

Demystifying Data: A Constructivist Approach to Teaching Statistical Concepts Using SPSS

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To improve public relations students' self-efficacy and knowledge of statistics, two hands-on activities were created. One activity used data simulation in the software program SPSS, and the other used printed statistical outputs. Both activities were introduced in a flipped-classroom format as part of a crossover experimental design. The results indicated that knowledge of statistics and self-efficacy for learning statistics increased following the two activities. The results also suggested that the activity using data simulation may have been especially effective for increasing self-efficacy for learning statistics.

Keywords: public relations research, statistics, constructivism, active learning

Acknowledgements: The author would like to thank the members of the 2018-2019 Scholarship of Teaching and Learning Faculty Learning Community at Georgia Southern University for their encouragement and advice during this project. Special thanks go to Dr. Claudia Cornejo Happel, Dr. Kathryn Haughney, and Dr. Taylor Norman.

Editorial Record: Original draft submitted to JPRES August 26, 2019. Revision submitted October 25, 2019. Manuscript accepted for publication November 15, 2019. First published online January 21, 2020

Certain challenges are inherent in teaching research methods to public relations students. In particular, public relations students tend to have high levels of math anxiety, and this anxiety causes them to avoid quantitative information (Laskin & Sisco, 2010). Although many public relations students may dislike numbers, a basic understanding of statistics is increasingly important for future public relations practitioners (Jain, 2016). Not all public relations programs require separate statistics courses, but, even so, public relations students increasingly need a basic understanding of how statistics relate to strategic decision-making. According to the Commission on Public Relations Education (CPRE, 2018), students “must be able to go beyond the numbers and identify the implications of those numbers to produce actionable insights for the client” (p. 83). The ability to use data for strategic planning may be particularly important for public relations practitioners operating in convergent communication models (Burton, 2019). Therefore, even if they do not plan to run statistical analyses in their future jobs, public relations students need a conceptual understanding of statistics so they can make strategic decisions based on statistical data. In particular, future public relations practitioners should understand information such as the meaning of correlations and p-values (Public Relations Society of America & The American Statistical Association, 2011). Although some public relations undergraduate programs require introductory statistics courses, the task of teaching students basic statistical concepts often falls to instructors of public relations research courses.

By using active learning strategies, public relations instructors can encourage math-averse students to use statistical data for strategic decision-making. For example, students can use the online platform Perusall, which requires students to comment on readings and respond to each other’s comments for a grade, to promote an active learning experience. Such readings could include articles from Harvard Business

Review such as “A Refresher on Statistical Significance” (Gallo, 2016), “When to Act on a Correlation, and When Not To” (Ritter, 2014), and “Beware Spurious Correlations” (2015). However, some students retain their fear of numbers even following active engagement with such applied reading activities.

Therefore, the author developed an in-class activity that used statistical software as an innovative way to allow for more in-depth, hands-on learning. Statistical Package for the Social Sciences (SPSS) was used to teach basic statistical concepts to public relations students who had never taken a statistics course. The software program activity, which required students to take a more proactive approach and simulate data, was used alongside a more traditional, paper-based activity using SPSS outputs. This paper examines how a flipped classroom approach incorporating both of these activities affected students’ statistics knowledge and self-efficacy to learn statistics. Furthermore, using an experimental crossover design, this paper compares the relative effects of the two different activities.

Literature Review

In an analysis of the Great Ideas for Teaching (GIFT) awards presented by the Association for Education in Journalism and Mass Communication from 2000-2009, it was found that 45% of the awards were given for teaching elements that reflected a constructivist approach for “higher learning” (Cuillier & Schwalbe, 2010). Constructivism suggests that, rather than simply disseminating information, teachers should give students opportunities to intentionally build knowledge (Anthony, 1996). This approach, which relies heavily on experiences and activities, may be more useful for helping students learn to evaluate ideas on their own (Cuillier & Schwalbe, 2010) and, therefore, may be appropriate for students who need statistics primarily for strategic decision-making (CPRE, 2018).

