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Identifying and Overcoming Challenges in Teaching and Learning College Level Statistics: Faculty Perspective

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Abstract: The purpose of this study is to determine what college statistics faculty perceive as the challenges of teaching and learning statistics at the college level and what are the best approaches to overcome these challenges.The study used a descriptive surveywith four related open-ended questions as a data collection instrument. The study population was comprised of undergraduate faculty from U.S. colleges and universities. The respondent population included 218 participants. After organizing the collected information, several specific challenges in teaching and learning statistics were identified as well as participants' perspectives on how to overcome those identified challenges. Four main areas were used as well as several categories within each main area were identified through the responses.Instructional pedagogy was identified as a key problem in teaching and learning statistics as well as a primary method to overcome these challenges.Other highlighted areas included student academic preparation and some focus on the content of these courses as well as the role of administrative support. Participants provided valuable tips, suggestions, and techniques to overcome the identified challenges for both, teaching and learning statistics. The study also shows a significant role for administrators and academic leaders in the process. Recommendations based on the findings are provided and discussed.

Keywords -Retention, student's success, academic readiness, student support, academic quality, teaching statistics

1. Introduction

Statistics has been described as the science of "data collection and analysis." In this sense, as an academic discipline, statistics serves two primary purposes which are, "*to summarize and describe a set of data from a research study, [and] to provide an objective basis for drawing conclusions from the data collected in a research study*" (Graziano, 2012). At the undergraduate college level, statistics is a course often taught after students complete at least two years of academic work and successfully finish some math courses. It is also embedded in the curricula of the certain programs such as psychology, business and management, engineering, mathematics, ecology, and urban studies to name a few.

The educational process is composed of both teaching and learning. Teaching is the responsibility of assigned instructors and the act of learning is the responsibility of the enrolled students. These two acts are cognitively and behaviorally related. There is no effective learning without effective teaching and no effective teaching without successful achievement of pre-determined learning outcomes. After all, faculty teach so students can understand, and to understand is to acquire understanding of something that one did not have before. Among the many forms of knowledge acquired through learning includes, but is not limited to propositions, skills, recognition, application, and transformation [2].

Despite the near universal offering of college statistics courses, the teaching and learning in these courses is a constant concern. There is a perception of increasing failure rates in various kinds of statistics courses especially at the undergraduate level ([3], [4], [5]).Teaching introductory statistics at the undergraduate level poses broad and consistent challenges for any university. Based on this, studies have focused on a variety of causes as well as solutions. This work builds on the previously researched concepts and ideas.

1.1 Role of Statistics for Career Preparedness

At the 2010 National ATE Principal Investigators Conference in Washington, DC, keynote speaker Charles Fadel [6], from Global Education Research Lead at CISCO System talked about the *"21st Century Skills – From Industry to Education and Back"*. In his speech, Mr.Fadel, explored how the 21st century skills movement was started by industry requirements that students graduate not only with traditional knowledge, but with skills such as critical thinking, creativity, communication, and collaboration and how this transformation impacted not only schools, community colleges, and universities on a global basis, but also the future of education and its importance in preparing U.S. workers for positions in the global economy. In that speech, Mr.

Fadel also discussedwhy schools, colleges and universities need to teach more statistics, even more than calculus to ensure STEM and technology advances in higher education.

Since statistics deals with data collection, analysis, interpretation, and providing an objective basis for drawing conclusions from the data collected in a research study, it could then be the discipline that help students to learn how to analyze, reason, solve problems, and think creatively. Developing these type of higher–order critical thinking skills is important for all students not only during school years but also beyond college life. However, while college presidents "remain confident about the readiness of graduates to enter the workforce" [7], business leaders and employers often want more specific training for new graduates including making decisions, technical skills associated with a job, planning and organizational skills, as well as the written and the oral communication skills [8 p. 1]

	The Divide Between College and Business Leaders When It Comes to Career Prep Among College Students [8 p. 1]	
	University Leaders	Business Leaders
1	*Written and oral communication skills*	*Making decisions*
2	*Making decisions*	*Technical skills associated with a job*
3	*Collaborating with others*	*Planning/organizational skills*
4	*Working with diverse groups*	*Written and oral communication skills*

1.2 Causes for Challenges in Statistic

The challenge of teaching and learning statistics may come from student preparation or attitude, faculty presentation, the content presented, or even administrative concerns.

A significant percentage of students enter college needing remedial mathematics and, therefore, are unprepared to take a statistics course [9]. While there is debate on whether these students should take a remedial course or go straight into college level math courses, that is not the focus of this study. The critical element for this study is that a significant percentage of college students may not have the math skills instructors assume as they enter their statistics course.

Student anxiety about statistics reflects their apprehension about the topic or past difficulties in math classes that they perceive to be easier than statistics. Sandoz, Butcher, and Protti[10] focus on student anxiety as a primary cause of difficulties in statistics and how that anxiety decreases performance in the course. The dampening effect of anxiety was a key assumption in the work of Huang and Mayer [11] who focused on efforts to reduce anxiety in order to improve accuracy of responses on statistical homework questions.

There is a concern among undergraduate students of whether taking statistic course will be transferred and accepted in their academic program or potential academic programs. This uncertainty might deter students from taking statistics early in their educational journey and/or inhibit their efforts in the course. For example:

> *"Although both the credit and developmental education STATS courses were offered they gained little traction. The announcement and policy revisions by the University of Houston to accept Statistics in most of their programs in 2016-2017 may spur renewed interest in the course as UH is Lee College's top transfer choice of students. 2015. Developmental MATH 324 and Credit MATH 1324 Statistics, offered each semester, remain a challenge to fill. Fear of non-transferability prevents students from enrolling and counselors from recommending enrollment."(*http://achievingthedream.org/intervention/15908/stat-path-developmental-math-342-pre-statistics)

In other studies, the content of the statistics presented or the manner in which that content is presented, was seen as a factor on how students performed in a class. One study supported the idea of removing inferential statistics from these elementary courses arguing that they are misleading [12]For example, this study urged the removal of confidence intervals and hypothesis testing. If removed, the replacement material might be more within reach of students and improve pass rates, depending on what topics were covered in place of these.

Another avenue for content related research centers on how that content is presented. Lai, Zhu, and Williams [13] added video tutorials to business statistics classes and found it helped students who otherwise would have probably earned a B or a C in the course. Those with A's already understood the material and those with low grades might have considered themselves too lost to improve their score. In a broader scope of adding fun elements to a statistics course, songs and mnemonics were implemented and tested in Lesser, Pearl, and Weber [14].They found a significant increase in test scores among students who had the song resources compared with a group of students covering the same material without the songs.

In this same vein, perhaps it is the manner in which the material is presented by instructors. For example,

> *"According to Hawkins ([5],a plenary speaker at the 1990 International Conference on Teaching Statistics (ICOTS), the UK Schools Council Project on Statistical Education stated to the Cockcroft Committee, "statistics is not just a set of techniques, it is an attitude of mind in approaching data… and …it enables people to make decisions in the face of uncertainty" (p. 25). Hawkins postulated that statistics needs to be taught in a practical manner, emphasizing that practical is quite different from the more commonly used term, applied, and that many teachers lack practical experience and, thus, are unable to impart to students the practical use of statistics. Hawkins further argues that the common expectation of statistics instructors that statistics students must be fluent in mathematics and calculus may actually be a negative to students' understanding statistics because of the delay it imposes on students' statistics education." ([3], p. 223; emphasis added)*

Finally, administrative issues such as the length of a course or prerequisite requirements have been perceived as inhibiting successful completion or low scores in these statistics courses. For example, massive open online courses (MOOCs) have been attempted. These courses are usually structured so that students can join the course anytime and work through the material at their own pace. Faculty are available for questions. These courses were studied in Ho, Reich, Nesterko, Seaton, Mullaney, Waldo, &Chuant[15].
Some universities use statistics courses as an accelerant approach from remedial education to college level math requirements. This strategy was developed with support from Carnegie Foundation at American River College and other community colleges ([16]. The design and the implementation of that course showed the achievement of intended outcomes among student's performance and success.

1.3 Instructor Insight, Experience, and Instruction

Instructors have a unique perspective on the reasons why students struggle in these courses as well as on the possible avenues improving pass rates. These insights were witnessed by one of our research team who was in charge of the improvement of student's performance in math courses at one nationwide university. Over a number of years, he worked with a team of faculty re-designing and re-developing math courses and programs. In this capacity, he had opportunities to visit many math classes and spoke with many of math and statistics faculty within a multi-campus university system.

Further, the personal experiences of two members of our research team in teaching various types of graduate and undergraduate math and statistics courses for many years in higher education. In addition, these two members where part of national mathematics curriculum committee and chairs of sub-committees of academic disciplines in their institutions for many years within a multi-campus university system.Their experiences and insights led to a motivation to talk with other faculty facing these concerns on a daily basis.
Several studies have more specifically addressed methods to improve teaching and learning in college statistics courses. For example, Anders [17] and Cook-Harvey, Darling-Hammond, Lam, Mercer, and Roc [18] pointed to these areas for potential improvement.

