

Broadening Interest in Science through Inquiry-Based Learning in Undergraduate Social Science Classrooms

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Abstract

Despite a basic level of science understanding becoming critical for everyday decision-making, public interest in science in the United States is low, especially among women and individuals from minoritized groups. Hence, there is a need for educational practices to encourage the broadening of participation in the scientific enterprise. This paper has three objectives. The first is to present an overview of the learning benefits of inquiry-based instruction as implemented in STEM-related fields, with a focus on traditionally underserved students (women, students from minoritized groups, and first-generation students). The second is to reflect on one model for implementing inquiry in a social sciences classroom. Finally, the article posits that the implementation of inquiry-based practices into social sciences courses may serve to broaden public interest and participation in the scientific enterprise. This is because women and students from minoritized groups are more likely to major in social sciences than STEM-related fields.

Keywords

inquiry-based learning; underserved students; guided discussion; nature of science; interest in science

Introduction

In our modern world, it is increasingly the case that basic science understanding is important for everyday decision-making (see Stilgoe et al., 2014). For example, a basic understanding of how to evaluate scientific claims can improve individuals' ability to navigate decisions like whether, or not, to vaccinate; whether, or not, to embark on a particular diet or exercise plan; and how to mitigate lead exposure (Marincola, 2006). Unfortunately, in the United States, public understanding of and interest in science is notably low, particularly among women and individuals in minoritized groups (Funk & Goo, 2015).

One strategy for increasing science interest and engagement has been to change the way STEM courses are taught, so they are more successful at engaging a wider range of students. One promising approach is to incorporate inquiry-based learning strategies into STEM courses (Barron & Darling-Hammond, 2008). Inquiry-based learning is an evidence-based practice shown to improve students' critical thinking skills, as well as their sense of ownership over learning, their content knowledge, confidence in scientific abilities, and persistence in a field of study. These benefits are especially strong for traditionally underserved students such as women, African American, Hispanic, and lower income students (Casem, 2006; Chaplin, 2003; Domin, 1999; Gormally et al., 2009; Howard & Miskowski, 2005; Kogan & Laursen, 2014; Russell & French, 2002; Siritunga et al., 2012). This approach has the benefit of improving science understanding and engagement, but its impact is limited to students who choose to take STEM courses. Unfortunately, there are large gender and racial disparities in who chooses to major in STEM and thus take STEM courses. Women are more likely to choose humanities and the social sciences, while men tend toward engineering, math, and physical sciences (Aud et al., 2010). Similarly, African Americans are much more likely to major in social science disciplines than in STEM-related fields (Georgetown University Center on Education and the Workforce, 2016). Thus, although inquiry-based instructional interventions in STEM courses may have an outsized benefit for women and students from minoritized groups, their impact is mitigated by relatively few such students in STEM courses.

These considerations raise the possibility a broader-impact alternative strategy for increasing science interest and engagement might be to implement inquiry-based learning strategies in social science courses. As previously mentioned, inquiry-based practices seem to increase confidence in science abilities and encourage persistence in a course of study particularly for women and minorities (Kogan & Laursen, 2014; Siritunga et al., 2012). Since women and African American students more frequently major in the social sciences than in STEM, social science courses are a more promising avenue for reaching them. Further, although inquiry-based pedagogies have primarily been used in STEM-based disciplines, they can be successfully used in social science (see, Zachery, 1998, for an example in Introductory Psychology).

We teach an undergraduate psycholinguistics course that covers material at the intersection of two social science disciplines: Psychology and Linguistics. In this paper, we describe how we implemented inquiry-based pedagogy in this course, with the aim of fostering our students' understanding of scientific reasoning and the scientific process. Our goal is to encourage instructors in the social sciences to consider whether, or not, inquiry-based pedagogies might be appropriate for their classrooms and to offer one example for how to implement this pedagogy. We do not intend to claim our course is unique or the way we have implemented inquiry is necessarily the only, or best way, to do so. But we have a track record of successfully teaching this course with a range of students in two quite different settings: one of us teaches at a university serving a reasonably selective population of students; and the other at a university serving a large proportion of first-generation college students as a result of its open-enrollment policy.

