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Content, Affective, and Behavioral Challenges to Learning: Students' Experiences Learning Statistics

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Content, Affective, and Behavioral Challenges to Learning: Students' Experiences Learning Statistics

Abstract
This study examined the experiences of and challenges faced by students when completing a statistics course. As part of the requirement for this course, students completed a learning check-in, which consisted of an individual meeting with the instructor to discuss questions and the completion of a learning reflection and study plan. Forty psychology students enrolled in two sections of an introductory statistics course volunteered for the research study. The types of questions raised by students during their meetings and the themes found in their learning reflections are presented. Results from this study provide information about the content, affective, and behavioral challenges faced by students learning statistics.

Keywords
Statistics education research, Non-cognitive factors, Teaching statistics, Statistics anxiety

Cover Page Footnote
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Introduction

The complexity of the modern world increasingly demands a scientifically literate citizenry. The courses students complete in university, including statistics, help meet this demand. Students in many fields, not just mathematics or science, are often required to complete courses that focus on scientific and numerical competency. For example, recent guidelines published by the American Psychological Association (2007, p.13) concerning the education of undergraduate psychology majors include learning outcomes that focus on competency in statistics; students are expected to be able to evaluate research results, in part by correctly interpreting statistical results. Indeed, interest across academic disciplines has led to a strong base of statistics education scholarship. A recent review of this scholarship identified six main categories that represent current research endeavors in statistics education: teaching and learning, statistical reasoning, non-cognitive factors, use of information communications technology, course design, and non-empirical studies (van der Merwe and Wilkinson 2011). The study presented here spans two of these categories, the teaching and learning of statistics and non-cognitive factors that influence one's understanding of statistics. Specifically, a learning activity focused on student reflection is described, and the resulting challenges identified by students are reviewed.

Previous work on the challenges students face when learning statistics has identified statistics anxiety as an important factor (Onwuegbuzie and Wilson 2003). When confronted with statistics, students who experience statistics anxiety show "a performance characterized by extensive worry, intrusive thoughts, mental disorganization, tension, and physiological arousal" (Zeidner 1990, p. 319). Statistics anxiety is a multidimensional construct and is most often evaluated with the Statistics Anxiety Ratings Scale (STARS) (Cruise and Wilkins 1980). This scale contains six subscales that represent a range of components that form statistics anxiety. A negative relationship between statistics anxiety and performance has been repeatedly observed (Onwuegbuzie and Seaman 1995; Zeidner 1991). More recently, findings suggest a curvilinear relationship between these concepts,

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where students with high and low levels of anxiety demonstrated poorer performance than students who reported moderate amounts of anxiety (Keeley, Zayac, and Correia 2008). Researchers hypothesize that some level of anxiety may be beneficial to motivating students, which may in turn positively affect performance (Keeley et al. 2008; Onwuegbuzie and Wilson 2003).

While considerable work has explored the concept of statistics anxiety, researchers have also explored other challenges students face when learning statistics. In particular, specific statistical concepts seem to be difficult for students to understand. Based on a review of studies, Garfield and Ben-Zvi (2007) have suggested students can struggle understanding key statistical concepts such as centre, variability, and distributions. Through tests and interviews (Lunsford, Rowell and Goodson-Espy 2006; Mathews and Clark 2003), students demonstrated difficulty in understanding these concepts.

Beyond statistics anxiety and the difficulty of specific statistical concepts, instructors responsible for service courses of statistics may meet an additional challenge, namely a lack of student interest in statistics. In a qualitative study that investigated psychology students' experiences in a required statistics course, the researcher learned "Seventy three percent of the students surveyed reported that they would not have studied statistics, if they had been given a choice" (Green 2004, p.46). The examination of open-ended responses also revealed that students questioned the personal relevance of statistics. Green's study sheds light on often overlooked contextual aspects of statistics courses. Similarly, the aim of the present study was to understand the experiences of students in a required statistics course through a qualitative approach. This approach gives voice to experiences that may otherwise have been overlooked.