Building Knowledge Through Active Learning

Constructivism is the theoretical background driving active learning in flipped classrooms, where lecture may be delivered via online videos and students take an active learning approach in the classroom through group activities (Bishop & Verleger, 2013). Research has suggested that the active learning itself, and not the flipped classroom, is the real reason that students develop a better understanding of material delivered in this format (Jensen et al., 2015). Virtual reality learning environments, for example, have been described as helpful because, in line with the constructivist paradigm, knowledge is based on active experience and dependent on the environment in which learning takes place (Huang et al., 2010). Similarly, computer-based modeling tools and simulations have long been considered useful for helping students build a deep understanding of course concepts (e.g., Dalgarno, 2001).

Active learning interventions have been demonstrated to improve learning outcomes significantly across a variety of different science and math courses (Freeman et al., 2014). Furthermore, several studies have demonstrated that active learning exercises consistent with a constructivist approach lead to student success in introductory statistics courses (e.g. Gnanadesikan et al., 1997; Smith, 1998). Instructors for statistics courses have propounded the use of real-life activities as a form of active learning, including simple field experiments, observation of chance events, and observation of correlated events (Smith, 1998).

Improving Self-Efficacy to Learn Statistics Through Active Learning Strategies

In addition to improving knowledge, hands-on activities may be particularly important for improving self-efficacy when teaching statistics to public relations students. Self-efficacy to learn statistics represents a student's confidence in learning to use statistical data (Finney & Schraw, 2003). Past research has found that active-learning class formats can

improve self-efficacy for statistical analysis in both biology (Ebert-May et al., 1997) and psychology (Harlow et al., 2006). Social science classes incorporating statistics into the coursework frequently use active learning strategies, and several instructors have created activities around SPSS. One study found that undergraduate criminal justice majors were less anxious when learning about statistics using SPSS rather than with a traditional class with calculations (Stickels & Dobbs, 2007). Journalism classes have used computer software to teach statistical concepts for decades (e.g. Burkhart, 1987) because learning to use SPSS allows students to gain the skills to analyze and interpret their own survey data. Statistical software programs may also improve communication students' self-efficacy for learning statistics. Burkhart (1987) argued that "intellectually, students who learn to use computer programs to perform statistical analysis of data will gain confidence in critical use of statistical data provided by news sources" (p. 4). Therefore, the use of SPSS to improve self-efficacy for learning statistics is worth examining in the context of public relations research.

Active Learning Through Simulations

SPSS and similar applications may be particularly useful as platforms for simulation activities for teaching quantitative methods in public relations research courses. For example, students can simulate their own datasets in SPSS that demonstrate what participants' responses would be if certain survey items are or are not correlated; SPSS can then be used to test whether their simulated responses do or do not correlate. Simulations, a form of active learning used in other types of public relations courses like crisis communication, can help students gain key skills (e.g. Wang, 2017). Simulations using statistical data may be similarly useful to help students gain knowledge of quantitative data analysis that can be applied for strategic communication practices. Student-simulated datasets have the particular advantage of requiring

students to actively create patterns in responses, whereas other activities require students to more passively recognize those patterns.

Simulation-type activities have been used to teach statistics in public relations in the past, though generally not with SPSS. Gallicano (2017) demonstrated the usefulness of an active, problem-based approach to teaching statistics in a public relations course using social media analytics from Facebook. Using information about social media interactions from a Facebook fan page, students learned about normal distributions using an online standard deviation calculating tool. Students then created visualizations of standard deviations for the purpose of understanding a social media fan page's distribution of interactions for the purpose of objective-setting. In Gallicano's (2017) activity, the combination of visualizations and active calculations may have been particularly beneficial. For concepts such as correlations and significance levels, however, other tools may be required.

Public relations faculty members at major universities do sometimes use SPSS in public relations research courses, but they may not use it for data simulation activities or to teach basic statistics. Current uses of SPSS in public relations research courses may include an overview of the application's uses and interpretation of an SPSS output. More involved uses of SPSS may include statistical analysis as part of a class research project. Because SPSS is already used in public relations research courses for other purposes, however, this software could be repurposed for simulation activities. In particular, by allowing students to simulate their own datasets and create graphs, activities using SPSS simulations may prove helpful for improving students' understanding of correlations.