Background

Inquiry-based learning is a teaching pedagogy rooted in the education theory of constructivism and can be traced back to educational theorists such as Dewey (1933). Proponents of constructivism posit individuals create or construct their own understandings or knowledge through the interaction with what they already know and believe, and the ideas, events, and

activities with which they come in contact (Cannella & Reiff, 1994; Richardson, 1997). Dewey (1933) argued training thought requires students to engage in the act of discovery by experimenting. This philosophy has led inquiry instructors to focus on having students answer compelling questions and to discover solutions on their own (e.g., Justice et al., 2009; Suchman, 1961). Instead of imitation or repetition, it is through involvement with content that knowledge is acquired (Kroll & LaBoskey, 1996).

Inquiry has sometimes been confused with simple “hands on” approaches. In these approaches, students may engage in laboratory tasks requiring the manipulation of objects, but no deep learning about the nature of scientific work (Huber & Moore, 2001; Meyer & Crawford, 2011). Inquiry is not just about giving students an opportunity to interact with objects of scientific interest; rather, what is important in inquiry is students are engaged in “doing science” not just “learning about” it. “Doing science” means developing an understanding of the nature of scientific questions, predicting and interpreting patterns of data, and connecting intuition to scientific theories and hypotheses (Meyer & Crawford, 2011). In our course, students engage in the process of science through thinking and reasoning, not through hands-on collection of data.

There is no single approach to implementing inquiry in the classroom. Depending on the level of the course and students’ knowledge levels, more or less scaffolding may be required to distinguish between structured, guided, and open modes of inquiry corresponding to different levels of scaffolding (Staver & Bay, 1987). Our course uses a structured approach to inquiry, in which we, the instructors, provide the issue and resources for addressing it. This type of approach has been shown to help students develop their inquiry skills (Spronken-Smith & Walker, 2010).

Challenges to Implementing Inquiry

Before describing how our course is implemented, we will review a number of important challenges to implementing inquiry-based pedagogy and provide a high-level explanation of how we try to mitigate each one. One primary challenge is instructors’ perceptions that inquiry-based methods teach less content than traditional lecture-based methods (Nelson, 1999). Inquiry methods necessarily force instructors to present less content than lecture-based methods. However, presenting material does not mean students learn it (Nelson, 1999). There is little empirical evidence students learn much from a lecture (Schmidt et al., 2015); on the contrary, traditional lectures can be an impediment to learning (Freeman et al., 2014; Schmidt et al., 2010). Thus, although lecture-based methods may allow instructors to introduce more content, there is little evidence students learn more content. To implement inquiry, we narrow the focus of the course on sentence processing (we chose this area because it is where we both have deep knowledge). The narrow focus allows students the chance to see how research builds upon itself and to appreciate the links between seemingly disparate topics.

Another challenge to implementing inquiry is students may resist active forms of instruction (e.g., Gormally et al., 2009). Although students often recognize they learn more in inquiry-based courses, they also report being frustrated with the process of “figuring it out” on their own and feel like their inquiry-based courses have a higher workload compared to other courses. For example, one student said, “I prefer ... just going in, looking at notes, taking a quiz ... I think that’s easier. But I wouldn’t learn as much.” (Gormally et al., 2009, p. 12). We have found adopting transparent teaching practices greatly reduces student resistance (Winkelmes et al., 2016). We discuss our use of transparent teaching methods in more detail later in this paper.

A third challenge is related to inquiry-based practices relying on minimal guidance from the instructor during learning. The progression of any given class is therefore highly influenced by what students do or do not notice or perceive to be relevant. The potentially high cognitive demands of identifying relevant information can make this problematic because it may decrease the amount students learn (Kirschner et al., 2006). For example, in a minimally-guided inquiry lesson, students may be shown a demonstration and be instructed to ask questions to figure out an underlying scientific principle. In some cases, this can be straightforward. For example, in a phonetics class, students may be asked to observe their tongue position when making sounds and may be able to figure out the classification of sounds through experimentation with their own bodies. However, deciding which information in a demonstration might be relevant to more an abstract principle may be more difficult. Searching for problem-relevant information places a large demand on working memory, which reduces resources available for encoding information into long-term memory (i.e., learning). This concern is a particular problem for courses in heavily theory-based, highly abstract areas relatively novel to students. In such situations, identifying the important details and why they are important can be extremely difficult without considerable background knowledge. We structure the content of the psycholinguistics course we teach to provide the support novice learners require (Kirschner et al., 2006). We do this by using discussion questions to guide students through the process of inquiry. As discussed below, our discussion questions follow the NIH's instructional model for promoting active, collaborative, inquiry-based learning (National Institutes of Health, 2005). The questions are designed to point students to the most relevant information (e.g., which data are most relevant to the hypotheses) so they can construct their own understanding of the issues.