Earley (2007, p. 64) has suggested that talking to students about their experiences in statistics classes is important and that researchers do not undertake this activity often enough. He calls for more "accounts of actual experiences of instructors teaching, and students taking, statistics, as opposed to relying only on the more quantitative outcomes currently presented (Becker 1996)". Along similar lines, Gal and Ograjensek (2010, p. 288) have articulated the

importance of qualitative research in understanding how students learn and use statistics. In discussing a recently published qualitative study, these authors note "the rich descriptions and insights reported by Petocz and Reid [(2010)] could not have been unearthed by a traditional quantitative approach that uses only predetermined response categories imposed by the researchers before the data collection begins". Finding that much of the statistics education research does rely on a quantitative approach, I sought to conduct a qualitative study that would provide a description of the experience of learning statistics in students' own words.

In an effort to uncover more about the experiences and challenges students face when completing a statistics course, I created a learning activity referred to as a learning check-in. A learning check-in requires students to submit questions for a one-to-one meeting with their instructor. Following the meeting, students complete a learning check-in form that asks them to reflect on their progress in the course and to identify any behaviors that may be interfering with their learning. This activity has been shown to positively influence student learning, as measured by test grade differences (McGrath, 2014). Additionally, and just as important, this set of tasks provides an opportunity for formative assessment, allowing both instructor and student to reflect on where and how progress toward statistical competency is being met and challenged. Results from this study provide information about the content, affective, and behavioral challenges faced by students learning statistics.

Method

Participants

Fifty-six psychology students across two sections of an introductory statistics course were eligible for participation in the study. I taught both course sections with the same format in a single term running from September to December. Forty students volunteered for the study, resulting in a participation rate of 71%. The average age of participants was 20.25 years. The majority of the participants were female (82.5%), as women form a larger percentage of psychology majors than men.

Course Context and Data Collection

All students who take this course are declared psychology majors completing a Bachelor of Arts program at a mid-sized Canadian undergraduate university. Many students perceive this course as a challenge to the completion of their degree, and a number of students approach the course with trepidation. This introductory statistics course is offered at the second-year level, and the content is presented in ways relevant to psychology students (e.g., with examples describing results from psychology studies). Topics covered in this course include displaying data, central tendency and variability, z scores, normal distribution, power, effect size, and hypothesis testing with z and t tests. Students were informed about the voluntary study on the first day of class. An individual not associated with the course collected informed consent forms. Work from students who agreed to participate in the study was collected for analysis.

Measures

Learning Check-in Questions. Students submitted two questions at least 12 hours in advance of their student-instructor meeting. Students received no directions on the types of questions to submit; rather, it was their responsibility to determine what questions would be the focus of the student-instructor meeting.

Learning Check-in Document. This document contained reflective prompts for students to complete. Students were asked to consider their progress in the course and to write a reflection on their learning up to that point. Additionally, students were asked to identify behaviors they thought interfered with their learning.

Procedure and Data Analysis

The learning check-in comprised an important part of this introductory statistics course. It was developed in an effort to meet each student individually and to address any concerns they had about the course. As I was unable to meet with all students at one time during the term due to time constraints, I met with half of the students in October and with the rest in November. Whether I met with a student in October or November was randomly determined. A minimum of twelve hours before meeting, students sent me two questions they wished to discuss. Our meetings lasted twenty to thirty minutes; during that time, we discussed their progress in the course and the questions they submitted. At the end of the

meeting, I reviewed the learning check-in document with students. The completed document was due 48 hours after the meeting. Students earned 4.5% of their final grade by completing the three components of the check-in.

The responses provided by students were all open-ended. Questions submitted by students were approached with a content analysis, which allowed for the identification of specific topics that students found challenging in addition to a frequency count for each topic. Behaviors that students identified as interfering with learning were also analyzed in this manner. The open-ended responses written by students about their progress in the course were approached with a thematic analysis. This analysis allowed for a descriptive account of participants' experiences that was achieved inductively with codes and themes emerging from the data (Robson 2011).

