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Using Reflective Journaling to Promote Achievement in Graduate Statistics Coursework

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Abstract. By encouraging students to reflect on their own learning processes and identify areas that they understand as well as areas that require further improvement, their academic performance can improve. This reflection promotes the development of metacognitive skills, and may be especially beneficial for students facing new and challenging material, notably statistics coursework. Students' grades from two different sections of a graduate-level introductory statistics course were compared. In the experimental section, students were encouraged to complete a weekly reflective journal about their learning progress and related experiences in the course. The control section followed the same course structure as the experimental section, but did not complete the journals. Independent samples *t*-tests were conducted on assignment and test scores as well as the final course grade for the experimental and the control sections. The experimental section performed significantly better than the control section on one assignment and one test. The experimental section also had a marginally higher average than the control section on a second assignment. The results and analysis of journal content show support for the use of reflective journaling to improve the student learning experience.

Keywords: Journals; statistics education; learning management systems.

Background

Instructors strive to encourage and support students to enhance their learning outcomes and to set them on a path to succeed not only in their coursework, but also in their objectives outside of the classroom. Motivation is undoubtedly a key component to college student success, yet can be hindered when the material to be learned is associated with negative affective components, evokes anxiety, and is perceived as difficult. Statistics is one such course that often fits the aforementioned description. This paper discusses how keeping weekly reflective metacognitive journals may have improved the learning experiences and academic performance of students in a graduate-level statistics course.

Factors Influencing Students' Statistics Attitudes and Performance

Coursework in statistics has been generally described by students as non-engaging and difficult (Pan & Tang, 2004), oftentimes resulting in generally adverse experiences (Murtonen & Lehtinen, 2003). A review of the literature

reveals a wide variety in potential factors underlying the reasons why many students harbor negativity towards statistics and exhibit difficulty in performing the coursework.

Seeing the value of statistics in one's career and other applications beyond the classroom is a factor influencing attitudes towards statistics (Fullerton & Kendrick, 2013; Ramirez, Schau, & Emmioglu, 2012; Schau, Millar, & Petrocz, 2012). Interest level in statistics also plays a role in statistics-related anxiety. Macher et al. (2013) reported a negative correlation between the two variables, as individuals tend to devote greater time and effort to objectives that interest them. Anxiety and lack of intrinsic motivation have been linked with students' procrastination of statistics tasks (Dunn, 2014). Indeed, task-engagement and seeing the value in a task are important motivational components that underpin learning (Ryan & Deci, 2000).

Academic self-concept (Marsh & Martin, 2011) involves students' perceptions of their own academic skill level and knowledge in a specific domain. Macher et al. (2013) found a negative relationship between mathematics self-concept and anxiety about statistics. Low self-efficacy in mathematics and negative prior experiences with mathematics can be linked to anxiety specific to statistics coursework (Zeidner, 1991). Students who feel they've performed well in previous mathematics coursework also tend to have positive attitudes towards statistics (Hannigan, Hegarty, & McGrath, 2014), yet an important consideration is that mathematical and statistical abilities, while related in terms of numerical manipulation, also differ in that statistical ability draws upon additional domains, such as verbal reasoning and use of logic (Fullerton & Kendrick, 2013; Johnson & Kuennen, 2006).

Statistics anxiety is a "situation-specific form of anxiety…that occurs when an individual is exposed to statistics content, problems, instructional situations, or evaluative contexts" and is "an enduring, habitual type of anxiety" (Macher et al., 2013, p. 536). It can interfere with the process of learning course material, thereby resulting in poor grades (Cook, 2010; Onwuegbuzie & Wilson, 2003; Williams, Payne, Hodgkinson, & Poade, 2008; Zeidner, 1991).

In the development of the Statistics Anxiety Rating Scale, a six-factor model of statistics anxiety comprised of two dimensions emerged (see Cruise et al., 1985). The first dimension, which pertains to anxiety, has three factors: a) interpretation anxiety, b) test and class anxiety, and c) fear of asking for help. The second dimension, which pertains to attitudes, also has three factors: a) worth of statistics, b) computational self-concept, and c) fear of statistics teachers. This model has been supported using several diverse populations of statistics students over the years (e.g., Mji & Onwuegbuzie, 2008; Papousek et al., 2012; Teman, 2013), and recently by DeVaney (2016) who validated it with graduate–level statistics students.

