Examining the impact of open and transparent research practices in an undergraduate research methods course in Psychology

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2018 SoTL Grant Submission

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Abstract

Over the past decade, in response to the so-called “replication crisis”, psychology researchers have begun adopting practices that promote openness and transparency. Currently, these emerging best practices are not consistently represented in the teaching of *Psychology research methods* at UNCC. Moreover, research in pedagogy has not systematically examined whether introducing undergraduates to open science practices improves their conceptual understanding of research methods. In the proposed work, we seek to evaluate the impact of integrating open science practices into the curriculum of *PSYC2103: Research Methods II (RM2)*. We will implement this integration through: (i) an Open Science module that situates questionable research practices in the current norms of science and identifies possible solutions, and (ii) practical tools for performing open and robust research, mapped on traditional RM2 components (e.g., labs will use open datasets and open-source statistical platforms; research proposals will be pre-registered on the Open Science Framework). We will develop and validate an Open Science Concept Inventory (OSCI) (Studies 1 & 2) to evaluate the Open Science module, and additional assessments to evaluate the practical tools. Evaluation of the new materials will take place over two implementation rounds (Study 3 - Fall 2019; Study 4 - Spring 2020). All material developed will be shared through OSF and as a Canvas course that can be adopted by other instructors. By providing validated tools that are easily integrated into existing curricula, we aim to facilitate the adoption of open science practices and to provide undergraduates the conceptual foundations for conducting robust and transparent research.

Budget Request Page
January 15, 2019 to May 30, 2020

BUDGET:*Request by budget category. Joint proposers must select one PI to be the lead and one department to receive this allocation.*

Lead Principal Investigator: Douglas Markant

Principal Investigator 800#: 801019615

Title of Project: Examining the impact of open and transparent research practices in an undergraduate research methods course in Psychology

Allocate operating budget to Department of: Psychological Science

Fiscal Year One (January 15, 2019 to May 30, 2019)		
Faculty Stipend	Paid directly from Academic Affairs fund on May 15, 2019	3850
911250	Graduate Student Salaries	
911300	Special Pay to Faculty other than Grantee	
915000	Student (Undergraduate or Graduate) Temporary Wages	
915900	Non-student Temporary Wages	
920000	Honorarium (Individual(s) not with UNCC)	
921160	Subject Incentive Fees	1000
925000	Domestic Travel	
926000	Foreign Travel	
928000	Communication and/or Printing	
930000	Supplies	
942000	Computing Equipment	
944000	Educational Equipment	
951000	Other Contracted Services	
Year One Subtotal		4850

Lead Principal Investigator:		
Fiscal Year Two (July 1, 2019 to May 30, 2020)		
Faculty Stipend	Paid directly from Academic Affairs fund on May 15, 2020	3850
911250	Graduate Student Salaries	4800
911300	Special Pay to Faculty other than Grantee	
915000	Student (Undergraduate or Graduate) Temporary Wages	
915900	Non-student Temporary Wages (see PD-17)	
920000	Honorarium (Individual(s) not with UNCC)	
921160	Subject Incentive Fee	
925000	Domestic Travel	1500
926000	Foreign Travel	
928000	Communication and/or Printing	
930000	Supplies	
942000	Computing Equipment	
944000	Educational Equipment	
951000	Other Contracted Services	
Year Two Subtotal		10150
	TOTAL FUNDS REQUESTED (Year One + Year Two)	15000

SoTL Proposals that do not receive SoTL funds may be eligible for support from the Office of Assessment and Accreditation. If your SoTL proposal is not recommended for funding, would you like for your proposal to be shared with the Office of Assessment for review and consideration for funding from that office? YES____X_____

NO_____

Budget Narrative

Faculty stipends (Year 1 - Dr. Markant: $3850; Year 2 - Dr. Galati: $3850)

Summer stipend support is requested for two faculty members, one in each summer period. In the first summer Dr. Markant will lead the design and execution of Studies 1 and 2. In the second summer Dr. Galati will lead the final analysis of results from Studies 3 and 4, preparation of materials for external publication, and dissemination efforts within the UNCC community. If the proposal is funded, Dr. Markant and Dr. Galati will have no more than two UNC Charlotte faculty development grants.