Finally, although inquiry has been shown to increase students' understanding of the scientific process as well as knowledge of scientific concepts and methods of investigation, inquiry alone is not enough to help students understand the nature of science (Lederman, 2004). Importantly, scientific literacy goes beyond knowledge of scientific concepts and methods of scientific investigations and includes understanding the process of scientific inquiry and the nature of science (American Association for the Advancement of Science, 1993; National Research Council, 1996). Inquiry does not teach students: (1) scientific knowledge is tentative; (2) scientific knowledge is empirically based; or (3) science is inherently subjective, which means it requires human interpretation and is theory laden. Explicit instruction is required to help students understand these features of science. Because an understanding of the nature of science is one of our desired learning outcomes, our course includes explicit instruction in the nature of science as described below.

Implementing Inquiry-Based Learning in Psycholinguistics

Our course has been taught in two quite different settings, as we describe below. It has been successful in both, suggesting it is likely to work for a range of students at different kinds of institutions. The second author, who initially designed the course, teaches at a relatively selective, state-related research institution. The prerequisite for the course is successful completion of either Introduction to Psychology or Introduction to Linguistics. The course is capped at 30 students who may be at any class rank. Students typically come from the Psychology, Linguistics, and Communication Science and Disorders Departments.

The first author teaches at a regional campus of a large public research institution. The regional campus focuses solely on undergraduate education and has an open-enrollment policy.

The course is capped at 30 students at any class rank and the only prerequisite for the course is the successful completion of an Introduction to Psychology course. The majority of students enrolled in the course are Psychology majors. Because of the campus' open-enrollment policy, the student body has a higher proportion of non-traditional students than campuses with more restrictive enrollment policies. Each year the freshman class is approximately 30% first-generation (i.e., neither of their parents has a 4-year degree), and these students are more likely than continuing-generation students (i.e., students with at least one parent with a 4-year degree) to continue their education by taking upper level courses at the regional campus rather than transfer to the main campus. As an upper level course, the course typically enrolls between 40-60% first-generation students.

Course Readings

The first part of our course is designed to ensure students have the relevant background knowledge needed to understand primary source readings in psycholinguistics. To that end, we begin with a basic introduction to syntax and pragmatics. This information is often a review for students in linguistics but is typically new for students from other backgrounds. While everyone has intuitions about the phenomena we cover (e.g., understanding a sentence can have two meanings), these discussions are an important opportunity for students to connect their own intuitions to the precise way language scientists talk about these phenomena. During syntax and pragmatics classes, the discussion focuses on the main points to be understood to understand research in sentence processing. For example, syntax discussions focus on the relationship between syntax and meaning, because many psycholinguistic experiments rely on the understanding some arrangements of words can be assigned more than one syntactic structure and be interpreted in multiple ways (i.e., syntactic ambiguity). While teaching this introductory syntax and pragmatics, both instructors frequently and explicitly flag how the topics will support future discussions in the course.

After establishing the common ground of basic syntax and pragmatics, major theoretical perspectives in the field of psycholinguistics are introduced. This is necessary because students need to understand the theoretical frameworks from which psycholinguistic hypotheses are being developed to be able to understand and critically think about those hypotheses. Although it is important to start with theory, doing so requires assigning some of the most difficult and most abstract readings during the beginning of the semester. However, with some guidance and encouragement, students engage with these readings with little difficulty. As part of our efforts at transparency, we acknowledge the difficulty of the initial readings and explicitly state the reason we start with those readings is that without an understanding of the major theoretical perspectives researchers take, it will be difficult for the students to fully grasp the work being done in the field. We assure students the readings will get easier during the semester. Making the course structure explicit in this way limits students' frustration and resistance to these difficult readings. Finally, positioning these theoretical articles at the beginning of the semester highlights science is inherently subjective, which means it requires human interpretation and is theory laden, a critical feature of the nature of science. To emphasize the theory-laden aspect of science, the early semester readings and discussions focus on important theoretical frameworks. Throughout the semester, class discussions continuously return to these theories and how the new data under consideration may be interpreted within these theoretical frameworks. To emphasize the human interpretation aspect of science, during course discussions, when contradictory data are presented,

we ask students to imagine what proponents of opposing theoretical perspectives might argue. This gives them insight into how data can often be interpreted in different ways depending on the theoretical framework adopted.

