behaviorist teaching. This finding, while apparently counter-intuitive on the surface, is plausible, given the complex nature of decision-making regarding pedagogical strategies, especially with attention to contextual factors. In this regard, this finding, although not a priori conceptualized, can serve as an indicator of divergent validity of the preliminary attitude scale by showing that measures that are theoretically dissimilar or should not be related are, in fact, not related.

It must be noted that the relationship between the constructivist and behaviorist subscales of the TISS has been reported to be orthogonal (Hassad, 2011). This implies that these practice orientations are not related on a continuum, are independent of each other, and are not mutually exclusive. Accordingly, these teaching orientations may coexist for a particular instructor and teaching session, as instructors may adapt their pedagogical methods based on student characteristics, the nature of the course material, as well as contextual factors. This can result in a mixed pedagogical approach, where teaching practice can be described in terms of a two-dimensional space, that is, varying levels of both behaviorist and constructivist teaching.

## 6.2 The Attitude Toward Technology Integration Scale (ATTIS)

An exploratory analysis revealed a homogeneous cluster of six attitude items, which can be used as a preliminary scale for measuring attitude toward technology integration for the teaching of introductory statistics (Table 3). An acceptable level of internal consistency ( $\alpha = 0.68$ ), and meaningful evidence of construct validity including content, criterion and divergent dimensions were established. While some existing attitude toward technology scales are composed of multiple subscales and a higher number of items, those measures typically address general use of technology rather than a specific task, group and context. It is therefore reasonable to expect that a scale with such focus as the ATTIS would have fewer items.

This 6-item preliminary attitude toward technology integration scale (ATTIS: Table 3) emerged from secondary data, which could limit its content validity. However, while the data were not collected with the specific goal of developing an attitude toward technology integration scale, they were obtained as part of a psychometric study aimed at developing a scale to measure the broader construct of attitude toward reform-oriented or constructivist teaching of introductory statistics, of which technology integration is a core component. It was therefore expected that items salient to technology use and integration would exist in the data set. It is recognized, however, that a dedicated study may identify a larger pool of related items, possibly along multiple content dimensions, that could then be subjected to factor analysis and other scaling procedures: an approach that should be used in further studies. Nonetheless, major psychometric measures have been developed from secondary data (Bromley, Johnson, & Cohen, 2006; Windle, Markland, & Woods, 2008).

This preliminary attitude scale should prove useful, especially given the importance of attitude as a barrier to and facilitator of best instructional practices, as well as the recognition that no other attitude toward technology scale specific to the teaching of introductory statistics at the college level is known to be published. At the very minimum, these attitudinal items can be used separately as an indicator of the respective facet of attitude that each represents.

The finding of no statistically significant variability in attitude toward technology integration score for selected personal and socio-demographic characteristics is not unusual, especially for age and gender, and to a lesser extent, ethnicity. As noted in a recent faculty technology survey report, technology users are not “stereotypical” (University of Minnesota, 2009, p.12), a characterization that is supported by these findings. However, there is evidence in the research literature of a positive relationship between duration of teaching or teaching experience and measures of attitude toward technology use among faculty (Petherbridge, 2007), as was the case in this study albeit weak.

## 6.3 Data Considerations

The use of these results should take into consideration that the data were self-reported by a maximum variation, purposive sample of instructors of introductory statistics from the health and behavioral sciences. While this was not a probability sample, and therefore, the external validity or generalizability of the findings could be limited, the recruitment strategies used to achieve maximum variation and the resulting distribution of the

background characteristics of the participants could render this technique an optimal sampling strategy in this context. Nonetheless, given that this survey was conducted via email, response bias cannot be ruled out, as it could be argued that those who elected to participate were more engaged in the use of technology, and hence more likely to use computer applications for the teaching of statistics.

Indeed, with regard to the development of the preliminary scale for measuring instructors' attitude toward technology integration, this is a desired sampling approach, as representativeness in the context of scale development research does not follow conventional wisdom; that is, the goal is not to closely represent any defined population but to ensure that those who are likely to score high and those who are likely to score low are well represented. This was facilitated by the use of a purposive sample (Gorsuch, 1997). Also, the generally recommended sample size of at least  $n = 200$ , deemed acceptable for scale development including stability and replicability of structural analyses was met (Gorsuch, 1983; Floyd & Widaman, 1995; Clark & Watson, 1995).

## 7. CONCLUSION

This initial exploratory study examined instructors' attitude toward technology integration, particularly computers for data analysis, and the use of real-world data, for the teaching of introductory statistics at the college level. Salient attitudinal elements, including perceived usefulness, self-efficacy, and comfort, which can serve as barriers to and facilitators of technology integration, were identified. Additionally, a preliminary scale for measuring instructors' attitude toward technology integration was developed and acceptable levels of internal reliability and validity were obtained. This scale will be referred to as ATTIS (Attitude Toward Technology Integration Scale).

The finding of an orthogonal relationship between attitude toward technology integration and behaviorist teaching, in contrast to the positive relationship with constructivist teaching, warrants further research and analysis and underscores the need to give greater importance to the pedagogy of technology integration. Integration in the constructivist context should be viewed as the meaningful and systematic incorporation of technology tools, intended to create stimuli to engage students in active learning, including critical thinking, collaboration, negotiation, construction of meaning, and, ultimately, conceptual understanding, leading to transferrable knowledge and skills. The mere use of technology does not imply integration of technology, and integration of technology does not necessarily imply constructivist teaching, unless effectively operationalized in that context. Indeed, an instructor can integrate technology toward behaviorist teaching goals.

These results also have implications for assessing the effectiveness of technology integration and specific tools in relation to learning outcomes. The development of this scale is a major step toward empirically describing and assessing faculty attitude toward technology integration, which can facilitate the adoption, use and maintenance of best practices for the teaching of introductory statistics. Further research is required in order to be conclusive about the structural and psychometric properties of this new scale. Additionally, larger appropriately designed studies should also check for sub-group differences in attitude.

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