Classroom exercises were developed by the author to provide students with active learning opportunities to gain a deep understanding of Pearson's correlation and significance. Two types of exercises were devised: a lab-based exercise, which allowed students to simulate data

consistent with a constructivist approach, and a paper-based activity, which required students to interpret statistical outputs without data simulation. Both the lab activity and the output activity were created using SPSS version 25.0. Although past research suggests that a simulated activity using SPSS would be more effective for improving statistics self-efficacy and knowledge (e.g. Burkhart; 1987; Gallicano, 2017), the seemingly advanced nature of the program and public relations students' level of math anxiety may make a simpler, paper-based activity more helpful for students.

RQ1a: Does learning about statistics using the combination of a computer simulation and a paper-based activity improve students' level of understanding of statistics?

RQ1b: Does the use of a computer-based simulation activity or a paper-based activity more greatly improve knowledge of statistics?

RQ2a: Does learning about statistics using the combination of a computer simulation and a paper-based activity improve students' self-efficacy to learn statistics?

RQ2b: Does the use of a computer-based simulation activity or a paper-based activity more greatly improve self-efficacy to learn statistics?

Method

Course Overview

Data regarding the use of the classroom activity were gathered from two public relations research classes during the spring 2019 semester. To establish a baseline, all students were given a survey regarding statistics knowledge and self-efficacy to learn statistics a week before any of the activities. The survey was given again following each of the activities the students completed. A total of 45 students took part in the study, but only 30 completed all measures and were included in the final analysis ($n = 17$ for Group A and $n = 13$ for Group B). Although small, a sample of 30 is considered acceptable for within-subjects studies

(Oberfeld & Franke, 2013), and, therefore, the data could be used to test RQ1a and RQ2a. However, the between-subjects tests for RQ1b and RQ2b were considered exploratory due to the small number of participants in each group.

No statistics courses are required as a prerequisite for this course, and basic quantitative methods, including survey question design, probability sampling, and basic statistics, are taught over a four-week period in the course. After one week discussing the normal curve, confidence intervals, and confidence levels in class, students began a two-week period of flipped classroom-style lessons consistent with active learning approaches. To support the flipped classroom format, students watched videos created by the instructor explaining basic statistical concepts. All students took an online quiz on these videos before class on Day 1 of the study, when the first in-class activity took place. Videos of SPSS demonstrations also prepared students ahead of time to interpret SPSS outputs and complete the lab-based SPSS activities.

SPSS Lab Activity

The simulation activity took place in a computer lab reserved for the class. This activity used an SPSS file with several variables in place but no participant responses (i.e., no data appeared in “Data View”). Students were guided through the steps in the exercise with written instructions and screenshots (see Appendix A). Several variables were named. For each variable, the original survey question was included in “Variable View,” and the response options were entered under “Values.” The primary variables used in this case were two scale items adapted for a coffee company from the integrity dimension of trust in Hon and Grunig’s (1999) relationship scale for publics: “Starbucks treats people like me fairly and justly” and “Whenever Starbucks makes an important decision, I know it will be concerned about people like me.” Students taking part in the exercise had previously used this integrity scale in a classroom

activity while discussing types of survey questions. For that activity, students responded to the items in class for a different chain restaurant and then averaged their responses. They also observed whether or not they answered similarly to the items to spark a conversation about the nature of reliability. As a result, students were expected to understand that people were likely to respond in a similar direction for the items in the integrity scale.

Students began with a warm-up activity in which they reviewed all of the variables in “Variable View,” labeled each variable as scale or nominal, and created new variables in SPSS. In addition to improving their comfort with using the application, this warm-up allowed students to become familiar with the two key scale items. Next, students engaged in the active learning activity for correlation. Students were given these instructions: “Create responses for participants 1-30 for the first two variables, Trust_1 and Trust_2, so that the responses should be strongly, but not perfectly, correlated.” Students then ran a Pearson’s correlation in SPSS and were asked to assess whether the correlation was strong and significant. The interpretation of Pearson’s correlation had previously been demonstrated and explained in the videos that students viewed before class as part of the flipped classroom format. If they were confused, students interacted with the instructor when they were unsure of how to interpret the information.