After establishing this common ground, the rest of the course introduces major topics (e.g., disfluencies, audience design) within the field of sentence processing. Most course sessions focus on a single topic and allow students to participate in a structured discussion designed to engage them in the scientific process. Prior to the class discussion, students are assigned one or two primary source articles to read and they are required to complete a writing assignment about the reading. Most of these readings are empirical papers because we want to emphasize scientific knowledge is empirically-based, a critical component of the nature of science. Although review papers and textbooks cite empirical studies, their comprehensive nature may obscure the nature of the experiments to students. To ensure students complete the reading, and to give them the opportunity to reflect on the reading, we ask the students to write a short reflection prior to coming to class. Additionally, readings are chosen to highlight another critical feature of the nature of science: scientific knowledge is tentative. Readings are chosen so students will read and discuss contradictory conclusions informed by the data they encounter.

Directed Discussion

In our course, we use directed discussion to guide students through the process of inquiry. We prepare a handout with background material and discussion questions we bring to class. The discussion questions encourage students to engage in the process of science by thinking and reasoning about hypotheses, predictions, patterns of data, and data interpretations. The discussion questions follow the NIH's instructional model for promoting active, collaborative, inquiry-based learning (National Institutes of Health, 2005). According to the "5E" instructional model, the Process of Scientific Inquiry is comprised of five broad actions:

- 1) *Engage*: students participate in the scientific process;
- 2) *Explore*: students investigate the nature of the problem and begin to construct their knowledge;
- 3) *Explain*: students connect their previous knowledge to prior learning;
- 4) *Elaborate*: students apply concepts to new situations; and
- 5) *Evaluate*: students demonstrate their knowledge by performing their own investigation.

Each discussion begins with a chance for students to reflect on the topic for the day and how it relates to their own experiences. For example, when we come to the topic of common ground, after ensuring everyone understands what is meant by common ground, we ask the students the following questions:

- 1) What kinds of knowledge might make up common ground?
- 2) How might your starting common ground be different with different people? Consider your sibling vs. a guy who sits down next to you on the bus.
- 3) How does common ground change over the course of a conversation?

Importantly, we are not asking students to describe research findings, or use jargon, we are asking them to reflect on their own experiences and describe their own intuitions about these processes. Some topics (e.g. common ground) are easy for students to relate to their own experiences. But for topics for which relevant phenomena are often not noticed (e.g. disfluencies) students prepare by doing a simple gathering of and reflection on a few examples of the phenomenon from their personal experiences between classes. For example, during the discussion on disfluencies, students

begin by sharing from their homework recent examples of disfluencies they made themselves or heard someone else make. Then they reflect on which situations and circumstances may have led to the disfluency. This part of the discussion encourages students to explore the nature of the problem and to begin to make connections with what they already know about language to the topic.

The discussion then moves to the nature of the questions researchers are asking about the topic. In many cases, this means we must start introducing linguistic concepts and jargon. For example, in the discussion of common ground, we introduce a foundational theory from linguistics on common ground computation and presupposition:

Herb Clark and his colleagues have studied common ground in depth. They argue that speakers design their utterances with their addressee and the common ground in mind, and addressees interpret utterances with the common ground in mind. The idea is that language use in conversation is a collaborative process, where A and B work together to establish that B understands A's meaning.

Issues to think about: What does this involve? Is it hard or easy to compute? Do people compute the full common ground? How does this fit with the work we've already looked at investigating whether speakers are helpful to their listeners?

After introducing the linguistic phenomenon under consideration, the discussion moves on to processing issues related to the linguistic phenomenon. Again, we ask students to examine their own intuitions about processing now they better understand the linguistic phenomenon. For example, during the common ground discussion, we ask them:

Getting back to the idea of calculating common ground... are there costs to correctly calculating common ground? What are the costs of getting common ground wrong?