1. High quality statistics curriculum with life and career-based content.
2. Multiple assessment strategies and measure of student success
3. High quality available tools and resources for teaching and learning
4. Applying approved Instructional strategies and techniques.

For example, in 2013, "fifty percent of college faculty who completed the annual Faculty Focus reader survey said that their job is more difficult than it was five years ago"[19 ¶. 1]. Not only faculty are running out of time of what they are supposed to do but also have been doing more administrative tasks that are not directly related to teaching and helping student learn.
The benefits of providing faculty more time to develop their instructor skills can benefit students as well.
Effective and engaging instructor pedagogy can help engage students.

> *Contributing factors to lack of engagement include how students feel emotionally, whether they feel the content is important and applicable to their lives, and whether they believe they can do the work. When effective relationships are established and maintained, and high expectations are set for all students, teachers can tackle issues of engagement head on. Other contributing factors include students' environment outside of school—their nutrition, health, physical activity, and whether they perceive school as important. These latter factors may be harder for teachers to overcome, which is why it's important to establish conditions in the classroom and the school that support learning for all students, regardless of external influences. [20 ¶. 2]*

Another example can be seen in a study dealing with why students fail from faculty's perspective. The study shows faculty instruction and behavior as the second root-cause behind students failing classes at the

college level by all the participants. However, unlike 2-year college faculty who ranked faculty instruction and behavior as the fourth root-cause factor, the 4-year college faculty who participated in the study identified faculty instructor and behavior as the second root-cause factor [21].

In summary, research to date has focused on the role of statistics in students' future careers, the content of the material presented in these courses, the manner in which those materials are presented, and the administrative structure of the course within a curriculum. This study leverages the unique insights and experiences of faculty to identify specific causes and potential solutions to the challenges of college statistics courses.

2. The Research Study

Being aware of how faculty perceive the challenges and strategies' to overcome those challenges is the best approach to improve teaching and learning statistics in academic settings. It is a necessary first step in clinically analyzing the complexity of the problem and in finding workable solutions that could productively lead to helping students overcome the challenges they encounter in learning statistics and for faculty to overcome the challenges to effective teaching statistics.

The methodological research strategy applied in conducting this study consists of four main integrated stages.

- Constructing, distributing, and collecting the survey for the study.
- Preparing the raw data of the survey for study and analysis.
- Analyzing the data.
- Interpreting the results.

2.1 Stage I: Survey Construction and Data Collection

A survey was prepared containing four open-endedquestionswhich was distributed between 2013-2015 to faculty who teach statistics at the college levels. The questions are listed in Table 1. While the data generated from the use of open-ended questions are not easy to compile and quantify, it is often the best way to find out detailed and specific insights. These types of questions can provide substantial and detail-rich information, especially when they are constructed in a way to obtain usable answers and elicit further explanation.

Table 1
The four main survey questions of the study

	The Four Main Open-ended Questions Used In The Study
1	What are 3-5 of the most critical challenges in teaching statistics to college students?
2	What are the best ways to overcome these critical challenges?
3	What are 3-5 of the most critical challenges in learning statistics for college students?
4	What are the best ways to help students overcome these critical challenges in learning statistics?

2.2 Stage II: Preparing Data for Analysis

Copies of the final survey were distributed to 350 faculty and instructors from four-year colleges in the USA. Of these 350, 218 were completed and returned, with a 62% response rate.

After the surveys were collected, a copy of each survey was distributed to three independent reviewers. Each of the reviewers read and identified key words, phrases, and/or sentences that indicated responses to the posed questions. Upon completion, the three reviewers shared and compared findings. A number of received completed surveys were disregarded for readability, clarity, or single word responses. Table 2 below shows the methodological strategy and mechanism that the three reviewers followed and applied for accepting a given response.Of the 218 returned surveys, reviewers agreed that 189 of those had legible responses. Each legible response included one or more insights per question.

Table 2
Methodology Applied for Accepting a Given Answer
(Adapted from Cherif, Movahedzadeh, Adams, and Dunning, 2013)

	Outcome Condition	**This means**	**Result**
1	Aresponse selected by the three reviewers.	Agreement among all three reviewers.	Accepted with no further analysis for use in the study.
2	Aresponse selected by two of the three reviewers.	Agreement among two of the three reviewers.	The response was critically discussed, but the one who disagreed with the response must convince at least one of the two who selected the given response. a. If at least one of those who selected the response agreed with the one who did not select the response, then the response was rejected and is not included in the analysis. b. If neither of the two who selected the response agreed with the one who did not select the response, then the response was selected and is included in the analysis.
3	Aresponse selected by only one of the reviewers.	Two reviewers disagreed with the third reviewer for selecting a given response.	The reviewer who selected the given response must convince the other two with the reason for selecting this response. a. If at least one of the two agreed with the response, the response was selected and is included in the analysis. b. If neither of the two who disagreed changed their mind, the response was rejected and is not included in the analysis.
4	The response was not selected by any of the reviewers.	Agreement among the reviewers.	The words, phrases, and sentences that were not selected were revisited, discussed and: a. If one of them was selected by the three reviewers, then it is included through the process above. b. If one was not selected by the three reviewers, then it was rejected.

To analyze the insights,the agreed-upon key words, phrases, and sentences were listed and given to the three reviewers, who were individually asked to organize the insights based on similar responses. Upon completion, the reviewers discussed how they each aggregated the participants' insights into main areas and categories within each area. Using a process similar to the one outlined above, reviewers worked together, established agreed-upon main areas and categories, and collectively placed each insight into a main area as well as a category within that area.

For each question, Table 3 shows the number of main identified areas, number of identified categorieswithin each area, and the total number of accepted insights for each of the four main questions in the study. The mean and median number of insights per category are given to aid in determining those categories with a significant number of mentions by survey respondents.

Table 3
Number of Identified Main Areas, Different Categories, and Total Number of Accepted Insights for Each Question

	Questions In the Survey	Number of Identified				
		Main Areas	Categories of Insights	Total Given Insights	Insights per Category	
					Mean	Median
1	What are 3-5 of the most critical challenges in teaching statistics to college students?	4	8	**211**	**26.3**	**24.5**
2	What are the best ways to overcome these critical challenges in teaching statistics?	4	6	**174**	**21.7**	**25.5**
3	What are 3-5 of the most critical challenges in learning statistics for college students?	4	8	**185**	**23.1**	**22.5**
4	What are the best ways to help students overcome these critical challenges in learning statistics?	4	8	**178**	**22.2**	**17.5**

2.3 Stage III: Analyzing the data

Based on the insights given through the survey, the identifiedchallenges in teaching and learning statistics and overcoming challenges for teaching and learning statistics were each divided into the same four main areas. Thosefour main areas areinstructor-related issues, student-related issues, curriculum and content-related issues, and other related issues. The identified categories for the challengesinteaching as well as the challenges in learning statistics included,academic readiness, curriculum and content, fear of math and statistics, instructional pedagogy, nature of statistics, student characteristics, technology, and time management. These are listed in Table 4.

Table 4
Main Areas and Categories of Identified Challenges in Teaching and Learning Statistics

	Main Areas and Categories of Identified Challenges in Teaching and Learning Statistics	
	Main Areas of Challenges	Categories of Specific Challenges
I	Instructor-related Issues	Instructional Pedagogy
		Time Management (by instructors)
II	Student-related Issues	Academic Readiness
		Fear of math and Statistics
		Student Characteristics
		Time Management (by students)
III	Curriculum and Content-related Issue	Curriculum & Content
		Nature of Statistics
IV	Other Related Issues	Technology

Note: "Time management" is one category that is divided in some tables between instructors' time management and students' time management.

As seen in Table 5, the identified categories for overcoming the challenging in teaching statistics were grouped into six main categories. These identified categories include administrative support, course materials and content, class and course management, instructional pedagogy and teaching approaches, assessment strategies and techniques, and instructor's characteristics.

The identified categories for overcoming the challenging in learning statistics were grouped into the following eight categories: instructor characteristics, administrative support, course materials and content, class and course management, instructional pedagogy and teaching approaches, learning strategies and techniques,

technology, and support beyond the classroom.

Table 5
Main Areas and Categories of Overcoming the Identified Challenges in Teaching Statistics

	Main Areas and Categories of Overcoming the Identified Challenges in Teaching and Learning statistics	
	Main Areas of Overcoming Challenges	Specific Categories of Overcoming Identified Challenges
I	Instructor-related Issues	Instructional Pedagogy and Teaching Approaches
		Assessment Strategies and Techniques
		Instructor characteristics
		Class and Course Management
II	Student-related issues	
III	Curriculum and Content-related Issues	Course Materials and Content
IV	Other Related Issues	Administrative Support

Table 6, shows the similarity and the differences among the identified categories for the four main questions of the study. The total insights provided for each question are shown at the bottom of each column. Furthermore, Table 7 shows what is meant by each identified category in this study.