Macher et al. (2011) indicated that students with statistics anxiety tend to exert less effort in studying and procrastinate in their coursework as well as in

studying for exams. Decremented intrinsic motivation has also been linked with students' statistics anxiety and task procrastination (Dunn, 2014). At the graduate level, statistics anxiety can extend into other aspects of academic performance, such as comprehending research articles involving statistical results (Onwuegbuzie, 1997), and performing research-related activities that require statistical knowledge (Onwuegbuzie, 2003).

Various individual differences in personality and disposition have also been linked with performance in statistics coursework. Furnham and Chamorro-Premuzic (2004) documented three such influential factors: The Big Five personality traits of conscientiousness and extraversion (see Costa & McCrae, 1992), and spatial ability. They reported a positive relationship between conscientiousness and statistics exam scores at the college level, a negative relationship between extraversion and statistics performance, and a positive relationship between spatial ability and statistics performance. Individual differences in mathematical orientation have been evaluated with the preference for numerical information (PNI) construct. Viswanathan (1993) describes PIN as a disposition for the use (or disuse) of numerical information in general, and that it reflects students' willingness to learn and use mathematics and statistics. Additionally, trait anxiety, a stable disposition toward feeling anxious in general (Spielberger, 1972) has been linked to statistics anxiety (Macher et al., 2013; Papousek et al., 2012). Anxious individuals also generally tend to be pessimistic about their future task performance (Eysenck & Derakshan, 1997), which could likely lead to negative attitudes regarding statistics coursework.

Metacognition and Reflective Journals

According to Paris and Winograd (1990, p. 7), "students can enhance their learning by becoming aware of their own thinking as they read, write, and solve problems." This awareness of one's own thinking process is referred to as metacognition, and is the basis for promoting self-directed learning, which encourages learners to become active participants in their own academic pursuits. Flavell (1976) further describes metacognition as:

> …one's knowledge concerning one's own cognitive processes and products or anything related to them, e.g., the learning-relevant properties of information or data. … Metacognition refers, among other things, to the active monitoring and consequent regulation and orchestration of these processes in relation to the cognitive objects or data on which they bear, usually in the service of some concrete goal or objective. (p. 232)

Cognitive self-appraisal is one component of metacognition. As observed by Flavell (1978), this self-appraisal focuses on students' abilities to address what they know about a subject, how they process information about the subject, and when and why they should apply related knowledge. Further, Douglass and Morris (2014) suggest that an understanding of one's own learning style promotes self-directed or more autonomous learning in which students develop their own comprehension of the topic at hand. This knowledge enables a learner to select and use appropriate metacognitive self-management strategies to

develop or modify plans for solving a problem in order to achieve his or her goal (Paris & Winograd, 1990). According to the theory of self-determination, intrinsic motivation to succeed academically is facilitated by a more autonomous style of learning (Ryan & Deci, 2000), the benefit of which is often improved performance in coursework (Giuffrida, Lynch, Wall, & Abel, 2013).

Understanding one's personal learning style is a result of the self-reflection of "intellectual and affective activities in which individuals engage to explore their experiences in order to lead to new understandings and appreciations" (Boud, Keogh, & Walker, 1985, p. 19). Students can use journals to document these experiences and synthesize them with their other prior knowledge to enhance learning (Boud, 2001). Moon (1999) describes several ways in which journal-keeping can promote proactive learning through reflection, such as developing critical thinking and greater inclination towards inquiry about a topic, increasing active participation and ownership in the learning process, promoting self-empowerment, and developing an alternative means of communication when self-expression is difficult. A journal can also aid the writer in identifying his or her intentions and goals as they relate to a situation, and is especially helpful when the situation is complex and unfamiliar. Further, through reflection, a writer can identify questions that need to be addressed in order to be productive in unfamiliar situations (Boud, 2001).

Journaling in Learning Mathematics

Writing to Learn (WTL) is a movement in education that emphasizes the benefit of language as a key component in knowledge acquisition, regardless of curricula. WTL asserts that students develop an understanding of material through their own written thoughts and observations (Bazerman et al., 2005). Writing about course material is an active, engaging process that encourages students to reconstruct the meaning of the material in their own relatable terms (Borasi & Rose, 1999). Particularly supportive of learning is expressive writing, in which writers probe their own thoughts and ideas for reflection (Britton, Burgess, Martin, McLeod, & Rosen, 1975).