Students who were unable to generate a strong, significant correlation repeated the exercise until they were successful. Students frequently had to attempt the exercise several times, but all were able to successfully complete the exercise. Once they were successful, students were directed to generate a scatter-dot plot for the two variables and assess what a strong correlation looked like. Finally, students were instructed to repeat all steps for a weak correlation. If students finished the assignment early, they were told to repeat it for a correlation in a different direction

(e.g. a negative correlation if the previous one were positive). Measures for knowledge and self-efficacy were administered at the end of class after all students had completed the exercise.

SPSS Output Activity

Outputs from statistical analyses in SPSS are already used in some public relations research courses, and therefore, an output-focused activity was used as the comparison activity. For this activity, students were asked to get into groups of three to four people. Students then worked through the steps outlined on an activity sheet (see Appendix B). The activity sheet was attached to a list of survey questions regarding students' perceptions of a local nonprofit gym. Also attached was an output of analyses for the dataset, including frequencies, descriptive statistics, an independent-samples t-test, and two correlation matrices. One of the correlation matrices was made up of items for the same integrity dimension of trust used in the lab-based activity, but in this case the scales were used for the nonprofit gym.

For the paper-based activity, students worked through similar information as in the lab-based activity. To make the activity more interactive and similar to the computer lab-based activity, the instructions required students to write a hypothesis about the relationship between two scale variables and drawing a scatter dot plot depicting one of the predicted relationships. Furthermore, to meet the constraints of the course schedule, this activity included information regarding descriptive statistics and a very brief introduction to an independent-samples t-test. Students worked through the problems in their groups, and then the groups shared their findings with the rest of the class. The instructor discussed any problems with the hypotheses they formed in their groups, gave a demonstration on a whiteboard for what scatter dot plots might look like for different types of associations, and corrected any erroneous interpretations from the outputs. Therefore, the activity was interactive and

covered similar material to the lab-based activity. However, the activity did not allow students to simulate their own datasets to produce outputs and graphs.

Experimental Design

An experimental crossover design was used to evaluate the overall usefulness of SPSS-based activities in the context of a flipped classroom and to compare the relative value of each kind of activity. Before covering information regarding probability and statistics, all students were given the opportunity to complete a paper-based survey measuring both self-efficacy to learn statistics and knowledge of Pearson's correlation. This measure took place one week before the first activity was scheduled. Subsequent data collection then took place over the course of three consecutive class meeting days.

Students were randomly assigned to two groups. Group A took part in a lab activity first and a paper-based activity second, and Group B completed the paper-based activity first and the lab activity second (see Table D1 for full schedule). On Day 1, Group A took part in the in-class activity using the statistical software SPSS in a computer lab and filled out the measures for statistics self-efficacy and statistics knowledge at the end of that class period. Group B used this time outside of class to complete a separate assignment not related to statistics. Then, both groups met in class for Day 2; all students took part in an activity using printed outputs from statistical analyses to learn about basic statistics. Measures for knowledge and self-efficacy (see Appendix C) were administered at the end of class. Finally, for Day 3, Group B took part in the same in-class activity Group A completed on Day 1 using SPSS in a computer lab setting while Group A completed an unrelated class assignment outside of the classroom. Students were offered five points extra credit for taking part at three different points in the intervention (the baseline and two activities; see Table D1). If they completed all three components, students then received

an additional five points extra credit. All measures were administered by colleagues from a different field of study so that students did not feel pressured by the presence of the instructor, and all students used anonymous identifiers on their surveys. All elements of the study were approved by the institutional review board before the study began.

Survey Measures

Survey questions for the statistics self-efficacy scale were adapted from Finney and Schraw's (2003) scale for self-efficacy to learn statistics. This scale asks participants to rate their confidence in their ability to learn about a number of statistical procedures (see Appendix C). Finney and Schraw's (2003) scale includes advanced statistical concepts not covered in the course and does not include measures for applied use of statistics in a public relations context. As a result, the original measures were adjusted for this project. For example, one of the items in the self-efficacy scale asked students to rate their ability to learn to, "analyze the results from a survey using a Pearson's correlation" on a scale running from 1 (no confidence) to 7 (complete confidence). Following the administration of the surveys, the measures were assessed for internal consistency, which was found to be high ($\alpha = .96$).

The measure of statistics knowledge, which was reviewed by an education expert to ensure content validity, took the form of five open-ended questions (see Appendix C). Open-ended questions were used so as to best capture students' constructed knowledge created through active learning. These questions were coded by the instructor with 1 point or half-point partial credit given per question. The measures for statistics knowledge and self-efficacy to learn statistics were administered simultaneously at all three points of measurement.