Results

Learning Check-in Questions

The questions from students were categorized based on their content. Below are tables that summarize the questions presented by students in October followed by the questions received during the November meeting period. Twenty students submitted two questions each round, which resulted in 40 questions submitted in October and 40 questions submitted in November. To ensure the reliability of the coding schemes that were developed and applied, a colleague also independently coded the questions from students. Interobserver reliability for both sets of data was acceptable, with 100% agreement for October and 87.5% agreement for November.

Table 1. Categorized learning check-in questions from October

Content	Frequency	Percentage
Distribution of means	8	20.00
Writing conclusions	5	12.50
Test preparation	4	10.00

1 versus 2 tailed tests	4	10.00
Stating hypotheses	3	7.50
Standard error	3	7.50
Steps of hypothesis testing	2	5.00
z test	2	5.00
Effect size	2	5.00
Meaning of p value	2	5.00
Alpha level	1	2.50
z score	1	2.50
Scales of measurement	1	2.50
Type I and II errors	1	2.50
Power	1	2.50

Table 1 displays how often a question about a particular topic was asked, which provides valuable information to the instructor about content areas that may require additional focus (e.g., distribution of means) for student mastery to be achieved. For the most part, student questions were focused on specific content areas within the course. For example, a number of students had questions about the distribution of means and one versus two tailed tests. Additionally, though, students also wanted guidance on how to prepare for upcoming tests and how to properly write APA formatted conclusions. As such, questions covered both course content and also skill development and study preparation.

Table 2. Categorized learning check-in questions from November

Content	Frequency	Percentage
Review of formulae and hypothesis steps	8	20.00
Population variance	5	12.50
Sample variance and degrees of freedom	4	10.00

Power	4	10.00
Test preparation	3	7.50
Review of previous test	3	7.50
Stating hypotheses	3	7.50
z versus t test	3	7.50
Reviewing symbols	2	5.00
Writing conclusions	2	5.00
Effect size	1	2.50
Which t test to use when	1	2.50
Distribution of differences between means	1	2.50

Five categories are present in both the October and November questions submitted by students. Students in both groups asked questions about power, effect size, stating hypotheses, test preparation, and writing conclusions. These content areas and skills remain relevant for the duration of the course, so it is not surprising to see these categories represented in both rounds. Students who met with the instructor in November were particularly concerned with reviewing formulae and the steps necessary to conduct a hypothesis test as well as achieving a better understanding of population variance, sample variance, and degrees of freedom – all topics that formed large parts of the course work during the month of November. The most popular topic in November, reviewing formulae and hypothesis testing steps, is understandable as by November students have been introduced to many formulae and different hypothesis tests, which may seem overwhelming to some.

Themes From Student Reflections

After meeting with the instructor, students had 48 hours to complete the learning check-in document. Several themes emerged from the analysis of these reflections.

Anxiety and Negative Expectations. Somewhat surprisingly many students wrote about negative expectations toward the course and their anxiety about the course even though the first prompt from the learning check-in document did not ask about these issues at all, which perhaps underscores the importance of this to students. This hesitancy about statistics was described by P2: "I came into stats being really unsure of myself and how the course would go… I really

expected to struggle with stats." P27 felt similarly: "Going into this course I was very unsure and pessimistic about how I would do. I honestly thought that I would fail or do very bad." Students expressed time and again the anxiety they felt about the course to the instructor through these reflection documents: "The fact that this course is difficult tests my abilities and my confidence level, which increases my level of anxiety" (P39). In reflecting on their learning in the course, many students felt compelled to provide contextual information regarding their expectations and emotions, even though the learning prompt did not request this information. When reflecting on their learning in statistics, many students included descriptions about their affective states, which suggest students see important links between how they feel about a course and how they learn in a course. Instead of simply reflecting on specific concepts they learned, students felt compelled to situate their learning within their experience of the course, which includes a large affective component for many.