Graduate student salaries (Year 2: $7000)

Graduate assistant (GA) support is requested during the 2019–2020 academic year at 10 hours per week. The dedicated assistance of a graduate student is critical to the project due to the demands of data collection and data management in Studies 3 and 4 (the two implementation rounds of the project in Fall 2019 and Spring 2020, across two sections of PSYC2103–RM2). The GA will be trained by Drs. Markant and Galati on administering the concept inventory developed to students in the classroom, compiling and managing data, and conducting statistical analyses. We will work with our department to hire a GA who also serves as teaching assistant for one of the RM2 sections to ensure their familiarity with the goals and structure of the class.

Participant incentives (Year 1: $1000)

As noted in the proposed Method (see *Development of the Open Science Concept Inventory (OSCI)*), a total of 350 participants will be recruited during the Summer 2019 period (100 for Study 1 and 250 for Study 2) to develop and validate the concept inventory that will be used for assessment in the classroom. We expect to recruit the majority of participants through

UNCC's SONA subject pool; however, we are requesting $1000 (100 participants x $10 per hour) to ensure that a sufficient sample size is collected during the summer.

Conference travel (Year 2: $3000)

Drs. Markant and Galati will disseminate their findings on the impact of the new open science curriculum integrated in research methods courses at a conference or symposium on pedagogy in psychology. In particular, they are targeting the Annual APS-STP Teaching Institute, a satellite conference of the annual meeting of the Association for Psychological Science dedicated to the teaching of psychology. Estimated travel costs are based on 2019 registration ($255 each = $510), city hotel fees at a group rate ($200/night for 4 nights per person = $1600), and airfare (current round trip ticket for target city is $400 per ticket = $800). This yields an estimate of $2910, which we round up to $3000 to account for fluctuations in airfare and accommodation costs.

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November 1, 2018

SOTL Grants Committee
Center for Teaching and Learning
ctl@uncc.edu

Dear Committee Members:

On behalf of Dean Nancy Gutierrez in the College of Liberal Arts & Sciences, I am writing this letter in support of the SOTL proposal submitted by Dr. Alexia Galati and Dr. Douglas Markant from the Department of Psychological Sciences which is entitled, "Examining the impact of open and transparent research practices in an undergraduate research methods course in Psychology." The researchers propose to integrate open science concepts into the curriculum of a research methods course required for Psychology majors, PSYC 2103 – Research Methodology II. Improvement in the undergraduate student's conceptual understanding and attitude towards research is anticipated. Successful implementation of this curriculum throughout all sections of PSYC 2103 has the potential to impact over 1000 majors.

I support this work. With the university's increased emphasis on undergraduate research, indicated by the official establishment of the new Office of Undergraduate Research, undergraduate students will become aware of research ethics and responsible conduct of research earlier in their academic careers. Then, they will be better prepared for further research endeavors at the undergraduate and/or graduate level.

Sincerely,

Banita W. Brown

Banita W. Brown
Associate Dean for Academic and Student Success
College of Liberal Arts and Sciences
Associate Professor of Chemistry

Project Narrative

1. Specific Aims

In recent years psychology researchers have begun espousing practices that promote openness and transparency, including sharing their data, code for analyses, and pre-registering their hypotheses. These best practices have emerged in response to crises in the field concerning failures to replicate previous findings, practices that undermine the robustness of published research, and outright fraud. Despite these methodological shifts, open science research practices are not consistently integrated into the teaching of research methods in Psychology at UNCC and elsewhere. Moreover, since pedagogical research in this area is inchoate, it is unknown how introducing undergraduates to open science practices affects their conceptual understanding and attitudes toward research.

In the proposed work, we seek to evaluate the impact of integrating open science practices into the curriculum of *PSYC2103: Research Methods II (RM2)*, a required course for Psychology majors at UNCC. The *overall purpose* of the project is to develop and evaluate course materials on open science that are easily integrated into existing curricula for research methods in Psychology. This integration is central to the Department of Psychological Science's mission to teach students to critically evaluate scientific findings and conduct research using the field's best practices.

Our *specific objectives* are: (i) to create an open science course module and lab materials, (ii) to evaluate whether introducing open science practices improves undergraduates' conceptual understanding of robust research methods; this will be achieved by developing and validating an *Open Science Concept Inventory (OSCI)*, and (iii) to evaluate through targeted assessment whether introducing undergraduates to practical tools for robust and transparent research further improves their conceptual understanding and attitudes toward research.