Demographics

Demographic information was gathered from students on the last scheduled activity day for their group; one student declined to provide any

demographic information but responded to all scale items and was retained for the final sample. As previously stated, 30 students ($n = 17$ for Group A and $n = 13$ for Group B) completed measures for the scale items all three times, and those who did not complete all three were removed from the sample. The demographic make-up of the students who completed all measures was 73% White, 17% African American, and 3% mixed race. The sample was 80% female and comprised of 18 juniors and 11 seniors. Only 30% of the students reported previously taking a statistics course.

Results

The first research question addressed whether a) the use of hands-on activities as part of a flipped classroom would improve public relations students' understanding of statistics and b) if one type of activity was more helpful than another. A paired-samples t-test comparing knowledge measures for the entire sample both before the flipped classroom format began (baseline) ($M = .28, SD = .67$) and following the final activity (activity 2) ($M = 2.60, SD = 1.30$) did show a significant increase in knowledge ($t(29) = -8.10, p < .001$). Therefore, when used as part of a flipped classroom format, the activities did help students understand statistical concepts.

To further explore the relative advantages of the two types of activities, a mixed-design ANOVA with group (Group A, Group B) as a between-subjects measure and day in class (baseline, activity 1, activity 2) as a within-subjects factor was used to test for an interaction. No interaction was found for the between group assignment and students' knowledge across the three measurement points ($p > .05$). Although the study did not demonstrate that using SPSS was better for constructing knowledge than using a paper-based activity, the findings support that the use of both exercises together contribute to the construction of knowledge.

Tests were also conducted to answer the second research question regarding the effects of the activities on self-efficacy for learning statistics.

A paired-samples t-test comparing self-efficacy measures for the entire sample from the baseline ($M = 3.4$, $SD = 1.81$) to the activity 2 ($M = 5.47$, $SD = .96$) also showed a significant increase in self-efficacy ($t(29) = -6.16$, $p < .001$). To explore the second part of RQ2 and compare the effects of the two activities on self-efficacy for learning statistics, a mixed-design ANOVA with group (Group A, Group B) as a between-subjects measure and class day of measurement (baseline, activity 1, activity 2) as a within-subjects factor was used to test for an interaction. Because Mauchly's test for the assumption of sphericity was significant ($\chi^2(2) = 18.63$, $p < .05$), the degrees of freedom were corrected using Greenhouse-Geisser estimates of sphericity ($\epsilon = .67$). The interaction between group and measurement time was significant ($F(1.34, 37.37) = 6.59$, $p < .05$), and inspection of the marginal means indicated that this interaction was driven by Group A's greater self-efficacy for learning statistics following activity 1 compared to Group B's self-efficacy following its activity 1 (See Figure D1).

Follow-up tests were conducted to interpret the interaction. Independent-samples t-tests indicated that, although the difference in self-efficacy for the two groups was not significant at baseline, when both groups were assessed before they took part in any activities ($p > .05$), there was a significant difference between the two groups in the measure of self-efficacy for activity 1 ($t(28) = 2.67$, $p < .05$). Group A, which was made up of students who took part in the lab-based activity as their first active learning experience, had higher self-efficacy for learning statistics following the activity 1 ($M = 5.52$, $SD = .98$) compared to students in Group B ($M = 4.47$, $SD = 1.20$), who took part in the paper output-based activity as their first active learning experience. Group A maintained this level of self-efficacy when measured again following the paper-based activity for activity 2 (see Figure D1 for a graph of the marginal means). Due to the low number of students in each group, the analysis comparing

the two different teaching activities (lab activity for Group A vs. paper-based activity for Group B) should be considered exploratory. However, the findings do suggest that the lab-based activity may have had a particularly strong influence on self-efficacy for learning about statistics.