Not a Math Person. Beyond expressing nervousness about the course, some students explicitly indicated their belief that they simply did not have mathematic ability. P14 wrote: "There is definitely room for improvement for me but I don't really know how well I can improve. This is mostly due to my inability to understand many math concepts (I'm really right-brained)." Certainly, the anxiety expressed by students is understandable if they believe they simply cannot perform mathematical functions. This sentiment was captured by P20: "I am absolutely terrible at math so I tend to expect the worst." The stability of students' beliefs in regards to their lack of statistical aptitude is sobering. Some students feel success in statistics is beyond their reach due to some sort of genetic programming, which may negatively influence students' persistence in statistics. Fortunately, not all students felt defeated by a lack of mathematical ability. P12 also believed his math ability was weak but he remained hopeful about his learning outcomes:

> I took this course as a personal challenge. I have always had a weakness when it comes to numbers, math and the logic behind mathematical/statistical theories and formulas. Since the beginning the class has

> been challenging for me, and the difficulty understanding the material has been represented in my poor performance on tests 1 and 2. Still yet I go on hoping to grasp more information and looking forward to understanding and interpreting it properly.

Fortunately, some students experienced a positive change in perceived ability, which is encouraging.

Pleasantly Surprised. Students expressed hesitation about the course initially, and after receiving feedback in the form of grades, some students noted being pleasantly surprised by their performance. The essence of this theme was clearly noted by P1: "I have pleasantly surprised myself at how much I understand statistics." P38 felt similarly:

> I've been doing better in the class than I anticipated I would. My score on the first midterm surprised me (in a good way). It was encouraging to realize that I am capable of obtaining a good grade in this class. Concerning the next exam, I do not doubt my ability to do statistics as much as I used to and hope to improve my grade.

It seems that many students had negative expectations regarding their performance in statistics, and positive feedback surprised them. P14 wrote: "My performance on test one and two was surprising for me. I didn't expect to do as well as I did (this is not a bad thing of course but it does confuse me)." Providing feedback in statistics courses may be particularly important for students because it can challenge preconceptions they hold about their inability to learn statistics. This theme also highlights that the negative expectations and anxiety students bring into the course influences their expected levels of achievement.

Room for Improvement. Many students, whether satisfied with their performance or not, still indicated that there was room for improvement. After reflecting on their understanding of the course material, most students concluded that they could do more and achieve a better result. P33 specified how he could go about this: "There is definitely room for improvement on my part, especially with the assignments and making sure I keep up with the readings

and practice problems." P35 wrote that she was satisfied with her performance and continued to say "I am finding that the material is not as intimidating as I once thought it would be, but I believe there is room for improvement." Conversely, P18 was not satisfied and wrote, "I feel there is a lot of room for improvement. I am not satisfied with my progress in this course because I feel that with more dedication, I could have done a lot better." Many students were able to critically assess their effort in the course, and concluded more could be done. Students presented realistic descriptions about their learning and the effort they put in the course. Importantly, they identified connections between what they did and their performance, highlighting their responsibility as learners to direct their own level of achievement.

Understanding Concepts. Beyond some students being relieved that the course was not as math intensive as they had expected, others commented on the difficulty of understanding the concepts and logic presented in the course. In this course, students were required to convey their written understanding of statistical concepts, and some found this particularly challenging. P34 wrote: "I need to improve my knowledge on the concepts and understanding why certain equations are important". Similarly, P16 wrote: "I find the formulas and distributions easier to work with than the actual theory behind why we're doing this." P28 thought her performance specifically suffered in this area:

> When the test got handed out I realized there was also theory of statistics and got nervous. I didn't do as well as I had hoped. At the second test, again I was more confident in the math work than in the theory section and I did much worse than the first overall… I believe I would be able to teach someone how to do the math, but I'm not 100% confident I would be able to explain why they are doing what they are doing.