Table 6
Comparative Summary of the Identified Categories
In Each of the Four Questions of the Study

Identified Categories for			
The Challenges in		**Overcoming the Challenges in**	
Teaching Statistics	**Learning Statistics**	**Teaching Statistics**	**Learning Statistics**
Instructional pedagogy	Instructional pedagogy	Instructional Pedagogy & Teaching Approaches	Instructional Pedagogy & Teaching Approaches
Course Materials & Content	Course Materials & Content	Course Materials & Content	Course Materials & Content
Technology	Technology		Technology
Time Management	Time Management		
Academic Readiness	Academic Readiness		
Fear of Math & Statistics	Fear of Math & Statistics		
Student Characteristics	Student Characteristics		
Nature of Statistics	Nature of Statistics		
		Class & Course Management	Class & Course Management
		Instructor's Characteristics	Instructor's Characteristics
		Administrative Support	Administrative Support
		Assessment Strategies and Techniques	
			Learning Strategies and Techniques
			Support Beyond the classroom
211	**174**	**185**	**178**

Table 7
Identified Main Categories and Their Meaning in the Study

Identified Category	Meaning of the Category
Academic Readiness	The degree to which a student is academically prepared with the necessary knowledge and skills to learn statistics.
Administrative Support	This would include such academic services provided by the university such as scheduling class times, assigning instructors, registration, and advising.
Assessment Strategies & Techniques	The methods used to assess student learning such as exams, papers, and discussions.
Class & Course Management	An instructor's ability to manage the class to create a positive environment and to cover all the course material within the assigned time frame.
Course Materials and Content	This is the curriculum included in the course and how the materials will be presented in university-wide settings such as online. Often, these decisions are not made by the student nor by the faculty but by selected group of expertise and professionals.
Fear of Math and Statistics	Students' preconceived notions about math and statistics and their own abilities in these areas.
Instructional Pedagogy (& Teaching Approaches)	Instructors' methods to best present the knowledge, skills, and practice of statistics to students in a ways that can be understood, remembered, and applied.
Instructor Characteristics	The basic behavior of the instructor, unrelated to statistics, such as enthusiasm for teachings and building connections with students.
Nature of Statistics	Some of the concepts in statistics are challenging, but they are parts of characteristics that statistics and are considered essential elements to an introductory statistics course.
Student Characteristics	The basic behavior of the student, unrelated to statistics, such as study habits and note taking skills
Support beyond the Classroom	Support provided outside of the university such as from friends, family, and any other outside support structures.
Technology	The effective use of technology in the classroom and online to help student learning, without hindering student learning.
Time Management	The constraints imposed on the course by time. If divided between instructor and students, this includes the instructor's ability to effectively allocate the right amount of time to the right activity to maximize student learning of the material. For students, this would include their ability to effectively allocate the right amount of time to the right activities to maximize their learning of the material.

2.4 Stage IV: Interpreting the results

Based on the analysis completed and how it adds to the body of research, the results are interpreted.

3. Results and Findings

The results of the study were organized into the four questions of the study: critical challenges in teaching statistics to college students, critical challenges in learning statistics for college students, overcoming the identified critical challenges in teaching statistics, and overcoming the identified critical challenges in learning statistics.For each question, the focus is on the three or four most significant and frequently mentioned areas of challenges and areas of corresponding solutions. Any category that is mentioned above the mean and or the median is deemed significant in the study.

3.1 Results

All the participants in this study were from 4-year institutions in the US. While a few of these institutions also offer associate degree programs, all of them offer baccalaureate (Bachelor)degrees and graduate degrees, at least at the master degree programs in certain areas. Furthermore, there were slightly more males (56%) than female (44%) participated in the study.

Out of 350 surveys distributed to students, 218 completed surveys were collected, a 62% response rate. Anumber of received completed surveys were disregarded for readability, clarity, or single word responses, etc. in their answering of the four main questions. In the end,only 54% were deemed useful completed and returned

surveys. Thus of those 218 completed returned surveys, 189 (86.6%) of them are used in this study.

Table 8
Number of Distributed, Completed, and Accepted Surveys in the Study

	Distributed Surveys	Completed Returned Surveys	Deemed Useful Completed Surveys
Number	350	218	189
Percentage	100%	62%	54%

Respondents then provided one or more insights to each of the four questions. On the 189 useful completed surveys, a total of**211**insightswere identified to question 1, **174**insights were identified to question 2, **185**insights were identified to question 3, and a total **178**insights were identified to question 4.

3.2 General Results

Based on the analysis of the insights given by the faculty and instructors participants, the reasons for critical challenges in teaching and learning statistics at the college level were grouped into four main areas of challenges and either six or eight main distinctive separate categories. All responses fell under one of the specific identified-categories. While it could be disputed as to which main areas or category some of the responses belong in, reviewers discussed any disagreements until a consensus was reached.

3.2.1 Identified Critical Challenges in Teaching and Learning College Statistics

3.2.1.1 Most critical challenges in teaching statistics to college students

Faculty identify a variety of challenges in teaching statistics at the college level. The 211 insights provided on the challenges of teaching statistics were grouped into four main areas with nine categories.

Respondents identified student-related issues as the primary challenge of teaching college statistics. Table 9 shows a total of 55.4% of all the respondents' insights were categorized in this area. Instructor-related issues comes second with a total of 27.9% of all insights. Curriculum and content-related issues and other issueseach with far fewer insights indicating those as concerns in teaching statistics.

Table 9
Main Areas and Categories of Identified Challenges in Teaching Statistics

	Main Areas	Categories	Frequency by Category	Frequency by Main area
I	Instructor-related Issues	Instructional Pedagogy	54	**59 (27.9%)**
		Time Management (by Instructors)	5	
II	Student-related Issues	Academic Readiness	40	**117 (55.4%)**
		Fear of Math and Statistics	33	
		Student Characteristics	30	
		Time Management (by Students)	14	
III	Curriculum and Content-related Issue	Curriculum & Content	11	**23 (10.9%)**
		Nature of Statistics	13	
IV	Other Related Issues	Technology	11	**11 (5.2%)**
	Total		**211**	**211**

When viewing the insights based on their categories, however, a somewhat different picture evolves. Here, an instructor-related issue rises as a top concern, rather than a student-related issue. As shown in table 10, the category of instructional pedagogy was the most frequently mentioned root cause for challenges in teaching college statistics noted in25.9% of the total insights. Instructional pedagogy deals with the instruction applied in teaching statistics such as teaching methods, strategies and techniques.

The other categories noted in more than the median number of insights were student academic readiness (18.9% of insights), students' fear of math and statistics(15.5%), and student characteristics (14.2%). Together, these categories represent 48.6% of the insights, reflecting the many insights focusing on student-

related concerns.

Table 10
Insights on Challenges in Teaching College Statistics by Category
(bold categories have frequency larger than mean and median)

Category	**Identified Critical Challenges In Teaching Statistics**	
	Frequency	Percentage
Instructional pedagogy	**54**	**25.9%**
Academic readiness	**40**	**18.9%**
Fear of math and statistics	**33**	**15.5%**
Student characteristics	**30**	**14.2%**
Time management(by students)	14	6.6%
Nature of statistics	13	6.1%
Curriculum and content	11	5.2%
Technology	11	5.2%
Time management (by instr.)	**5**	2.4%
Total	**211**	100%

Mean: 211 / 8 = 26.3 (12.46%) Median: 24.5 (11.6%)

Time management of students and instructors (9.0%), nature of statistics (6.1%), curriculum and content (5.2%), and technology (5.2%) are all mentioned less frequently. Each of these was mentioned below the mean and the median of all the giveninsights on challenges of teaching college statistics.

3.2.1.2 Most critical challenges in learning statistics for college students.

Responding faculty also considered the challenges students face when learning college statistics. Under this question, a total of 185faculty insights were grouped into four main areas with nine categories.

As one might expect, student-related issues was the main area identified as a challenge in learning college statistics with 53.5% of all insights (see Table 11). Curriculum and content issues as well as instructor-related issues are each noted with about 20% of the total insights. This indicates that what is taught and how it is taught both contribute to challenges in learning statistics. However, each of these is noted less than half as often as student-related issues.

Table 11
Main Areas and Categories of Identified Challenges in Learning Statistics

	Main Areas	Categories	Frequency by Category	Frequency by Main Area
I	Instructor-related Issues	Instructional Pedagogy	34	**36 (19.4%)**
		Time Management (by Instructors)	2	
II	Student-related Issues	Academic Readiness	37	**99 (53.5%)**
		Fear of Math and Statistics	17	
		Student Characteristics	32	
		Time Management (by Students)	13	
III	Curriculum and Content-related Issue	Curriculum & Content	28	**37 (20%)**
		Nature of Statistics	9	
IV	Other Related Issues	Technology	13	**13 (7%)**
	Total		**185**	**185**

The most frequently mentioned category reflects the importance of student-related issues to learning

college statistics. This category of academic readiness is noted in 20% of the insights provided (see Table 12). The second most mentioned category was instructional pedagogy. This category is from the instructor-related issues area, but is still mentioned in 18.3% of the insights provided. The third most frequently mentioned category is again student related, focusing on the characteristics students bring to college statistics. The final category with more than the average number of insights was curriculum and content with 15.1% of the insights. While in a broad sense student-related issues are the primary issue in learning college statistics, more specific analysis points to a sharing of these challenges across students, instructors, and curriculum.