After students have reflected on their own intuitions and been introduced to critical linguistic concepts (i.e., engage & explore), we then ask them to connect the new concepts to prior learning in the course (i.e., explain). To do that, we ask students to connect the current issue to major theoretical perspectives introduced at the beginning of the semester, or we may ask them how previous findings might relate to the issue. For example, during the common ground discussion, we ask students:

Think back to the class in which we discussed whether speakers use prosody (or insert an extra word) to disambiguate their utterances. Remember that we saw evidence that speakers did provide helpful prosody, regardless of whether the situation was ambiguous or not.

Do you think people take common ground into account when they communicate?

Does the previous evidence we've seen about audience design sway your thinking?

After giving students the opportunity to explore and explain, we guide them through the process of elaboration. In this part of the discussion, students discuss experiments described in the relevant readings for that class. If there were two readings for the day, each paper is discussed

independently, before considering both sets of findings together. Each paper is introduced in such a way as to ensure students understand the experimental paradigm being used and the logic behind the paradigm. Then we ask them to make predictions about data patterns from both theoretical positions. Coming back to the common ground example, students are asked to predict what the data pattern would look like if the people understanding the sentence (i.e., comprehenders) were taking common ground into account and then what the data pattern would look like if comprehenders were not taking common ground into account. After discussing the predictions, we ask students to describe the pattern of data in the paper. Finally, after discussing the data, students are asked which theoretical account is more consistent with the data. While it may seem redundant to have students explain predictions, data, and interpret the results, we have found these are three separate skills. It is not uncommon for students to be able to articulate the predictions and describe the data and then have trouble interpreting the data within a theoretical perspective.

After ensuring students have understood the reading(s) for the day, our discussion questions allow students to demonstrate their knowledge (i.e. evaluation) by performing their own investigation. This means we guide students through thinking critically about: (1) what exactly has been learned from the experiment(s) presented in the reading(s); and (2) outstanding questions. That is, we ask them to critique the readings. In our experience, undergraduates struggle when asked to critique research. The most common criticism students offer about experimental research with human participants is the sample size is too small (they offer this critique even when a power analysis is presented to justify the sample size). Thus, we have found it necessary to provide probing questions to facilitate students' critical thinking skills. For example, if we discuss contradictory data, we ask students to consider why the data were inconsistent and to consider other experimental methods that might be useful. If the experiments used different paradigms, we might ask them to consider the task demands of each paradigm and whether they may have led to the differing results. We may ask them to consider the linguistic constructs and whether different kinds of sentences may or may not lead to the same findings. Essentially, we ask our students the questions psycholinguists implicitly ask themselves when they critique research. We find, as the semester progresses, students become better at considering alternative accounts of data and proposing follow up experiments to address unresolved issues.

An important feature of the format of our discussion handouts is they are highly structured in an effort to constrain the discussion. We do not hand students a list of potential discussion questions and allow them to choose which questions are discussed in class. Instead, the handouts we create provide a structure to the discussion (i.e., an outline of the process of inquiry). Additionally, after each question on the handout, we leave ample room for students to take notes, so their notes are also organized in terms of the inquiry process. This makes it easy for students to reconstruct the inquiry process on their own and to identify important information when they are studying.

Although the discussion questions used in transparent teaching methods constrain the discussion, they do not limit it. The purpose of the questions is not to dictate what students discuss, but rather to aid them in the process of inquiry. We have found students are more responsive to specific questions (e.g., Does the previous evidence we've seen about audience design sway your thinking?) than to open-ended questions (e.g., Are there findings we've discussed already this semester that relate to this issue?). Importantly, we find students often diverge from the specific questions in productive ways. For example, when we ask students about how previous data are relevant to the current issue, they often use question as a springboard for discussing how other findings, not just the ones we have mentioned, may relate to the issue.

Transparent Teaching Methods

One of the major benefits of using guided discussion is it affords us immediate insight into why students struggle. During a discussion, we can respond immediately to address the ways in which students may have misinterpreted or failed to understand key issues in the readings. We can also notice and address any resistance students may have to our teaching methods. Students do not come to any class as a “blank slate”. They have preconceived notions about how college courses are structured and who has and who does and does not have authority in the classroom. When these expectations are violated, students may resist (e.g., Gormally et al., 2009). In early iterations of this course, both instructors encountered student resistance. However, adopting transparent teaching practices (Winkelmess et al., 2016) has reduced resistance. A transparent classroom is one in which there is an explicit conversation about the processes of learning and the rationale for required learning activities. Adopting transparent teaching practices requires only minor adjustments to any instructors’ current teaching practices. These practices have been empirically demonstrated to improve student learning, especially for African American and first-generation students (Winkelmess et al., 2016). In what follows, we will describe some ways in which students resisted our teaching practices and the transparent teaching practices we implemented to address that resistance.