The focus on understanding the concepts presented in the course took some students by surprise:

> I went into this course expecting it to be very heavily math based and that I would be comfortable with the material and would not struggle to get the grade I

> desired. However, while I have not struggled with all of the material it is not coming to me as easily as I expected. I certainly have struggled with the theory content in the course. The actual math has not been a problem (P21).

In these reflections, students have identified an important divide in their understanding. While many of them report being able to do the math, they note the limitations of their statistical understanding. For example, they may be able to calculate variance but at the same time struggle to explain exactly what variance is.

Reading Difficulties. Lastly, several students commented on the difficulty of reading the textbook. P6 wrote "I have trouble reading the textbook, mostly because it does not feel concise and it takes a long time to get to the information described in the lecture power points in a few sentences." Some students thought the lecture was integral to them understanding the material from the textbook:

> I usually don't understand what I'm reading before class, but I don't have a lot of trouble following the lectures. I find it interesting to go back and review the chapter after the lecture because suddenly everything that made no sense starts to make a little sense (P16).

Others expressed frustration at the difficulty of the readings, "When I go to read the textbook outside of class I get frustrated and can't understand the material" (P28). Furthermore, the frustration experienced while reading led some students to modify their study habits. P29 wrote "Personally I find the textbook very confusing, so I tend to study more from the lectures and what I have gone over with my tutor." By noting their difficulties reading the textbook, students have highlighted an important challenge to their learning of statistics, a challenge that could be overlooked because students typically read their textbooks in private. Much learning takes place outside the classroom, and if students struggle with their readings to the point that they disengage from the readings, this will no doubt be an impediment to their learning. The challenge of reading the textbook presents itself again in the following section.

Behaviors that Interfere with Learning

Students listed behaviors that they thought interfered with their learning. The most common behaviors identified as interfering with learning are presented in Table 3.

Table 3. Most common behaviors reported as interfering with learning

Behavior identified as unhelpful	Percentage Reporting
Technology as distraction (cell phone, TV, Internet, music)	41.00
Procrastination*	38.50
Skipping practice problems	20.50
Not reading textbook before class	18.00
Not reading textbook thoroughly or at all	15.00
Missing class	15.00
Not sleeping enough or too much	15.00

*This percentage of students specifically mentioned procrastination. Students also mentioned distractions, but unless they specifically identified procrastination as a problem, they were not included in this count. As such, the occurrence of procrastination is likely even higher.

Many students identified procrastination as interfering with their learning. They also noted many distracters (e.g., different types of technology) that interrupt their studying. Also, some students are not reading the textbook appropriately, even though it is an important resource in this course. Others who reported not reading the textbook before class may be identifying procrastination again as a problem.

Discussion

Students may be intimidated to ask questions in class; they may not have enough time to develop a question; or after being presented with new material, they may require additional work with the material before formulating a question. The learning check-in questions allowed students time outside of class to review material and to develop questions that were important to their understanding of the course content. In addition to question development, the learning check-in also provided an opportunity for students to reflect on their learning in the course. Below I discuss the

content, affective, and behavioral challenges students raised through the learning check-in.

Content Challenges Identified by Students

The learning check-in provided important information about content challenges. In October, twenty percent of students asked questions about the distribution of means during their meeting. The concept of sampling distribution can be challenging to learn. Indeed, even instructors can struggle with this concept, "I recall studying the concept of sampling distribution in a few undergraduate courses, but it was only in my fourth year of teaching a statistics course that this concept came together for me" (Sheese 2012, para. 2). Another topic frequently asked about was variance. Just over twenty-two percent of students in November asked questions about variance. This large percentage may reflect not only that variability is a core topic in statistics, but also that it is one students find particularly challenging. In reviewing articles about variation, Garfield and Ben-Zvi (2005, p.92) noted, "understanding of variability is much more complex and difficult to achieve than prior literature has led us to believe". In addition to sampling distribution and variability, twenty percent of students in November asked questions that centered on understanding formulae and reviewing the steps of hypothesis testing. By November it is not surprising that some students wished to review this material as it can become overwhelming. Indeed, other researchers have found that students see the number of concepts introduced during a quantitative methods course as a challenge (Murtonen and Lehtinen 2003). Therefore, the roots of some of the most frequently asked questions may stem from both the difficulty of some topics and the amount of information presented in a statistics course.