Table 12
Insights on Challenges in Learning Statistics by Category
(bold categories have frequency larger than mean and median)

Category	**Identified Critical Challenges In Learning Statistics**	
	Frequency	Percentage
Academic readiness	**37**	**20.0%**
Instructional pedagogy	**34**	**18.4%**
Student characteristics	**32**	**17.3%**
Curriculum and content	**28**	**15.1%**
Fear of math and statistics	17	9.2%
Time management (by students)	13	7.0%
Technology	13	7.0%
Nature of statistics	9	4.9%
Time management (by instr.)	2	1.1%
Total	185	100%

Mean: 185 / 8 = 23.1 (12.48%) Median: 22.5 (12.1%)

In summary, for challenges in both teaching and in learning college statistics, instructional pedagogy and student's academic readiness were the two most mentioned challenges (table 13). Between these two categories, instructional pedagogy was clearly the main challenge in teaching college statistics, while academic readiness and instructional pedagogy were noted equally as challenges in learning college statistics.

Table 13
Insights on Challenges in Teaching and in Learning Statistics by Category
(bold categories have frequency larger than mean and median)

Category	**Identified Critical Challenges In …**			
	Teaching Statistics		**Learning Statistics**	
	Frequency	Percentage	Frequency	Percentage
Instructional pedagogy	**54**	**25.9%**	**34**	**18.3%**
Academic readiness	**40**	**18.9%**	**37**	**20.0%**
Fear of math and statistics	**33**	**15.5%**	17	9.1%
Student characteristics	**30**	**14.2%**	**32**	**17.2%**
Time Management (both)	19	9.0%	15	8.1%
Nature of statistics	13	6.1%	9	4.8%
Curriculum and content	11	5.2%	**28**	**15.1%**
Technology	11	5.2%	13	7.0%
Total	**211**	100%	185	100%

3.2.2 Overcoming Identified Challengesin Teaching and Learning College Statistics

After being asked to identify the challenges in both teaching and learning college statistics, faculty

respondents were asked what they considered the most effectively methods of overcoming these challenges. These insights were organized into similar main areas and categories as were the challenges.

3.2.2.1 Overcomingchallengesin teaching statistics

Under this question, participants' responses were grouped into four main areas with six categories and with a total of 174 identified insights.

To overcome challenges in teaching college statistics, faculty most frequently mention instructor-related issues. This is consistent with the identification of most challenges in this area. Instructor-related methods of overcoming these challenges was mentioned in 80.4% of the insights provided. The second most listed insights fell into other-related issues with 12.6% of insights. Interestingly, the content of what is being taught was not considered a primary avenue for addressing these teaching challenges as this was mentioned in only 6.8% of the insights. In other words, responding faculty had few concerns with what was being taught and focused instead on how the material was being taught. Of course, students-related issues are not related to how to overcome challenges in teaching college statistics.

Table 14
Main Areas and Categories of Overcoming Challenges in Teaching Statistics

	Main Areas	Categories	Frequency	Percentage
I	Instructor-related Issues	Instructional Pedagogy & Teaching Approaches	69	**140 (80.4%)**
		Instructor's Characteristics	29	
		Assessment Strategies and Techniques	10	
		Class & Course Management	32	
II	Student-related Issues			
III	Curriculum and Content-related Issue	Course Material and Content	12	**12 (6.8%)**
IV	Other Related Issues	Administrative Support	22	**22 (12.6%)**
	Total		**174**	**174**

The three categories most frequently noted in responding faculty insights were also focused on instructor-related issues. Table 15 shows that instructional pedagogy was by far the most frequently mentioned category with 39.6%. Class management and instructor characteristics were also mentioned more than the median number of times with 18.3% and 16.6% of the insights, respectively.

Table 15
Insights on Overcoming Challenges in Teaching Statistics by Category
(bold categories have frequency larger than mean and median)

Category	**Overcoming Challenges In Teaching Statistics**	
	Frequency	Percentage
Instructional Pedagogy &Teaching Approaches	**69**	**39.6%**
Class & Course Management	**32**	**18.3%**
Instructor Characteristics	**29**	**16.6%**
Administrative Support	22	12.6%
Course Materials & Content	12	6.8%
Assessment Strategies & Techniques	10	5.7%
Total	**174**	100%

Mean: 174 / 8 = 21.7 (12.47%) Median: 25.5 (14.6%)

In overcoming concerns with teaching college statistics, responding faculty focused less on

administrative support (12.6% of insights), course materials and content (6.8%), and assessment strategies and techniques (5.7%) are each mentioned below the median number of insights.

3.2.2.2 Overcoming challenges in learning statistics

As the last element in the study, respondents were asked to identify methods for overcoming challenges in learning college statistics. The 178 insights provided were grouped into four main areas with eight categories.

As with overcoming challenges in teaching, instructor-related Issues was the most mentioned area with a total of 38.7% of all the respondents' insights for learning college statistics as well. After that, curriculum and content-related issues as well as other issues were mentioned about the same number of times with 23.5% of insights and 24.7% of insights, respectively. Interestingly, students-related issues were mentioned least frequently with a total of 12.9% of all respondents' insights on how to overcome challenges in learning college statistics.

Table 16
Main Areas and Categories of Overcoming Challenges in Learning Statistics
(bold categories have frequency larger than median)

	Main Areas	Categories	Frequency	Percentage
I	Instructor-related Issues	Instructional Pedagogy & Teaching Approaches	51	**69 (38.7%)**
		Instructor Characteristics	8	
		Class and Course Management	10	
II	Student-related issues	Learning Strategies and Techniques	23	**23 (12.9%)**
III	Curriculum and Content-related Issues	Course Materials and Content	42	**42 (23.5%)**
IV	Other Related Issues	Technology	24	**44 (24.7%)**
		Administrative Support	12	
		Support Beyond the classroom	8	
	Total		**178**	**178**

The category of instructional pedagogy and teaching approaches was the most frequently mentioned solution to overcome the challenges in learning college statistics, included in28.6% of participants' insights. The second most frequently mentioned category was outside of instructor-related issues and was focused on course materials and content. This category was included in 23.5% of respondent insights.Technologywas mentioned as a method to overcome challenges in learning college statistics in 13.4% of the insights, while student learning strategies and techniques was the fourth most frequently mentioned with 12.9% insights. The most frequently mentioned categories of insights provided on how to overcome challenges in learning college statistics covered all four main areas of insight classifications. This result indicates a lack of consistency in how to address student challenges in learning college statistics.

Table 17
Insights on Overcoming Challenges in Learning Statistics by Category
(bold categories have frequency larger than mean and median)

Category	**Best Ways to Overcome Challenges In Learning Statistics**	
	Frequency	Percentage
Instructional Pedagogy & Teaching Approaches	**51**	**28.6%**
Course Materials & Content	**42**	**23.5%**
Technology	**24**	**13.4%**
Learning Strategies & Techniques	**23**	**12.9%**

Administrative Support	12	6.7%
Class & Course Management	10	5.6%
Instructor Characteristics	8	4.4%
Support Beyond Classroom	8	4.4%
Total	**178**	100%

Mean: 178 / 8 = 22.2 (12.47%) Median: 17.5 (9.8%)

Administrative support, class and course management, instructor's characteristics, and support beyond classrooms are all mentioned below the mean and the median of all insights to overcoming challenges in learning college statistics.

In summary, instructional pedagogywas the most mentioned method to overcome challenges in both teaching and in learning statistics. From there, however, insights differ on how to overcome challenges in these two areas of statistics. Overcoming challenges in teaching statistics are focused more on instructor-related issues, while a variety of methods are mentioned to address overcoming challenges in learning statistics.

Table 18
Insights on Overcoming Challenges in Teaching and in Learning Statistics by Category
(bold categories have frequency larger than mean and median)

Category	**Identified Methods to Overcome Challenges In …**			
	Teaching Statistics		**Learning Statistics**	
	Frequency	Percentage	Frequency	Percentage
Instructional Pedagogy & Teaching Approaches	**69**	**39.6%**	**51**	**28.6%**
Class & Course Management	**32**	**18.3%**	10	5.6%
Instructor Characteristics	**29**	**16.6%**	8	4.4%
Administrative Support	**22**	**12.6%**	12	6.7%
Course Materials & Content	12	6.8%	**42**	**23.5%**
Assessment Strategies & Techniques	10	5.7%	0	
Learning Strategies & Techniques	0		**23**	**12.9%**
Technology	**0**		**24**	**13.4%**
Support Beyond Classrooms	**0**		8	4.4%
Total	**174**	100%	**178**	100%

4. Analysis and Discussion

Based on the preceding tabulation of the leading main areas and leading identified categories in each question of the study, the analysis will delve into similarities and differences as well as why these occur. As seen in Figure 1, this study will focus only on those identified challenges and how to overcome them in teaching and learning statistics that are cited by more than the means or medians of the insights in that category for each question.