Writing to Learn Mathematics (WTLM) is a branch of WTL that focuses on writing activities to enhance understanding of mathematics. Examples of such activities include writing to explain topics in terms that are more relatable to the student and writing about attitudes regarding the topic. Barker et al. (2004, p. 16) assert that "requiring students to write about mathematics helps them learn and gives instructors valuable insight into the nature of their understandings". Indeed, by reading students' journals, instructors can gain an awareness of their students' perceptions and in turn, this can give them opportunities to evaluate their own pedagogical styles (Kenny, Schoffner, & Norris, 2014). Further, Meel (1999) describes how writing about mathematics helps to personalize otherwise unfamiliar concepts to the students.

Borasi and Rose (1999) showed how WTLM is an expressive form of writing that can take the form of journals. In their study, undergraduate algebra students

used journals to document their feelings about mathematics, and reflecting on their own learning processes bolstered their knowledge about the course material. In a study by Bagley and Gallenberger (1992), high school mathematics students kept daily journals to help develop problem-solving strategies. They described this activity as "a means of knowing what we think – a means of shaping, clarifying, and discovering our ideas" (p. 660). Loud (1999) found that undergraduate mathematics students who kept a weekly journal exhibited not only higher final exam scores, but also more positive attitudes regarding the course.

Writing activities have also been shown to aid in reducing statistics-related anxiety and improve statistics course performance (Chiou, Wang, & Lee, 2014). In the *one-minute paper* strategy, students anonymously document and submit to their instructors their responses to the following questions: *What is the most important concept you learned in class today?* and *What questions remain unanswered?* This exercise allows students to identify concepts that require further understanding and describe difficult concepts using their own words.

Research Questions and Hypotheses

Given the current body of knowledge, the researcher sought to address whether keeping a reflective, online journal could improve the learning experiences of students enrolled in a statistics course, specifically at the graduate level. In doing so, an exploratory study was conducted in which students from one section of the course were offered an optional journaling task, and their average grades were compared to those from a section in which journaling was not offered. It was hypothesized that students who completed the journals would have higher mean scores on the evaluation items in the course (e.g., grades on assignments and tests) as well as the final average in the course as compared to students who did not complete the journals. If results indicated that keeping a journal was associated with higher average grades, then a more widespread implementation of journaling activities in future statistics courses might be supported. Additionally, the content of the journals was evaluated in the interest of investigating trends in student perceptions of the course and self-assessments of their own knowledge, skills, and affective states. The researcher was also interested in the nature of the questions and concerns students had throughout the course, as well as any evidence of motivational factors that could be driving academic behavior and performance.

Methodology

Study design. This study used a mixed-methods quasi-experimental design to investigate the effect of reflective journaling on student performance in a statistics course. Students enrolled in two different sections of a graduate-level introductory statistical analysis course were recruited as participants. This course is a 16-week, in-person, core requirement in a Master of Science degree program in the university at which this study was conducted.

In the experimental section of the course, the students (n = 13) had the option of volunteering to keep online journals to document their learning experiences in

the course throughout the semester. The control section (n = 14) was conducted in the same manner as the experimental section, with the exception that the students were not offered the option to complete the journals. Participation was voluntary, and approval to conduct the study from the institution's ethics review board was obtained.

Participant description. Students enrolled in both sections of the course were comprised of a variety of backgrounds; they were a mixture of traditional and nontraditional types, various nationalities, and differing levels of prior mathematics coursework. While all of the students had completed at least one introductory level mathematics course at the undergraduate level, only a portion of them had completed any undergraduate statistics coursework. All of the students were familiar with the Blackboard online learning management system (LMS) that was used in the course, but none had expressed previous use of the journal tool available on it.

Procedure. On the first day of class in the experimental section, the instructor announced the option of participating in the study to the students, explaining that they had the option of completing an online journal regarding their learning progress each week. The journals were made available through a journal tool embedded in the Blackboard LMS site for the course. Students in the experimental section were asked to document briefly their weekly learning experiences (not including weeks in which tests were administered) using the online journal regarding the following issues:

- Concepts covered in class in the current week that they felt they had difficulty understanding and might necessitate further clarification
- Questions they had regarding the concepts covered in class that week
- Information that they felt might be helpful to explain or clarify the difficult concepts
- How they planned to seek clarification of these concepts

Although these specific journal topics were posed to them, they were not prohibited from writing about other topics pertaining to their experiences in the course.