While past research has highlighted some concepts students find difficult (Garfield and Ben-Zvi 2007), an additional area identified as challenging by students in this study was how to write conclusions. I did not anticipate questions about writing, but I can understand why this topic arose. Firstly, in my statistics course I emphasize the importance of being able to convey one's understanding in writing. It is important for students to be able to communicate results clearly (Radke-Sharpe 1991). Given the importance I place on writing clear conclusions, it makes

sense that students asked questions about this area. Secondly, writing results in APA format is new to students enrolled in this course, and the format is very particular. Students need to understand each piece of information they include in the paragraph and how to present that information properly; there is little room for error. The novelty and preciseness of this form of written communication may present students with challenges. Schmidt and Dunn (2007) provide a helpful overview of a writing intensive research methods and statistics course along with examples of assignments that may be particularly helpful to students developing their writing skills in a statistics course.

Requiring students to submit questions provides an instructor with an opportunity to see content areas that students find challenging. By categorizing these questions and noting their frequency, it is possible to focus on topics that may benefit from a different approach or the inclusion of additional examples and learning activities. These questions also allow an instructor to approach material from the students' perspective, a perspective that typically fades after teaching a course multiple times. For example, Garfield and Ben-Zvi (2007) warn that it may be easy for instructors to underestimate the difficulty students have with concepts from statistics. Hearing the difficulties expressed by one's students about the material may counteract this. In this study, students described the difficulty of understanding concepts compared to doing the math. So although I endorse the goal that students should understand why statistical analyses are used (Gal and Garfield 1997), in my course additional work is required "to encourage students' development of understanding over their mastery of mechanics" (Earley 2007, p. 64). The difficulties encountered by students in this study, highlights the importance of both conceptual and procedural knowledge in statistics education (Groth and Bergner 2006).

When considering the questions posed by students, instructors should remember that students have a tendency to focus their effort on topics they expect to be assessed (Garfield 1995). Although distributions and variability are difficult statistical concepts to understand (Garfield and Ben-Zvi 2007), they are also central concepts that students likely anticipate being questioned about. Because students value topics that will be assessed in a course, we have tremendous

influence, as instructors, in directing our students' attention. I suspect one of the reasons students asked questions about how to write conclusions was because of the emphasis I place on the written communication of statistical information; students expected to be assessed on their ability to do this.

While assessment partly directs the content students focus on, it seems that in this course students' concerns about assessment also led them to ask more general questions about test preparation. In both October and November, students asked questions about how to prepare for tests or wished to review previous tests they had completed. These questions not only highlight student interest in assessment (or grades), but also that students desire information from their instructors beyond content; they also desire information about study skills. Wingate (2006) has suggested that students are best situated to develop study skills (a term she finds problematic) in courses through consultation with instructors, rather than in separate extracurricular courses offered through learning centers. If this is the case, a learning check-in with a statistics instructor may prove valuable to a student who desires to improve her academic skills within a statistics course.

Affective Challenges Identified by Students

Although students were not asked to reflect on their affective experiences in the course, many did comment on how they felt about learning statistics. In line with past research (Onwuegbuzie and Wilson 2003; Perepiczka, Chandler, and Becerra 2011; Williams 2013; Zanakis and Valenzi 1997), students experienced anxiety about their statistics course. While statistics instructors are aware of the anxiety that can surround their courses, reading the experiences of anxiety detailed by students in one's own course can provide a greater appreciation for the affective challenges students face. For example, knowing that for many of my students anxiety is a prominent challenge, I will invest more time and resources toward helping them overcome that barrier. Williams (2010) found that statistics anxiety is related to instructor immediacy, and she has suggested that instructors can practice immediacy behaviors (e.g., smile, make eye contact, speak at a close distance) as a way to reduce student anxiety.