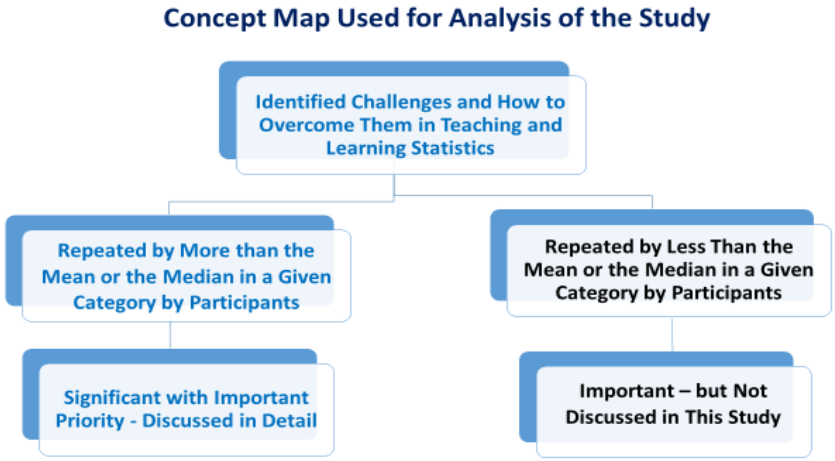
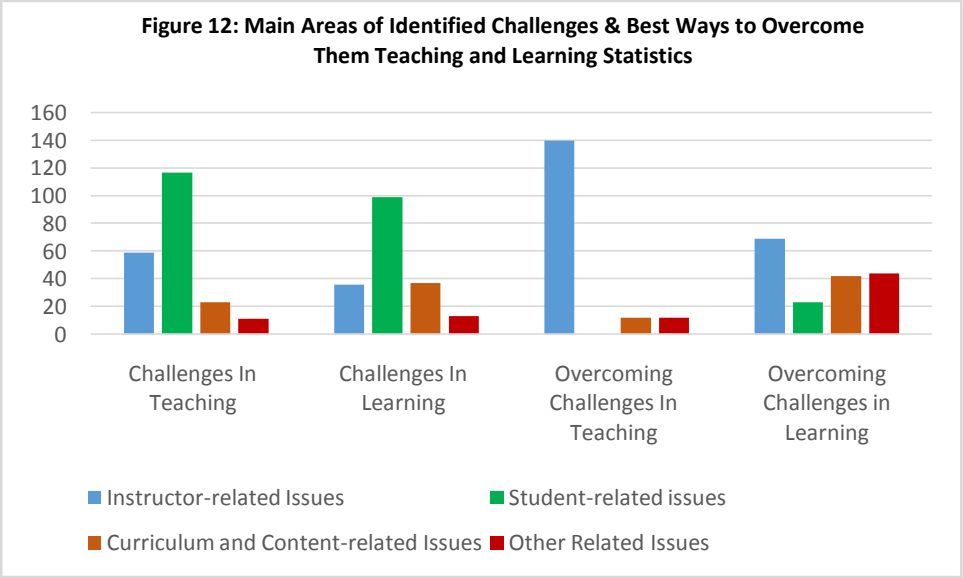


Figure 1

In looking at the four main areas of the of participants' responses, participants identified more categories of the challenges in teaching and learning statistics under the "Student-related Issues" and with a total of 55.4% and 53.5% of total insights respectively. However, this is not the case when considering how the same participants identified in the best ways to overcome the identified challenges in teaching and learning. Here, the participants identified more categories **on**how to overcome the challenges in teaching and learning statistics under the "Instructor-related Issues" and with a total of 80.4% and 38.7% of total insights respectively. While the total provided insights identified under the "student-related Issues" in the best ways to overcome the challenges in learning statistics, was the lowest (12.9%) of the four main areas.



Specific categories of responses allow for a deeper analysis. Table 19 presents the percentage of insights in each category with the significant category percentages highlighted.

In looking at the result of the study, a few that are related stand out as clear and significant indicators of what the participants believe not only on the challenges in teaching and learning statistics but also on how to overcome those identified challenges.

- Instructional pedagogy and teaching techniques
  - Instructional pedagogy has the distinction of being clearly identified in all aspects of this study as a critical challenge as well as an important avenue to overcoming that challenge.

- Student's academic readiness coming to statistic courses
  - While a significant challenge to teaching and learning, a variety of the methods could be associated with overcoming this specific challenge.
- Personal characteristics of students and instructors
  - Student characteristics were identified as a challenge while instructor characteristics was noted as a potential method to overcome challenges.
- Curriculum, course materials and content
  - This was noted as a method to overcome challenges in teachings and learning statistics. It was not noted as a challenge in neither teaching nor learning statistics.

Each one of these, individually as well as in combination with others, affect both how instructors teach and how students learn college statistics.

Table 19
Insights on Challenges in Teaching and in Learning Statistics and Overcoming Those, by Category
(bold categories have frequency larger than mean and median)

Category	Percentage of Insights in Each Column			
	Challenges		Overcoming	
	Teaching	Learning	Teaching	Learning
Instructional pedagogy	**25.9%**	**18.3%**	**39.6%**	**28.6%**
Academic readiness	**18.9%**	**20.0%**		
Fear of math and statistics	**15.5%**	9.1%		
Student characteristics	**14.2%**	**17.2%**		
Time management(by students)	6.6%	7.0%		
Nature of statistics	6.1%	4.8%		
Course materials and content	5.2%	**15.1%**	6.8%	**23.5%**
Technology	5.2%	7.0%		**13.4%**
Time management (by instruct.)	2.4%	1.1%		
Class and course management			**18.3%**	5.6%
Instructor characteristics			**16.6%**	
Administrative support			**12.6%**	6.7%
Assessment strategies			5.7%	
Learning strategies				**12.9%**
Support beyond classroom				4.4%
Total	100%	100%	100%	100%

4.1 Instructional Pedagogy and Teaching Techniques

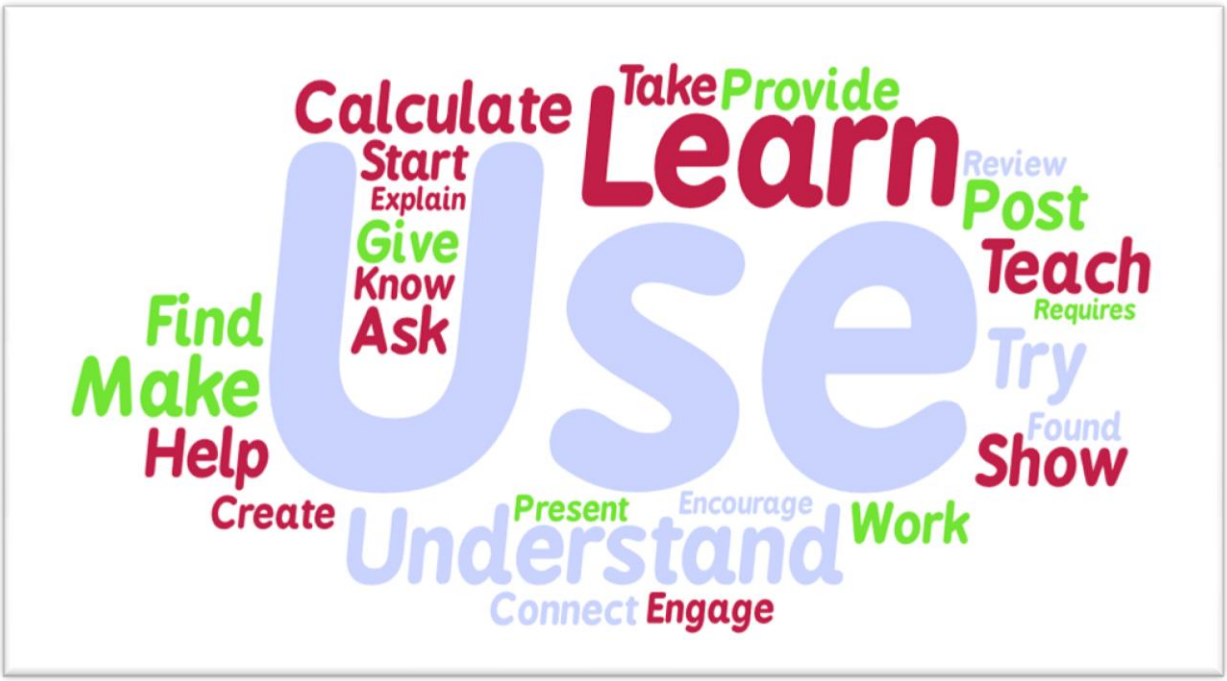
Respondents in this study highlighted their own instructional pedagogy as a main root-cause of the challenges for and the solution of how to overcome them in teaching and learning statistics. This instructional pedagogy would include teaching techniques and practices that are used in teaching statistics. Recognizing the importance of their own teaching to the challenges as well as a primary source of solutions to improving teaching and learning, instructors are in need of support. Additional support would allow instructors to more fully develop their teaching to meet the needs of more students. This has significant implications for college administrators. College administrators could better support faculty to explore and experiment with new innovative teaching strategies, educational technologies, student's engagements techniques, better methods for assessing student's needed, performance, and learning, etc. It means that faculty want college administrators and academic leaders to do better job in:

1. Increased professional development to keep up with the advancement in pedagogical technology.
2. Smaller classes and less heavy course loads.
3. Less committee work and administrative responsibilities.