We will address the following *research questions*:

- Does the introduction of open science topics improve students' conceptual understanding of research methods? Will performance on the OSCI be better upon completion of the open science module (Post-test 1 vs. Pre-test)?
- Does the introduction of hands-on practical tools further improve students' conceptual understanding of research methods? Will performance on the OSCI at the end of the semester be better than earlier in the course (Post-test 2 vs. Post-test 1)?
- Do students' attitudes toward research and reported self-efficacy improve by the end of the course (Post-test vs. Pre-test)?

Our findings will contribute to pedagogical research by elucidating whether the adoption of open science practices bolsters students' conceptual foundations for research methods. Moreover, the project will facilitate the adoption and dissemination of tools for robust and transparent research by other instructors, since all material developed (open science lectures, OSCI, lab activities) will be shared through OSF and Canvas. These efforts will help align research methods curricula–at UNCC and beyond–with the field's best research practices.

2. Literature Review

Over the past decade, psychology has undergone a transformation as a field. A confluence of events around 2010–2012, including revelations of replicability failures and data fraud, forced researchers to reflect on the best practices for collecting, analyzing, and reporting data (Nelson, Simmons, & Simonsohn, 2018). Concerns during this "replication crisis" centered on a number of questionable research practices (QRPs), including: failing to report all conditions manipulated or studies conducted (Simmons, Nelson, & Simonsohn, 2011), "fishing expeditions" during statistical analysis (e.g., testing on multiple measures) and reporting only those meeting statistical significance (referred to as *p-hacking*; Simonsohn, Nelson, & Simmons, 2014),

reporting unpredicted results as if they had been hypothesized in advance (i.e., “hypothesizing after the results are known” or HARKing; Kerr, 1998), and more. In contrast to clear cases of data fabrication or fraud, QRPs are previously culturally accepted practices (John, Loewenstein, & Prelec, 2012) stemming from pervasive incentive structures in science, which generally reward the publication of positive, confirmatory findings.

In response to the replication crisis and the QRPs fueling it (attested also in other fields, such as medicine; Ioannidis, 2016), researchers started embracing new methodological practices that promote transparency and openness. These practices include voluntarily posting data, sharing analysis code, pre-registering hypotheses, and documenting methods and results fully through open science tools (e.g., Gernsbacher, 2018a).

Since these shifts in methodological practices are recent, little is known about how to best integrate them into the teaching of research methods to psychology undergraduates. In a study by Chopik and colleagues (Chopik, Bremner, Defever, & Keller, 2018), after a 1-hr lecture that communicated issues surrounding replicability and open science, undergraduates reported being more skeptical about findings from specific studies but expressed increased confidence in psychology as a field (e.g., considering it more similar to the natural sciences). Other educators have shifted the focus of the students’ term projects to replications of published findings (Frank & Saxe, 2012; Grahe et al., 2018). Advocates of this approach argue that didactic replications provide a rich pedagogical context for undergraduates to learn the basic tools of science, while also contributing independent replications of existing findings.

Educational interventions aligned with open science may indeed help the field; for instance, by making replication mainstream (Gernsbacher, 2018b). However, they have not been accompanied by systematic evaluation of whether they in fact improve students’ conceptual foundations for conducting research, in keeping with a broader need for better

assessments in undergraduate research methods instruction (Linn et al., 2015). Through this project, we aim to bridge this gap in the literature by systematically assessing the effectiveness of open science tools integrated in a research methods course.

3. Methods

Creation of lectures, lab activities, and project materials

During Spring 2019 we will develop the Open Science module, consisting of 2 hour-long lectures, and the practical tools (lab activities and term project resources). Rather than supplanting the existing RM2 curriculum, our goal is to enable instructors to integrate open science resources into existing elements of the course.

The first lecture will present a historical and cultural perspective on the open science movement, including the origins of the replication crisis, incentives and norms that produce QRPs, and initiatives for changing research culture. The second lecture will focus specifically on QRPs (see Table 1). Its aim will be to situate QRPs (e.g., *p*-hacking) and proposed solutions (e.g., pre-registering analysis plans) in existing topics of the course curriculum (e.g., "Type I errors" in hypothesis testing). Recognizing QRPs is an essential part of training in research methods, similar to existing training in identifying threats to validity in experimental design or evaluating potential limitations of published findings.