Students were expected to spend not more than approximately five to ten minutes per week on the journaling task, and were advised to work on the journal when it was convenient for them. They were told that participation was strictly voluntary with no bearing on course grade and that the journals were to be used as a learning aid and would not be read by anyone except the instructor. They were also informed that the instructor only assessed the journals for completion and honest effort, not for content. Neither course credit nor any other compensation was offered in exchange for participation. The instructor described the journaling activity as an optional task to the students in the first week of the course, and listed it as an optional weekly task on the course syllabus. The instructor did not remind them to do the journals afterwards; considering the exploratory nature of this study, the instructor preferred to observe the natural tendency for students to use the journal without being prompted.

In both sections, students were evaluated on three assignments, two tests, and one final exam in fulfillment of course requirements. These evaluation items are described below.

Data analysis assignments. Students' scores on three different data analysis assignments were collected. The course lectures, textbooks, and other instructional resources (e.g., checklists for proper formatting and requirements for what to report in results sections, templates to use for the assignments) instructed the students in how to successfully complete the assignments.

The Statistical Package for the Social Sciences (SPSS) was the statistical software package students learned to use in the course. For each of the three data analysis assignments using SPSS (i.e., SPSS Assignments 1, 2, and 3), students were provided with a dataset and asked to test several different hypotheses using the software. Each of the three SPSS assignments covered a different set of statistical operations taught in the course (e.g., one assignment covered *t*-tests, another covered correlations and regressions, etc.). To succeed in these assignments, the students were required to know the proper type of statistical test to execute, how to execute it using SPSS, how to interpret the SPSS output, and how to write the results and discussions in the American Psychological Association (APA) format.

Tests. There were two multiple-choice tests administered in the course. The questions covered statistical concepts that were taught in the course lectures, but did not cover the use of SPSS or APA formatting. Test 1 covered material taught in the first half of the course, while Test 2 covered material taught in the second half of the course.

Final exam. The final exam was cumulative, covering all statistical operations taught in the course. For the final exam, students received a dataset and were asked to test several hypotheses using SPSS. Successful performance on the final exam required students to be able to determine which statistical operation to execute for each hypothesis test and explain why they chose each particular operation, report the results of each hypothesis test, and briefly explain what the results of each hypothesis test meant.

For both the experimental and control sections, student grades were collected from the LMS at the end of the semester. Independent samples *t*-tests were conducted on grades for all evaluation items to compare the experimental and control sections. For the experimental section, the content from the online reflective journals was collected from the journal tool in the LMS.

Results

Student performance. Grades on three SPSS assignments, two multiple-choice tests, one cumulative final exam, and the final course average were compared. The experimental section performed significantly better ($p < .05$) than the control section on SPSS Assignment 1 and Test 1. The experimental section had a marginally higher mean score ($p = .07$) than the control section on SPSS Assignment 2. Although not significantly different, the experimental section also had numerically higher mean scores than the control section on the remaining evaluation items. See Table 1 for the significant differences.

Table 1: Significant Differences between Experimental and Control Sections

Evaluation Item	Experimental Section Mean Score (*SD*)	Control Section Mean Score (*SD*)	*t*-statistic and Cohen's *d* (where significant)
SPSS Assignment 1 (200 points possible)	173.75 (17.77)	157.79 (15.14)	$t(24) = 2.416$, $p = .024$* $d = .93$ (large effect)
SPSS Assignment 2 (200 points possible)	183.46 (10.86)	173.79 (14.97)	$t(25) = 1.884$, $p = .071$
Test 1 (100 points possible)	86.15 (9.02)	77.32 (9.88)	$t(25) = 2.377$, $p = .025$* $d = .93$ (large effect)

Note. * Indicates significant at the .05 level.

Although the mean scores of the experimental section were numerically higher than those of the control section in the remaining evaluations (SPSS Assignment 3, Test 2, and the final exam), the differences were not significant (all $p > .05$). There was also no significant difference in the final course averages between the two sections ($p = .096$).

A closer look was then taken at the students in the experimental section. Six of the 13 participants opted to complete a journal entry more than once. The performance of these six journal writers was compared to that of the students who opted to not use the journal more than one time. Performance was significantly higher among journal users on SPSS Assignments 2 and 3 (see Table 2). Although not significantly different, the journal users also had numerically higher mean scores on the remaining evaluation items than those who did not opt to use the journal.