Instructional Pedagogy has the unique advantage of being highly rated in each of the four questions. For this matter, reviewing each of the responses is enlightening to challenges and overcoming both teaching and learning statistic. From the perspective of the challenges in teaching statistics, faculty insights from the survey focus on motivating the student, keeping the material interesting in order to get the student to understand the concept and to effectively complete the basic tasks of statistics, and to keep the material relevant to everyday life. These insights are reflected in the words of the participants as:

Instructional Pedagogy Challenges in TEACHING statistics Faculty insights to Question 1
Relevance: Motivating students to see the relevance of the material presented in their current daily life and future academic careers.
Making the material interesting
Staying current and bringing examples of statistics that are relevant to students
Getting students to conceptually understand the material and not focus only on the mechanical aspects of statistics
Getting students to effectively interpret, analyze, and evaluate the statistics they are dealing with.
Providing effective real world activities/problems for students to apply their learning to.
Keeping the students motivated.

Faculty reflect that the teaching challenges can be overcome by including material that is interesting and relevant to the student, by demonstrating the students previous exposure to the subject, and by reassuring the students that statistics can be a part of their everyday life. Verbs used three or more times in the responses to this question created the following word cloud:



This art demonstrates that faculty value their abilities to use, learn, calculate, make, and understand key to the process of teaching statistics. It is interesting that the verb "teach" was not the most prevalent verb. Faculty view their job within instructional pedagogy of statistics as a more complex process involving many activities and strategies.

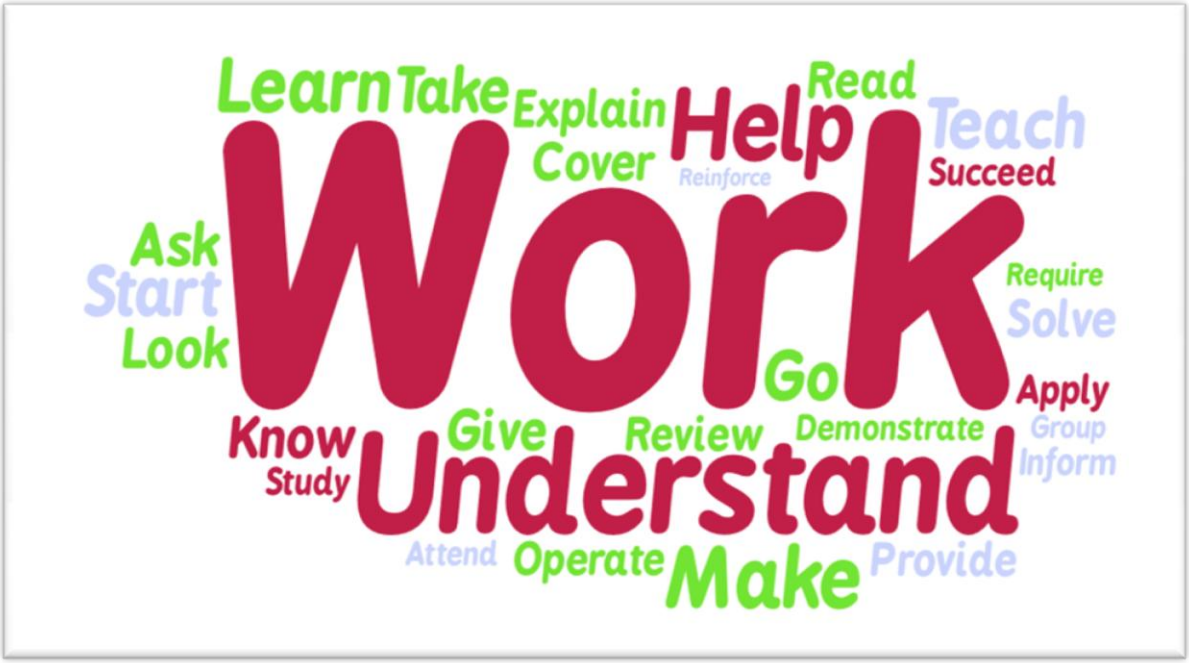
Examples of specific insights from faculty were:

Instructional Pedagogy Overcoming Challenges in TEACHING statistics Faculty insights to Question 2
Teachers should use different methods of cooperative learning in teaching statistics.
Appreciation: Associate current events and activities that are considered important to the student to statistical topics, theories, and reasoning.
Lots of activities, practice and repetition with actual data.
Teachers should experiment with different teaching approaches by carefully listening to students.
Lack of mathematical knowledge and skill – provide basic math tutorials and access to tutors; focus on concepts more than computation (especially given tools such as Excel).
Have them find examples of everyday uses of statistics and explain what they mean to the rest of the class
Many times, students who believe that they are not "good" at math need alternative learning strategies to demonstrate their understanding in math/stat courses.
By assigning projects where students need to apply the statistics, you can get the students to conceptually understand the material.
Show how the students really do have some knowledge of the subject
Give students a rich list of vocabulary to learn and use in daily bases so they become familiar with these terms and how to use them; they need to become part of their daily conversation.

Meanwhile, faculty are aware of the challenges in learning statistics. Statistics is a new language to the student and require an understanding of complex terminology. An understanding is developed with an association to the material and real life. These insights are reflected in the following quotes:

Instructional Pedagogy Challenges in LEARNING statistics Faculty insights to Question 3
Teachers underestimate the difficulty students have in understanding basic concepts of probability and statistics.
Appreciating deviation – without deviation, there would be no need for statistics; if students can recognize the impact of deviation, they get the course; this can be done by demonstrating how variance within the standard deviation impacts the equations, resulting in different outcomes when hypothesis testing.
Appreciating alpha, Type I and II errors, and p-values – recognizing that we're always dealing with probabilities and not certitudes; though evidence from a sample could lead to a given conclusion, the sample might not represent the population.
Understanding the nature of variables – recognizing that how one asks a question will provide answers in a given form; that form will dictate what tests can be run; all data is not created equally.
Knowing they have someone to turn to when they have concerns.
Retention of material is low because students do not see the clear connection to what they are currently doing on the job or to what they intend to do when they complete their degree. Most indicate they will not be performing quantitative roles, and do not use or expect to use specialized statistical software. The larger concepts are often quite valuable, but they seem to get lost in the effort to understand how to do the calculations so points aren't lost on homework and tests.
Formulating appropriate statistical analysis scenario, migration from word problems into mathematical analysis/calculation, and interpretation of statistical results.
Understanding statistical terminologies and meanings.
This is the hardest one. The only solution is to just keep offering, be available, and make sure you give worthwhile, thorough answers to any questions asked.

Faculty have used this knowledge to overcome challenges in learning statistics. As faculty listed their insights of how students could overcome their challenges in learning statistics, several verbs were highlighted. Verbs used three or more times in response to this question created the following word cloud:



The primary verbs were work, understand, help, make, and learn. A key to component within instructional pedagogy to overcome challenges in learning statistics is to put the work into the course. These verbs were used more than the verb teach. This indicates that faculty recognize the effort necessary within their instructional pedagogy to overcome the challenges students face when learning statistics.

These insights reflect an approach that is comforting to the students by presenting the material in a relevant and appropriate manner. A few faculty reflections in this area are:

Instructional Pedagogy Overcoming Challenges in LEARNING statistics Faculty insights to Question 4
Most students overcome the issues by taking the necessary time to work through some problems, attend the iConnect lectures. I will work with students one on one as necessary on specific problem solving techniques.
Engage with the students in a way that goes beyond teaching the mechanics.
Start at the beginning of the material and get the basics down
Have faculty remember that this is the first statistics course the students are taking and assume they don't have stat background before, and teach it accordingly; yes, it will consume more of your time as instructor, but this is the only way you can overcome this challenge.
Try to reassure students frequently that you are here to help them learn and succeed.
When we emphasize statistical thinking over statistical methods, our students understand and learn what stat is all about. Yes, it is a way of gathering and organizing data, but more important is that it is a way of analyzing and interpreting the data and come up with informative and supportive conclusions.
Reinforcing and reviewing both in class and online methods to help students' success. Take the opportunities provided to explain and demonstrate to students different resources and methods, that way students will be reminded and shown successful strategies.
I make sure to present the material in an easy to understand format and provide tutoring help outside the classroom.
There is a core path for learning within and in every human being, and if we can find that core-path for learning and use it, then we can help each student to learn; and statistics is not exception to the role.