Discussion

This paper supports past findings that active learning strategies can improve both learning self-efficacy (Ebert-May, et al. 1997; Harlow, et al., 2006) and knowledge (Gnanadesikan, et al. 1997; Smith, 1998). Students' self-efficacy improved primarily when they participated in activities that allowed them to experience the data through virtual simulation in SPSS. This finding is consistent with research that the learning environment is key for learning construction to take place (Huang, et al. 2010). Students can gain confidence about statistics by using statistical analysis software and creating their own dataset simulations. Most of the students in this study had never previously taken a statistics course, but they were able to engage with SPSS in a way that improved their self-efficacy for learning statistics. Based on the findings from this study, both activities are recommended for improving the self-efficacy of public relations students, but students may receive the greatest benefit by taking part in the lab-based simulation first.

Furthermore, although the study was not able to distinguish between the effects of two types of activities on knowledge, over the course of the entire study, students' knowledge of statistics also improved. Students did not demonstrate significantly different knowledge of statistics following the first activity; this may be in part due to the challenging nature of the open-ended questions, which may have weakened the discrimination power of the knowledge measure. However, by the second hands-on activity, knowledge for all basic statistical concepts increased significantly for both groups of students. Therefore, although the study could not demonstrate that one activity was better than another for

increasing knowledge, there is evidence that the combination of both activities improved knowledge of statistics. These activities may therefore be used over a two-day period as a part of a flipped classroom to improve student knowledge of basic statistical concepts.

Related Activity Learning Opportunities

The lab activity also offered multiple opportunities for discussion regarding other aspects of correlations and survey questions related to the course content. For example, students in the study who did not use the whole 5-point scale for their simulated responses had difficulty finding significant Pearson's correlations. This experience led to discussions regarding the nature of scale variables and why 5-point and 7-point scales are often used to measure attitudes rather than scales with fewer items. These discussions were used to teach students to design surveys with specific uses of the data in mind.

Similarly, when they tried to assess if they had simulated the activity properly, some students initially had difficulty distinguishing between the meaning of correlation coefficients and the significance level. The instructor used this opportunity to reinforce the importance of the two separate pieces of information and, in particular, to note that significance is important for all of the statistical tests discussed in class, but that the correlation coefficient was information unique to correlations. To demonstrate how the correlation coefficient indicates the strength and direction of a relationship between two scale variables, the instructor used the scatter dot plots students created as part of the lab activity (see Appendix A).

The simulation activity also gave students the opportunity to learn the process for analyzing actual survey data, even though that was not the main purpose of the exercise. The steps for running correlations in SPSS are the same for real data as for simulated data. Students who want to conduct quantitative research in the future have, therefore, not only

improved knowledge and self-efficacy for statistics but have also been given instructions that can be used to analyze their own survey results. However, even if these students never analyze their own data again, they will have experience with how survey data can be analyzed and interpreted, which may improve their ability to discuss analysis provided by others.

Limitations and Future Research

This study used a crossover design with random assignment to understand which active learning strategies best improve statistics knowledge and self-efficacy to learn statistics. Due to class schedule constraints, the crossover design did require that students from the two groups take part in the printout activity during the same class (see Table 1). The presence of both groups could have influenced the results even though students were told to engage only members from their respective groups for the printout activity.

Furthermore, although the randomized groups are a strength of the study, participant attrition was a problem. A total of 15 participants did not complete all components of the study. Slightly more students in Group B did not complete the study, which, with the small sample available, could have influenced the results. However, based on the findings, students who completed the lab-based activity first (Group A) should have had higher self-efficacy. Their relatively higher self-efficacy may have made members of Group A more disposed to come to class for subsequent lessons, which may explain the differences in participant attrition for the two groups. Furthermore, although the sample was sufficiently large to make reasonable conclusions about changes in knowledge and self-efficacy based on the pretests and posttests for the entire sample ($N = 30$), the interaction and comparisons between Group A ($n = 17$) and Group B ($n = 13$) for self-efficacy should be considered exploratory. Therefore, the small sample size limits the conclusions that can be drawn about the different

effects of the lab-based and computer-based activities.

In addition to limits in the study design, limits should also be acknowledged in the classroom exercises described here. Additional activities should be used to complement this approach and to make sure students understand how correlational data may be used in the context of strategic planning. Furthermore, the activity described here does not address the common misconception that correlation can lead to causation. Therefore, students who took part in this study also participated in other learning assignments during the semester to supplement their understanding of correlation and significance.