Table 2: ***Significant Differences between Journal Users and Non-Journal Users within the Experimental Section***

Evaluation Item	Journal Users Mean Score (*SD*)	Non-Journal Users Mean Score (*SD*)	*t*-statistic and Cohen's *d* (where significant)
SPSS Assignment 2 (200 points possible)	189.86 (9.55)	176.0 (8.56)	$t(11) = 2.759$, $p = .019$* $d = 1.53$ (large effect)
SPSS Assignment 3 (200 points possible)	189.43 (6.13)	178.67 (4.27)	$t(11) = 3.603$, $p = .004$* $d = 2.04$ (large effect

Note. * Indicates significant at the .05 level.

Analysis of students' journal contents. The contents of the journals from the experimental section were analyzed. Of the 13 students enrolled in the semester in which the metacognition journals were introduced, seven students used the journal at least once (six of whom used the journal more than once), creating a total of 25 entries. Six of the students refrained from using the journal altogether. The number of journal entries was greatest in the first five weeks of class, and then declined thereafter (see Figure 1).

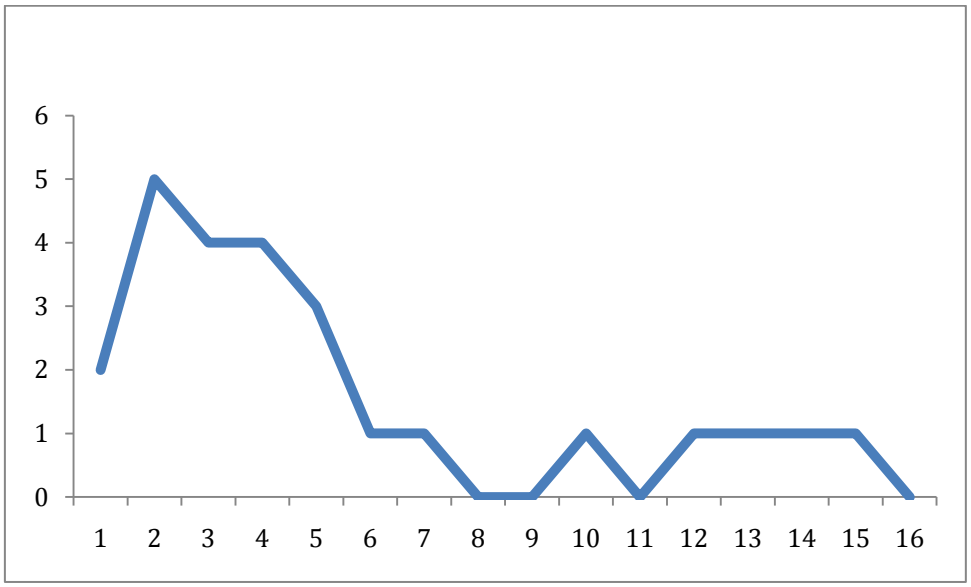

Figure 1. Number of journal posts by week.

Some journal entries documented multiple topics. The content was categorized according to whether it featured a question or a statement, and then by the topic. The content of the entries in terms of the specific topics posed to the students is as follows. Students made eleven statements about their learning of statistical concepts, four statements about using SPSS, and one statement about using APA format. Students also used the journal to ask the instructor a total of seven

questions regarding statistics material: four questions were about statistical concepts, two questions were about how to do an assignment, and one question was asked about how to use APA format.

In addition to the specific topics posed to them, students also used to the journal to express general motivational factors; there were ten instances of this type of content. One student (i.e., "Student A") regularly used the journal to document her feelings about the course: how she was progressing, external pressures that added to her workload, her desire to perform well in the course, questioning her ability at times, and also expressing confidence in herself. Some of her selected quotes are as follows:

Student A: "The hard work really paid off! I still can't believe how well I did on this last paper. Now I just need to keep up the work and do well on the next paper and test."

"Alright, so I had a lot of things going on at work and in my life so I was not able to take as much time for the paper…then again, I didn't realize how much time was really needed."

"I am happy to see the other students from our class tutor each other…it shows how dedicated we all are to try to do well in this class."

Some examples of the entries made by other students are as follows:

Student B: "This week in class the professor went over the basics of SPSS. I understood most of the topics covered. However, I will likely review on my own with the SPSS software to become comfortable with the processes of re-coding data, analyzing it, and creating charts to represent the data visually."