For the practical tools, we will develop 3-5 lab activities–focused on hands-on experience with standard statistical techniques, e.g., correlations, t-tests, ANOVA–involving open data in *R*'s open source statistical platform. We will leverage the resources of the Open Stats Lab (https://sites.trinity.edu/osl), which provides published open datasets from psychology with suggested activities. By integrating open datasets and source code in the labs, as we have done in past and ongoing RM2 sections, we aim to underscore the importance of reproducing

others' findings and developing transparent workflows. Our current material will serve as a starting point for the proposed lab activities.

Table 1. *Preliminary list of topics covered in the Open Science module.*

Topic	**Concepts**
Questionable Research Practices (QRPs)	P-hacking, HARKing, unreported measures or conditions, optional stopping (deciding to stop collecting data after checking whether results are significant), reporting bias (selectively reporting results that "worked")
Research culture	Incentives, publication bias, the "file drawer problem", fraud (data manipulation and fabrication)
Replicability & Reproducibility	exact vs. conceptual replication, analytic reproducibility (reproducing reported analyses on open data)

Development of the Open Science Concept Inventory (OSCI)

The OSCI will be developed to evaluate the impact of the new material on learning gains. Concept inventories are multiple-choice questionnaires designed to assess understanding of new concepts and differentiate correct responses from common misconceptions. Unlike measures of overall course performance (e.g., cumulative exams, final grades), concept inventories assess reasoning within a targeted domain. They have been developed for a range of STEM domains, including statistics (Stone et al., 2003) and psychology research methods (Veilleux & Chapman, 2017), but no existing concept inventories or similar instruments exist for open science.

Development of the OSCI will involve two stages. First, we will identify a list of target concepts during the creation of the lecture material (see preliminary list in Table 1), and for each concept generate a set of prompts (brief vignettes describing scenarios faced by a researcher and a question probing understanding of the situation). In Study 1 these prompts will be presented to *N*=100 Psychology major undergraduates to elicit open-ended responses.

Responses will be used to assess participants' understanding of the vignettes, evaluate prompts' reliability (i.e., the extent to which responses fall in consistent categories), and generate possible distractor responses for the multiple-choice questions of the OSCI. This ensures that distractors capture real misconceptions seen in the target population (Sands et al., 2018), allowing instructors to diagnose gaps in understanding.

For Study 2 the materials will be modified into multiple choice questions comprised of a prompt and 4-5 response options, derived from the open-ended responses collected in Study 1. The aim of Study 2 is to test items for inclusion in the OSCI. N=250 Psychology undergraduates will be recruited through email announcements and SONA and asked to complete an online questionnaire including candidate items. Using Item Response Theory (IRT) analysis (Veilleux and Chapman, 2018), we will identify items that vary in difficulty and are high in discrimination.

Table 2. *Example items in open science concept inventory, with correct answers underlined.*

Topic	**Prompt**	**Question**
Research culture (**Publication bias/file drawer problem**)	David's research project is based on a well-known effect in the psychology literature. After attempting to reproduce the effect in two experiments, David finds that he hasn't replicated the published findings despite using a very similar procedure and large samples. Concerned that he won't be able to publish nonsignificant results in a journal, he's considering abandoning the project.	*What would you advise David to do?* a. He should move on to a different project where he might obtain significant results b. He should move on to a different project since he lacks the expertise necessary to replicate the effect c. <u>He should make the nonsignificant findings publicly available since the published evidence for the effect may not reflect failures to replicate</u> d. He should try one more experiment in order to replicate the effect, and only publish the results of that experiment if they are significant
Questionable research practices	Anna is a graduate student researching how introverts and extroverts differ in their stress	*What is the best course of action for Anna at this point and why?* a. <u>She should continue data</u>

(**optional stopping**; see Erica et al., 2014)	responses. For her study she proposed collecting data from *N*=100 participants. After 50 people participated, Anna performs a preliminary data analysis and finds a significant difference between the groups with $p = .03$. Since she found a significant effect, she is considering ending data collection in order to write up the results for publication.	collection until reaching the planned number of 100 participants in order to reduce the risk of a false positive b. She should stop data collection since she already obtained a significant effect c. She should stop data collection since the additional participants are unlikely to change the conclusion of the analysis d. She should continue data collection since a sample size of N=50 is too small to draw any conclusions