Future studies of activities for teaching public relations students statistical concepts might explore how learning about Pearson's correlation may lay a foundation for understanding other statistics. Learning about correlation can help students to understand the general principle of covariance. Therefore, this single activity can be used as a springboard to discuss the conceptual meaning of Cronbach's alpha and simple linear regression by drawing conceptual comparisons. Cronbach's alpha can be compared to a correlation with more than two items, and linear regression may be described as a more advanced form of correlation that can be used to draw lines and make predictions. Although these definitions are not precise, a vague and intuitive understanding of information, called gist, is often more likely to be used in decision making (Reyna, 2008). "The gist representation is the answer to the question 'What does 22.2% mean?' to that individual" (Reyna, 2008, p. 851). Consequently, students are more likely to use an intuitive understanding of statistics for decision-making rather than a technical definition. Therefore, this exercise for a single statistical test prepares students to have constructed conceptual knowledge of several statistical procedures without using any equations or mathematical calculations. Future research may also examine other activities with student-simulated datasets, which could be used to explore,

for example, concepts like standard deviation.

Conclusion

Using an experimental crossover design, this study examined how statistical software can be used to teach basic statistical concepts. SPSS and similar programs allow students to create simulated datasets. By attempting to create participant responses that would lead to certain statistical outcomes, students learn on a deeper level about what those outcomes mean. As part of an active learning approach in a flipped class format, this activity significantly increased students' self-efficacy for learning statistics. Knowledge of basic statistical concepts also improved, although this change was not specifically tied to the simulated data activity. An active learning approach to teaching quantitative methods is recommended for encouraging public relations students who may be otherwise intimidated by statistics in the public relations research curriculum. Using SPSS in lab-based activities, either alone or in combination with activities based on SPSS outputs, may help students gain confidence and construct knowledge for how to use statistics in their professional practice.

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Appendix A

SPSS Computer Lab Activity

Note: Screenshots of SPSS have been removed from the original activity.

Working with Nominal and Scale Variables

- 1) You have been emailed the dataset for this exercise in a file called SPSS_Blank_Exercise_SP19.sav; please download this file to your desktop. Please note that you will only be able to open files ending in .sav (and .spv for the output files) on computers that run the application SPSS.
- 2) Review the variables currently in Variable View, especially the Label and the Values for the first two variables, Trust_1 and Trust_2. To see the values, click once and then click again on the [...] that appears
- 3) Label each of the variables as Scale, Ordinal, or Nominal under the Measure Column
- 4) Create a new nominal variable, including the information for Name, Label (the question as it would appear in Qualtrics), Values (response options), and Measure category.
- 5) Create a new scale variable, including the information for Name, Label (the question as it would appear in Qualtrics), Values (response options), and Measure category.

Understanding Strong and Weak Correlations

- 1) Switch to Data View.
- 2) Create responses for participants 1-30 for the first two variables, Trust_1 and Trust_2, so that the responses should be strongly, but not perfectly, correlated.
- 3) Test the Pearson's correlation between Trust_1 and Trust_2 in SPSS:
Analyze > Correlate > Bivariate
 - a. Select the variable (please note that the Label, not the Name, appears in SPSS, but if you hover the cursor, the Name will appear).
 - b. Click the arrow button in the middle to move the variables over that we want to test.
 - c. Click Ok.
- 4) Review the Output window. Look for the correlation coefficient – is it strong? How do you know? Is it significant? How do you know?
- 5) Visualize the results by creating a scatter dot plot. Go to Graphs > Chart Builder.
 - a. Choose the first “Scatter/Dot” option (Select Scatter/Dot and then double click on the first option that appears)
 - b. Place Trust_1 on the x-axis and Trust_2 on the y-axis by dragging the variable over to the picture of the graph.
 - c. Click “OK”
- 6) What does the plot look like for a strong correlation?
- 7) Repeat steps 1-6, but this time create a weak correlation.