4.2 Academic Preparedness

Insights in the survey were consistent with students showing a significant number of today's students seem less prepared and less motivated for the rigors of college works for many reasons including finding college courses to be boring, perceiving college instructors of not caring enough, lack of time because of work and

family responsibilities, etc. What is interesting is that research shows that both faculty and students are aware, to some extent, of these student challenges ([22], [19], [23]).

A common example is that one of the major differences between college and high school academic work is that "college work requires all types of thinking (critical, analytical, creative) and in-depth readings, rather than just rote memorization and shallow reading" [23]. While this is true in all types of college courses, it is even more essential in statistic courses because of the fundamental nature of statistic.

On a basic level, steps administrators can take to address these initial concerns in student academic preparedness would be:

1. Making sure to accurately diagnose student's college readiness at least academically, before enrolling them to the college and in given classes.
2. If a number of students, somehow, accidently misdiagnose and admitted and or enrolled in given classes without the needed qualification, making sure that the college provide them and their instructors with the needed support to help students succeed.
3. College administrators working with high school and college counseling to improve college advising.

The prevalence of this concern in this study indicates a larger issue. Participants in this study mentioned student's academic readiness as the first most mentioned challenge in learning statistics (20% of insights) and the second most challenge in teaching statistics (18% of insights) at the college level. Taken broadly, academic preparedness means cognitive ability, the ability of attaining and using learned academic content, and communication skills. The combination of these three abilities is what makes a given academically prepared student. Thus, lack of academic readiness does not always mean that students are not intelligent, bright, and/or hard workers. So often, students are not prepared academically because they lack the language, communication, and writing skills that are needed in order for them to comprehend what they learn and to communicate what they understand to others [23].

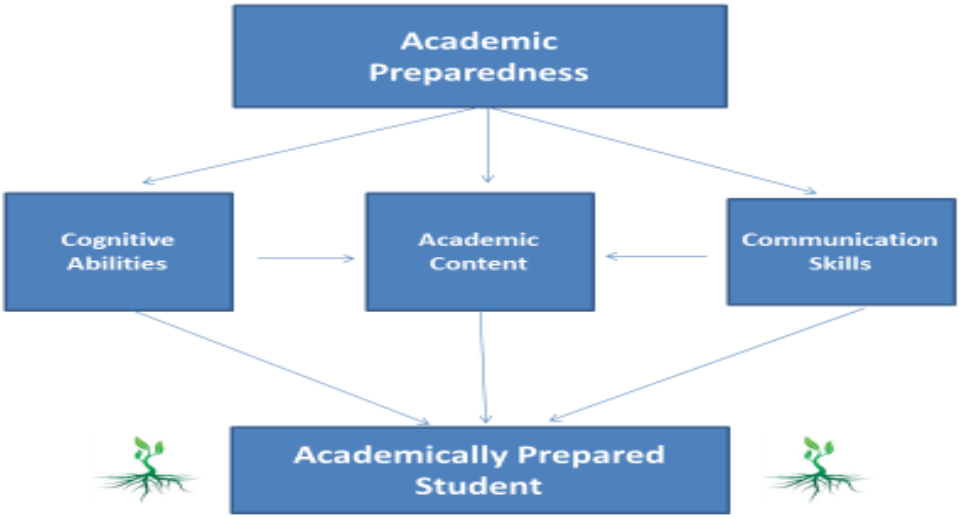


Figure 10

At the same time, faculty acknowledge that there is no such thing as a "homogenous class" even among those classes in which students with selected characteristics are specifically selected to be enrolled in a given class. Students in a statistics class are not homogenous in the way they learn and process information. Simply because every one of them or group of them have their own pedagogical preferences, intellectual abilities, and ways of learning and relate to exposed knowledge and information.

> *"It is also a well-known fact that faculty every day enter classes full of students with a wide range of learning needs, levels of preparedness, levels of interest and self-motivation, and social and cultural backgrounds. This range of capabilities in the classroom is not only a frustrating phenomenon that drives faculty to feel overwhelmed, but also a condition that often drives some students to feel lost in the traditional classroom environment" (Cherif, et. al., 2013).*

Within the context of nonhomogeneous student groups, there are challenges faced in teaching and learning statistics when students are not sufficiently prepared. This is supported by respondent insights such as:

Academic Readiness Challenges in TEACHING statistics Faculty insights to Question 1
The students' lack of preparedness
Student Preparation. Do students have the appropriate quantitative skills to succeed in statistics? If they don't they can be severely hampered.
Many faculty assume that students already have an understanding of statistics.
Many students have limited communication abilities. In particular, their ability to communicate in appropriate business English is poor. Online discussions are intimidating for students who lack the ability to write coherent sentences, and frustrating for students who are trying to understand what is being communicated. This also hinders students' ability to express where they are struggling and to ask questions.
Their study skills are weak. If they get behind it is very hard for them to catch up.
Poor computer skills.
By far number one is the lack of critical reasoning skills: an inability to apply what they are learning in the context of how it is being used.

The overall message is that a number of students fail to learn simply because they are not ready cognitively or not prepared academically for college work in statistic courses. It also means that regardless of the best efforts faculty apply in teaching statistics, if the students are not academically ready, then this becomes a critical challenge and a potential problem in whether students learn the intended course material; **not to mention their ability to apply what they learn in different situations.**

Further, respondingfacultyacknowledged that they must pay attention to the characteristics of modern learners in order to effectively focus any potential improvements in the teaching of college statistics. Here is where personal characteristics of both students and instructors come to play. For example, respondents gave insights such as:

Academic Readiness Challenges in LEARNING statistics Faculty insights to Question 3
Communication skills. Students have to be able to think critically, and be able to communicate in writing (and in some cases orally). Knowing the mechanics, but not how to communicate the results will not be useful in the workplace.
Having to use calculators and stat software when they don't know what they are trying to find
Communication: Students must be able to write effectively to show they understand what they are learning.
Many students are poorly prepared for Statistics; i.e. they have poor mathematical skills.
Many students have limited computer proficiency.
Weak problem solving skills.
Students do not have good study habits.

Furthermore,Modern learners seem to have a different kind of expectation about the interactivity and how a given learning environment could draw them in. Because of this, many of the modern students have the tendency to easily loss interest and disengage if they find the subject materials or how they are taught not interesting or not relevant to capture their mind and in turn invest the needed time and the energy. It is the realization such as this that made Christy Price [24], a psychologist at Dalton State College, to explain that "Modern learners have a different mind-set about education, but that doesn't mean they don't want to learn; they just go about it differently." College administrators and faculty need to keep this in mind when they enroll students in classes and when they start teaching given courses.

4.3 Student Characteristics

Student characteristics refer to the innate and acquired personal quality or trait that makes a given student or group of students to succeed in a given course while some others cannot. However, not every failure to succeed can be attributed to student's characteristics or failure to identify which students in your class are at-risk. What is clear is that, a student's own characteristics and attitude is an extremely important factor in

learning because it directs students' basic behavior, aspirations and ambitions. In an educational setting, there is correlation between student's positive state of mind, often called a positive attitude, and academic achievement [25].

Based on the responses, faculty reflect on the student's characteristics being challenges in both the teaching and learning of statistics. From a teaching perspective, students' commitment to their course work is influenced by family and work life, as well as previous education. These concerns are highlights in survey insights such as:

Student Characteristics Challenges in TEACHING statistics Faculty insights to Question 1
… their understanding of what the course is about
They are students with full time work and family so it is easy for them to get behind
…believing they can do it
They will not try to read the material before class. They prefer to think they will learn it all by sitting in the classroom.
Students come to stat classes with low levels of motivation and less enthusiasm.
…getting them to set aside enough time
In general, I have found that students have been out of school for a number of years and they have trouble with getting used to studying again.
Academic Integrity – a big challenge, especially with projects. The temptation to cheat, find solutions on the internet, or collude with other students is overwhelming. Too many students don't even see it as cheating.
Overcoming the tendency to use calculators and [statistical software packages] to find solutions to problems that they do not even know or understand what the question is asking

The student characteristics also challenge faculty on the learning aspect. These challenges can be adjusted by a student's commitment and attitude to approach the learning with motivation and good study habits.

Student Characteristics Challenges in LEARNING statistics Faculty insights to Question 3
Lack of motivation amongst students.
Study habits. Students tend to skim through class slides and resort to internet search engines as a substitute to reading the course material as outlines in the course shell [syllabus] and highlighted in class.
They assume they will not do well in the class.
Many of the students believe they are "good" at math. Getting them past this idea is very difficult.
Students that come with preconceived notions (hard, never use it, must be exceptional at algebra).
Understanding it is OK to ask for help
Attitude towards the subject (stereotype).