Student C: "Pretty much I understand everything covered in class, however this [*sic*] are the things I might bump into later:

- Forgetting specific definitions and concepts
- Remembering the rules for the whole course

The plan? Keep going back to do quick readings of notes and search for material on the internet that reviews the topics... regarding the rules my idea is to keep in touch with the TA and read the syllabus...

Other thing for me was that many things were new to me since I haven't been in ERAU before or for that matter in a University in the U.S.A."

Student D: "I knew the day would come when the material becomes more difficult. I still understand most things in class but when I started working on the paper, APA and the table made it so difficult. I will definitely seek help and try to see if the TA has time to help."

Instructor reply to Student D: "Formatting tables is one of the most difficult parts of APA. Do your best on the tables for now and come see us for help. You will get it right with practice."

Discussion and Conclusion

In general, the experimental section that used the journals executed better academic performance in the course assignments and tests than the control section. These differences were significant for SPSS Assignment 1 and Test 2, and marginal for SPSS Assignment 2. The differences were not significant in the other course evaluation items. There was also no significant difference in final course averages.

Though completing the weekly journals was entirely voluntary, some students participated somewhat regularly. At the beginning of the semester, participation was more frequent; however, participation declined as the semester continued, possibly due factors such as students forgetting to participate and reduced novelty of the task. To maintain a naturalistic environment, the instructor did not regularly remind students to complete their journals. This hands-off approach may have contributed to the decline in journal entries as a function of time. Similarly, Borasi and Rose (1989) reported that students' journaling in a mathematics course waned when instructors did not prompt them to do so.

While it cannot be determined why some of the students refrained from using the journals, Boud (2001) describes some of the factors that can discourage individuals from keeping journals. Writing about one's perceived deficiencies, sources of unease, and problems can be prohibitive, especially if the writer is concerned about the identity of the reader and perceived negative consequences that could result. Knowing that the instructor would be reading about students' criticisms of not only themselves, but also possibly of the course itself, could have been deterrents to participation.

Students used the journals to document what they had learned that week mainly in statistical concepts; however, some also documented what they had learned about the SPSS software and APA formatting. Statements about what they had learned outnumbered questions they had about the course material. Questions about statistics were the most frequent, followed by questions about the assignments and one question about APA format. According to Douglass and Morris (2014, p. 16) "talking with professors to identify gaps in learning" facilitates student self-directed learning. The content of students' journals showed that the journals indeed served as a means of communicating with the instructor about where their perceived knowledge needed improvement.

Another positive use of the journal was students reflecting on their own learning experiences. In some cases, students had been anticipating having a difficult time with statistics, yet were surprised that they were learning effectively and pleased with their own progress in the course. These statements likely reflected their intrinsic motivation to succeed in the course. One student regularly used the journal as a means to express her motivation-related feelings; sometimes

they were positive and sometimes negative, but the instructor used her writings as an opportunity to encourage her perceived self-efficacy. As Herman (2012) states, students' intrinsic motivation can improve when they feel their instructors believe in their abilities.

Aside from reflecting on their own learning, the journals may have also provided another means for students to communicate with the instructor. While students were encouraged to express themselves in class, and visit and email the instructor for assistance during the course, the journal provided an additional, perhaps less formal means of communication between the students and the instructor. The instructor noticed that some students who did not vocalize during class did write journal entries; in accordance with Moon (1999), perhaps the journal served as a more comfortable format in which communicate.

This study was exploratory in nature and thus it only investigated two different sections of a graduate-level statistics course. A larger sample size may have produced more powerful hypothesis testing. With only 14 participants in the control section and 13 in the experimental section, the study could have benefited from larger sample sizes, but may still provide a glimpse into the advantages of journaling in statistics coursework. Collecting more data from future sections could increase the ability to detect achievement benefits as well as trends in how the students are choosing to use the journals.

In conclusion, the practice of keeping a journal may have been a positive influence on student performance in graduate-level statistics coursework. It may have improved some aspects of student performance in terms of grades, and also served as an effective and comfortable venue for students to communicate with the instructor and receive positive feedback on their learning. Keeping reflective journals in statistics coursework is a practice that is worthy of continued exploration. Many online LMSs currently provide journal platforms that can be employed for documenting students' reflections on their coursework in statistics and other quantitative methods. Future work can address the impact of reflective journaling using a larger sample size as well as possibly reminding students about participating in the journal multiple times throughout the semester in order to increase the number of entries made.

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