Appendix B
SPSS Paper-Based Output Activity

1. Review the survey questions on p. 1 (Variable View).
2. Review the responses for participants 1-10 on p. 2 (Data View).
3. Write a hypothesis for the relationship between 2 of the starred scale variables.
4. Draw one conclusion from the information on p. 3 (Frequencies Output) that is relevant to a campaign for a gym.
5. Draw one conclusion from the information on pg. 5 (Descriptive Statistics).
 - a. Which variable has the highest standard deviation? What does this mean?
 - b. Which variable has the lowest standard deviation? What does this mean?
6. Find the information that will give you the confidence interval on p. 7 (you will have to do some simple math).
7. What do the 1s mean in the correlation matrix on p. 9?
8. Circle all of the negative correlations on p. 9.
9. Put a square around all of the nonsignificant correlations on p. 9.
10. Draw a picture of what a graph for what one of the significant correlations would look like. Is it strong? Weak?
11. Find the significance level for the t-tests on pg. 10. Signal the instructor once you have finished this step.

Appendix C
Measures for Self-Efficacy to Learn Statistics and Statistics
Knowledge

Part 1: Self-Efficacy to Learn Statistics

Directions: Please indicate how confident you are that you could learn to complete the following tasks (1=no confidence, 7=complete confidence).

1. Explain what a Pearson's correlation is conceptually.
2. Interpret the information regarding a Pearson's correlation (correlation coefficient) that appears in a journal article.
3. Use Pearson's correlation coefficient to draw a basic graph indicating what the results might look like when graphed.
4. Explain what significance level (p value) means conceptually.
5. Interpret a significance level (p value) that appears in a journal article.
6. Design survey questions that will allow you to run a correlation.
7. Analyze the results from a survey using a Pearson's correlation.

Part 2: Statistics Knowledge

Directions: Please give as much information as you can to answer each of the following questions. We have intentionally given you more room than we think you will need; please write as much information as you can. Make sure to put something down for each question even if you are unsure of the answer.

1. What does a Pearson's correlation tell us?
2. What does it mean if a Pearson's correlation is strong?
3. What does it mean if a Pearson's correlation is weak?
4. What is a significance level (p value)?
5. How does the significance level (p value) for a Pearson's correlation influence how we interpret the correlation?

Appendix D

Tables and Figures

Table 1
Order of Activities

	Day 0	Day 1	Day 2	Day 3
Group Activity	Baseline measure for Group A and Group B	Group A Lab Activity; Group B not in class	Group A and Group B Classroom Activity	Group B Lab Activity; Group A not in class
Intervention Order	Baseline	Group A Activity 1	Group A Activity 2 Group B Activity 1	Group B Activity 2

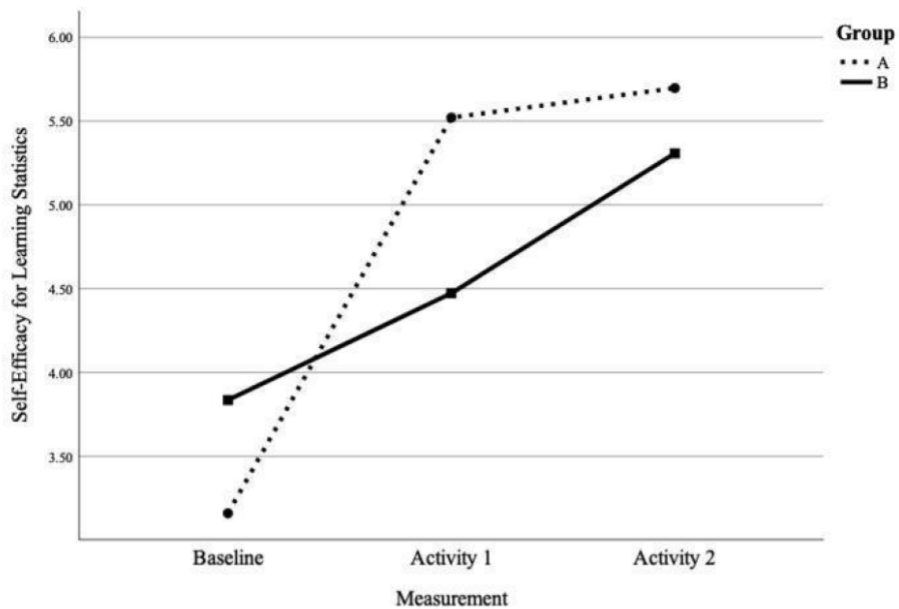


Figure 1. Graph showing increase in self efficacy for Group A and Group B.