Development of the Attitudes Toward Research Questionnaire (ATRQ)

We will adapt questions from Kardash (2000) and Chopik et al. (2018) to measure students' self-efficacy and attitudes toward research. Self-efficacy will be measured by having students rate their perceived ability to complete certain research activities (e.g., generating a hypothesis, statistical analysis, etc.). Attitudes toward research will be measured through students' degree of agreement with statements about the research process, the field of psychology, and their own motivation to pursue research-related careers.

Implementation

The new material, including the lectures and lab activities, will be implemented in two sections of RM2 (approx. *N*=50 students) in Fall 2019 (Study 3) and in Spring 2020 (Study 4), and evaluated through the OSCI and ATRQ as described next.

4. **Evaluation**

Learning gains will be evaluated with the OSCI using a longitudinal design with three timepoints: a Pre-test during the first 1-2 weeks, Post-test 1 following completion of the lectures, and Post-test 2 approximately 2-3 weeks prior to the end of the semester. Since the lab

activities are distributed throughout the semester, the inclusion of Post-test 2 will allow us to evaluate the impact of practical tools of open science on consolidating the concepts introduced in the lectures. We will analyze within-subjects learning gains following the lectures (Post-test 1 - Pre-test) and near the completion of the course (Post-test 2 - Post-test 1).

To evaluate attitudes toward research, the ATRQ will be administered in the first 1-2 weeks of the course (Pre-test) and at the end of the course (Post-test 2). Again, we will examine within-subjects changes in attitudes as a result of the course (Post test - Pre-test).

At the conclusion of the Fall 2019 semester we will analyze the results from Study 3, including learning gains (OSCI) and students' self-efficacy and attitudes toward research (ATRQ). Based on the findings of Study 3, we will revise the materials and evaluation plan for the second implementation round in Spring 2020 (Study 4).

5. **Knowledge Dissemination:**

Our findings will be disseminated within our department through a departmental seminar for faculty interested in adopting our materials. We will also present our work to the UNCC community through the SoTL Showcase at UNCC. At a national level, we aim to present the work at the annual APS-STP Teaching Institute, a satellite conference of the annual meeting of the Association for Psychological Science dedicated to the teaching of psychology. Potential journals to target for dissemination include *Teaching of Psychology* and *Scholarship of Teaching and Learning in Psychology*. As noted, all our educational materials will be shared on OSF and as a module on Canvas.

6. **Human Subjects**

Institutional Review Board approval will be obtained prior to each study to ensure that the rights and welfare of participants are protected.

7. **Extramural Funding**

We do not plan to seek extramural funding for this study.

8. Timeline

Period	Objective
Spring 2019	● Develop Open Science module (lecture slides) ● Develop practical tools (lab activities) ● Obtain IRB approval for Studies 1 & 2
Summer 2019	● Develop Open Science Concept Inventory (OSCI) ○ Study 1 (open-ended responses) ○ Study 2 (OSCI validation) ● Develop Attitudes Toward Research Questionnaire (ATRQ) ● Obtain IRB approval for Studies 3 & 4 ● Hire Graduate Assistant for Fall 2019 and Spring 2020
Fall 2019	● Study 3 ○ Week 2: Pre-test (OSCI & ATRQ) ○ Weeks 3-4: Open Science module ○ Week 4: Post-test 1 (OSCI) ○ Weeks 5-10: Lab activities ○ Week 11: Post-test 2: (OSCI & ATRQ) ● Week 12: Interim results meeting + planning changes to course for next semester ● Weeks 13-15: Revise materials
Spring 2020	● Week 1: Post materials ○ Share Open Science module and OSCI as Canvas module ○ Share lab activities on Canvas & OSF ● Study 4 (Implementation round 2) ○ Week 2: Pre-test (OSCI & ATRQ) ○ Weeks 3-4: Open Science module ○ Week 4: Post-test 1 (OSCI) ○ Weeks 5-10: Lab activities ○ Week 11: Post-test 2: (OSCI & ATRQ) ● May 2020: Present findings at conference
Summer 2020	● Prepare manuscript for publication

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