In early iterations of this course, students often expressed frustration over the difficulty of early readings and about the use of a discussion format. Students asked us, “Why do you make us [the students] guess the answers instead of just telling us the answers?” To address this, we began to lead a discussion on the first day of class about how the nature of science and the desired learning outcomes shape the organization of the course. We use this opportunity to tell the students one of the course goals is to give them the opportunity “to think about really big, confusing ideas and to realize that you can make progress with an idea even if you do not fully understand it.” We point out as scientific knowledge is both tentative and inherently subjective, this is essentially how scientists engage in their work. We also point out this understanding is not just important for scientists but for equally complex and confusing issues outside the classroom. Thus, learning to engage with complicated ideas is important regardless of one’s career trajectory. This conversation allows us to explain and justify why our course is structured differently from many other courses, and to motivate students to engage and do the necessary work to succeed in the course. Since implementing this conversation, students no longer complain about the discussion format and, on end of semester evaluations, students consistently list “using discussion” as the number one thing we should “not change about the course”. Additionally, students no longer complain about the difficulty of the initial readings. They acknowledge they are difficult, but express enthusiasm about the pieces of the readings they were able to fully understand. Furthermore, as the semester progresses, they express enthusiasm that the readings become less difficult and recognize this is an indication of what they have learned. For example, one student in the first author’s course wrote on the discussion board, “I am so happy these articles are getting much easier to read, and I think I am getting faster at reading them. I was happy when I was able to predict what the researchers were going to find based off of [sic] their abstract.”

Even after addressing resistance to the use of discussion, the first author noticed, initially, students in her course resisted engaging with their peers during discussions. Specifically, students directed their comments and questions during class discussions to her and rarely commented on anything their classmates had said. This may be due to her course having a high proportion of first-

generation college students, and those students who are less likely to view them as resources and therefore less likely to interact with their peers than continuing-generation students (Terenzini et al., 1996). In addition to the conversation about building confidence in discussing complex ideas, early on in the semester the first author finds it necessary to redirect students' comments in class to their peers. It often takes a few class periods of this kind of redirection, but students eventually address one another during discussion. Requiring them to comment on one another's posts on the online discussion board also increased their willingness to address each other in class. Using classroom discussions alone may not be sufficient to help students recognize their peers as resources. Instead explicit instruction in how and why they should utilize their peers can be important for helping first-generation students recognize their peers are one of their most important resources on campus.

Transparent teaching practices also require instructors to help students understand the nature of academic discourse. First-generation and other underserved student populations are often unfamiliar with academic discourse in general. Oldfield (2007), reflecting on his experience as a first-generation college student, reported:

I wish I had known that higher education considers debate and argument integral to sound learning. In my hometown, when two working-class kids disagreed about something important, they began by speaking louder and louder until one of them backed down. If the matter remained unsettled (meaning that the physically weaker one had not relented), they usually started fist fighting. After settling the matter, they usually went several months before talking to each other again. Sometimes this silence lasted a lifetime.

In college, everything was upside down, for faculty and students alike. I was shocked to learn that you were expected to question other students, in class and out. In the best courses, the professors encouraged you to debate them. (p. 7)

During her first iteration of this course, the first author noticed this misunderstanding of academic discourse during a classroom discussion. After listening to a student articulate a well-argued position for the weight of the evidence under consideration, she reflected the student's position to her by stating, "So, you are arguing that..." When the first author was finished speaking the student said, "I'm not arguing! It's just what I think." Although this particular student was comfortable having an "opinion" about the evidence, she was uncomfortable labeling that "opinion" as an "argument" due to a misunderstanding of how argument was being used in this context. Because many of the students arrive in her class unfamiliar with academic discourse, the first author now explicitly discusses the nature of academic discourse early on in the semester. Additionally, to help familiarize students with academic discourse, students are required to identify the main argument in each paper they read on the discussion board prior to coming to class. During class discussions, the first author carefully restates students' comments as arguments or directs them to reframe their statement as an argument to help them connect their way of thinking to a scientific way of thinking. With these efforts, students become more comfortable with using the word argument and having it applied to their own class contributions. One student even commented on final evaluations, "Now when I read an article, I know that I'm supposed to look for the argument!"