For example, students who are not willing to ask questions and/or are not ready to say that they need help, have a greater tendency to fail than those who do ask for help. By asking questions and for seeking help when they need it, students maximize their rate of success. Developing a negative attitude toward a given course and course work (which prevents students from easily engaging in the course work) could happen as a result of a negative learning experience, or a faulty communication or misunderstanding with an instructor, staff member, administrator, or even fellow students or even simply not having the needed background, and no one is there to recognize this and step-up to help.

4.4 Course Materials and Content

When classes are perceived by students as boring and/or are not challenging, so often students do not make any effort and thus end up failing. There is growing evidence that "courses with learner-centered approaches — those approaches that use active learning strategies to engage students directly in learning processes — enhance academic achievement and promote the development of important learning skills, such as critical thinking, problem solving, and the ability to cooperatively work with others" [26, ¶ 2).

The participants in this study seem to agree that "although we have only limited power over students' attitudes, academic readiness, and study habits, in the classroom setting we (faculty and instructors) control the

learning materials, learning environment, and pedagogy through which we can influence student's motivation, study habits, and attitudes, and help them see the relevancy of what they learn to their lives and future careers ([23]. As Jackson [27] argued, we help them to make decision to invest in our courses by simply making them to be interested in what and how we teach.

Students will invest more time and energy as well as demonstrate more perseverance if they are interested in what they are learning. This means that the responsibility of learning is not only on them, but also on facultyand college administrators. Faculty need to inspire students through teaching, class management, and personal behaviors, etc. The first step is to make informative efforts to engage and educate students by making statistics personally relevant and career focused.

Course materials can do this by implementing a variety of ways to meet their learning styles. This could include ideas such as (but not limited to):

Focused, short-bit lecture,
Reinforce with video,
Participate in peer group discussions,
Animation,
Repetition of material,
Hands-on learning,
Technology-based learning

Each of these ideas could be implemented within studies to determine their effectiveness in teaching and learning college statistics.

5. Recommendations

Survey results along with the experience and discussions with many other professors of college statistics, lead recommendations to be organized into four main areas:

- Instructional pedagogy and teaching techniques
- Student academic readiness for college statistics
- Personal characteristics of students
- Curriculum, course materials and content

5.1 Instructional Pedagogy and Teaching Techniques

This survey highlights that faculty at the college level recognize the need for dedicated and focused instructional pedagogy to overcome many challenges in teaching and learning statistics. Many of the comments as well as the verbs used in the responses pointed to the importance of faculty working to use engaging examples with the materials. They highlighted the work necessary by both faculty and students to achieve a full understanding of this material by the most students possible.

- Today's faculty and instructors require different skills than in years past. As a result, diverse faculty with diverse training needs.
- While faculty are not and cannot be experts in all educational tools, today's faculty need to have fast approaches to adapt to changes in technology and to become experts in tools to help students navigate through various options.
- For example, create opportunities to use technology to facilitate individualized instruction and learning with technology

Recommendations point to the importance of building a strong connection between instructors and students. This starts on the first day where professors can use a variety of strategies to connect such as informal introductions on the first day and have students to complete an interest inventory. This allows students the opportunity to form personal connections and meaning with statistics material even before the course begins. As Kelsey Metzger [28] from the Center for Learning Innovation at University of Minnesota Rochester demonstrated in her recent article, "Starting Right: ... at the Beginning of a Course", [28] "*Events that occur on the first day of class can leave a lasting impression on students and affect their motivation and performance*". Throughout the course, other strategies were consistently mentioned to improve instructional pedagogy and teaching techniques, such as:

- Establish a connection between new materials and something already learned.
- Have fair, high standards with clear expectations for students.
- Allow students to work together, learn from and teach each other in small group activities and discussions.
- Use more hands-on activities, meaningful visual aids, and demonstrations rooted in topics familiar and

relevant to the students.
- Build student confidence in mastering basic concepts
- Maximize student engagement time inside the classroom with resources outside the classroom
- Using assessments as a teaching and evaluation tool.

5.2 Student Academic Readiness for College Statistics

Determining each student's academic readiness for a college statistics course is multifaceted and an inaccurate science. While some general assessments can help determine academic readiness, this may still allow some unprepared students to enroll in college statistics. For those students who are able to enroll in college statistics, but are not academically prepared for the course, universities should be ready to provide any additional needed support such as a tutor center.

The academic support can be combined with more interaction within instructional pedagogy by providing incentives for students to support each other. Grade incentives could be provided to students who help peers or other group activities within the classroom could provide incentives for students to interact and teach each other.

5.3 Personal Characteristics of Students

At many universities, students are tending to be over 25 and their learning is focused on how to apply principles learned. Younger, more traditional students tend to focus more on the content as they learn. They want to achieve the objective of learning the material. Older students, in contrast, tend to focus on what they perceive to be important based on their experiences. They also look at problems they have seen in the past, or could envision, and how new knowledge might solve those problems.

It is the realization such as this that made Christy Price [24], a psychologist at Dalton State College, to explain that "*Modern learners have a different mind-set about education, but that doesn't mean they don't want to learn; they just go about it differently*" (Thursday, March 28, 2013). College administrators and faculty need to keep this in mind when they enroll students in classes and when they start teaching given courses.
Based on these characteristics, these non-traditional students are more likely to lose interest in material, perhaps especially in a course outside of their major such as college statistics, as they don't view it as relevant. It becomesincumbent on the professor to continually demonstrate the applicability of the new concepts, akin to getting buy-in from students, before students are willing to invest their time and effort in their learning process. Some ideas that came from the research are:
- Provide access to other students who have taken courses online to get information about the online learning platform and strategies for success
- Create a mentor system for students
- Offer course options in blended/hybrid or flipped course formats to prepare for coming to class ready to engage and learn.
- Provide training to resolve limitations in media and digital literacy.
- Students should be encouraged to analyze their own level of motivation, time management, time available for coursework, ability to self-direct one's learning before taking an online class
- Assist students to check the status of the devices that they plan to use for online classes
- Advise students to have a backup plan to access the Internet and Wi-Fi
- Help students to research their post-graduation career plans carefully.

Some specific strategies suggested throughout the survey responses included:
- Focused, short-bit lectures,
- Reinforce with video,
- Participation in peer group discussions,
- Animation and visual illustrations
- Repetition of material,
- Hands-on learning,
- Technology-based tutoring and learning
- Flourish in learning environment with options and fluid pathways.

5.4 Curriculum, Course Material and Content

While the curriculum and course materials were not mentioned in the survey responses as a challenge to learning or teaching statistics, it was noted as a method to overcome challenges in those areas. While no one specific change or element of course materials was listed by many participants, the responses included a variety of suggestions that are consistent with results of other studies.

To improve the content for college statistics, it was suggested to have each element of content referenced back to that content's relevance to the students. This might include practical applications, news articles that use such statistical analysis, or how the results provide information allowing individuals or businesses to make better decisions. Examples are:

- Pedagogical Course Concept Map
- Time allocation helps a student prepare
- Re-structure content with before class meeting, during class time, and after class meeting responsibilities and accountabilities.
- Course design (backward design)

5.5 Summary

Based on the open-ended responses to the survey, several specific recommendations for all professors stood out. These best practices are consistent with the experience of many college statistics professors and highlight some key suggestions for professors of college statistics to overcome challenges in teaching and learning these concepts.

1. Know your students-implement informal introductions on the first day and have students to complete an interest inventory
2. Establish a connection between new materials and something already learned.
3. Have fair but high standards for your students with a clear expectation.
4. Create the environment to allow students to learn from each other by allowing students to work together, teach each other, and learn from each other in purposely-designed small settings and small group discussion.
5. Use more of hands-on activities, meaningful visual aids, and demonstrations that are rooted in familiar and relevant matters to the students.
6. Instructors must be knowledgeable of the subject matter, have and employ professional attitude, and be friendly and approachable.

Faculty are keenly aware of their important role in helping students learn the challenging material in college. Working across university functions to improve statistics course material, placement, and programs can synergize with the efforts of professors to continually improve their delivery and connections with students.

6. Conclusion

Analysis of the survey feedback and follow-up interviews pointed to significant agreement among the participants on type of challenging students face in learning statistics and challenges instructors face in teaching statistics at the college level. The most challenging aspect of teaching statistics is how statistics is taught. When it comes to the most challenging aspect of learning statistics, the student preparation coming into statistics is key to their success while the instructional methods still play a role. Participants provided valuable tips, suggestions, and techniques to overcome all the identified challenges for both, teaching and learning statistics. After all, each classroom with its instructor, students, learning materials, and learning environment represents a dynamically active ecosystem in which "learning from instruction requires the learner to play an active role in order to acquire new knowledge successfully" [29 p. 276].

However any improvement in instructional pedagogy and in making course content personally relevant and career focus might not be enough without college administrators' and academic leaders' help and support. Working across university functions would improve student academic diagnostics, student course enrollment and placement, and the placement of statistics courses in the academic sequence program courses. Finally, administrators and faculty can work together to provide continuous and effective faculty professional development in content knowledge, instructional pedagogy, and educational technology.

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