Beyond detailing that they did experience anxiety, students in this study also wrote about their expected level of achievement in the course and their perceived level of ability. Bude et al. (2007) investigated these concepts among a group of non-statistics majors and found the attributions of students predicted outcome expectancies and affective responses. The reflective comments made by students map onto these findings. While noting room for improvement, some students questioned whether this was possible given their perceived lack of mathematic ability. Additionally, students who initially had low outcome expectancies but then succeeded on a task indicated more optimism in their ability to succeed. The students' sense of being pleasantly surprised by positive feedback echoes a recommendation by Bude et al. (2007) to incorporate feasible tasks for students to complete. If students successfully complete tasks, this may interrupt a process whereby negative cognitions and negative affect lead to poor learning outcomes. Instead, the successful completion of a task may increase motivation and study habits. As such, the assignments and feedback given to students provide a powerful way for instructors to support learning by helping students interpret progress and feedback as indicators of self-efficacy.

Behavioral Challenges Identified by Students

When asked to reflect on behaviors that interfere with their learning, students overwhelming cited procrastination as a problem. They also identified specific distracters that may represent the different ways in which they procrastinated (e.g., cell phone, TV, Internet). Procrastination has been conceptualized as a failure to self-regulate one's behavior. Instead of focusing on the completion of present behaviors that will benefit the future self, people seek to overcome the immediate experiences of negative affect produced by aversive tasks by disengaging from such tasks and procrastinating (Sirois and Pychyl 2013; Tice, Bratslavsky, and Baumeister 2001).

Previous research within statistics education has documented a positive relationship between academic procrastination and statistics anxiety (Macher 2012; Onwuegbuzie 2004). In order to address this problematic behavior, students may need to seek interventions that can disrupt patterns of procrastination (Ferrari, Johnson, and

McCown 1995; Pychyl 2010). Additionally, it may be worthwhile for researchers to learn more about how, why, and when students studying statistics procrastinate. From the results of this study, it seems that some students are not creating the type of focused learning environment necessary to study statistics deeply. Technologies that offer a multitude of distractions at the press of a button may give students a temporary respite, but likely interfere with one's ability to attend to the complexity of statistical concepts. Indeed, technology use has been linked to poorer performance and is a potentially important distracter to student learning (Fried 2008; Sana, Weston, and Cepeda 2013).

It would also be beneficial to know if the challenges students identified with completing textbook readings, either before class or at all, were related to procrastination. Some students experienced frustration when reading, and given the link between short-term mood repair and the tendency to procrastinate (Sirois and Pychyl 2013), it is possible that procrastination played a role in the non-completion of readings.

Limitations

The generalizability of these results is restricted by the gender composition of the sample (largely female) and the program major of the participants (psychology). Additionally, the questions and difficulties raised by students during the learning check-in reflect their experiences in this particular course; however, the results from this study have strong connections to the statistics education literature and readers may recognize their own students in these accounts.

Conclusion

In this study, a learning check-in provided students an opportunity to reflect on their experiences learning statistics, and in particular the challenges they faced during the semester. The reflective comments written by students provided a window, for both students and the instructor, to the entire learning process, one that encompasses the whole person, and not just the cognitive aspects of learning (Beveridge 1997). While quantitative assessment tools, such as the STARS, are immensely valuable to the field of statistics education research, so too are our students' voices. The questions and descriptions provided by students from the learning check-in can be used by instructors as a formative

assessment tool to learn more about the challenges students face when learning statistics. This information can also guide future inquiries (e.g., student writing in statistics, procrastination among students learning statistics, supporting the development of conceptual and procedural knowledge) in statistics education.

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