Conclusions

Many instructors in the social sciences understand the importance of science literacy and engagement with science not only within their disciplines, but with the public in general (Kaslow, 2015). In fact, the American Psychological Association includes an appreciation for the necessity of scientific thinking as one of its curricular guidelines for higher education (APA, 2007). Despite this, there is evidence while students in psychology develop their scientific thinking skills, neither their interest in/attitudes toward the scientific enterprise, nor their appreciation of psychology as a scientific discipline increase as a result of their psychology studies (Holmes & Beins, 2009). This is unfortunate because interest in and positive attitudes toward science can influence an individual's choice to engage in lifelong science learning, and people learn much of what they know about science outside formal education settings (e.g., Falk et al., 2007). Because an understanding of science is becoming increasingly necessary to make everyday decisions, it is critical formal science education utilizes practices to engage students in lifelong science learning. Inquiry-based teaching practices have been shown to have long-term effects on students' attitudes toward and levels of engagement with science (e.g., Chen et al., 2014; Gibson & Chase, 2002; Kogan & Laursen, 2014). Notably, students have been found to more likely enroll in more advanced college math courses if their first-year math class utilized inquiry-based pedagogies (Kogan & Laursen, 2014).

Additionally, two to four years after the completing a two week science inquiry camp, middle school students who participated in the camp had more positive attitudes and a higher interest in science careers than students who did not participate (Gibson & Chase, 2002). Additionally, long terms gains in attitudes toward science have been observed in low-achieving elementary students following their participation in an after school science inquiry program (Chen et al., 2014). Consistent with the evidence, students are more likely to continue in a field of study after an inquiry-based course, the first author of the current study asked students enrolled in the psycholinguistics course, "After taking this course, will you be more likely to try to learn more about the science of language by reading books or articles?" One hundred percent of students answered affirmatively, and two students in the course wrote they wished the campus offered more courses on language. This affirmative response rate is higher than the first author's course in cognition, which uses an active-lecture teaching pedagogy where only 65% of students responded affirmatively that they would continue to learn more about cognitive psychology.

One noteworthy finding in the literature on the impact of inquiry-based teaching practices, is improvement is especially large for students more likely to be underserved by traditional pedagogical methods such as women, students from minoritized groups, and first-generation students (Casem, 2006; Chaplin, 2003; Domin, 1999; Gormally et al., 2009; Howard & Miskowski, 2005; Kogan & Laursen, 2014; Russell & French, 2002; Siritunga et al., 2012). This finding is encouraging because it suggests inquiry may be one tool to address the notably low levels of understanding of and interest in science in the general public, particularly among women and individuals in minoritized groups (Funk & Goo, 2015). However, although inquiry-based instructional interventions in STEM courses may have an outsized benefit for women and students from minoritized groups, their effect may be mitigated as students from these groups are less likely to be enrolled in STEM courses. Given the importance of science in everyday settings, it is important everyone, no matter their course of study, be confident in their scientific literacy skills. Because individuals who are often underrepresented in STEM courses are often more likely to major in social science disciplines (Aud et al., 2010; Georgetown University Center on Education

and the Workforce, 2016) we suggest the inclusion of inquiry-based instructional methods in undergraduate courses in the social sciences may broaden interest in the scientific enterprise. The goal of this paper is to provide an example of how to implement inquiry-based practices in a social science classroom and to encourage other social science instructors to consider whether, or not, these pedagogical methods are appropriate for their own learning outcomes. Future research should focus on assessing the impact of inquiry-based practices in non-canonical science classrooms.

Finally, it is important to note inquiry-based teaching practices are not a panacea for low levels of engagement with science among women and individuals in minoritized groups. A number of factors contribute to an individual's interest in and engagement with science, such as stereotype threat (e.g., Beasley & Fischer, 2012; Shapiro & Williams, 2012) and congruity between goals and roles (e.g., Diekman, Brown, Johnston, & Clark, 2010) among others. Importantly, there are also barriers in place that prevent women and individuals from minoritized groups from being successful in science careers (e.g., De Welde, & Laursen, 2011; Strayhorn, Long III, Kitchen, Williams & Stentz, 2013.) Thus, truly addressing low levels of understanding of and engagement with science among the public, will require a multi-pronged approach.

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