

**Training the Future: Themes from a Content Analysis of Psychology  
Research Lab Manuals**

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### Abstract

**Background:** Lab manuals help researchers and students share a common understanding of the rules, guidelines, and expectations related to being involved with a research laboratory.

However, no formal guidelines direct the creation of lab manuals in psychology.

**Objective:** In this study, we conducted qualitative analyses of 10 psychology lab manuals to provide some broad guidelines for crafting a lab manual that would improve the research experience for undergraduate students.

**Method:** Taking an inductive approach, a team of researchers created codes from the contents of the manuals, and then derived themes from those codes.

**Results:** Themes included lab philosophy and direction, expectations and roles in the lab, communication inside and outside the lab, ethics, preparing for research, conducting research, presenting research, networking, and benefits of undergraduate research.

**Conclusion:** We defined and provided specific examples of each theme for consideration by educators and discussed limitations of our approach.

**Teaching Implications:** Ultimately, these themes could serve as a modest outline from which teacher-scholars can create their lab manuals from scratch or to revise/expand current manuals.

*Keywords:* undergraduate research, lab manual, research assistants, research experience, undergraduate students, faculty development, faculty-student mentoring

## **Training the Future: Themes from a Content Analysis of Psychology**

### **Research Lab Manuals**

The undergraduate research experience can shape the trajectory of a student's education. Even if students do not pursue research as a career, the skills and experiences associated with research can provide a foundation upon which students are equipped to chart their future paths. For example, undergraduate students who gained research experience as research assistants, compared to students who did not have such experiences, tended to have higher retention rates, GPAs, graduation rates, and rates of enrollment and acceptance into graduate programs (Boysen et al., 2020; Pawlow & Mainz, 2016). Additionally, research provides the opportunity for students to develop a collegial and professional relationship with faculty mentors. These personal and professional gains from both mentorship and group/peer learning can enhance a student's self-confidence in the development of their professional identity (Hunter et al., 2006). Thus, it is no surprise that students are more satisfied with their program of study when they interact more with faculty (Stoloff et al., 2012).

Although the quality of these mentored research activities may vary, students typically work in a group alongside faculty or directly with a faculty member. Experiences include creating or collaborating on a research study, conducting literature reviews, submitting ethics review applications, recruiting participants, collecting data, analyzing data, writing research reports, and presenting at academic conferences (Boysen et al., 2020; Pawlow & Mainz, 2016). Through these experiences, students can strengthen interpersonal skills such as cooperation/collaboration, leadership, time management, conflict resolution, public speaking, and negotiation (Landrum & Nelsen, 2002; McCloskey & Weaver, 2020; Pawlow & Mainz). Likewise, students can improve their technical skills such as writing, editing, creating study

stimuli and surveys, and managing projects (Boysen et al.; Landrum & Nelsen, 2002; McCloskey & Weaver, 2020; Pawlow & Meinz). These skills are advantageous to students during their research experience, but also assist students who decide to pursue graduate school and careers outside of academia. They might even be helpful to reduce certain types of academic anxiety and stress, particularly for minority students (e.g., Huynh et al., 2023; Huynh, Sifuentes, et al., 2023).

Given the pivotal role that research plays for undergraduate students, it is essential that faculty help prepare students for a successful experience. This preparation may include the creation of a laboratory manual which lays out the rules, guidelines, and expectations related to being involved with a research lab. Additionally, lab manuals can be used as recruiting tools that allow potential research assistants insights into what skills they can expect to gain and reinforce during their research experience. Nevertheless, no established, universal guidelines help researchers create such a document, despite available advice on research mentorship more generally. For example, Boysen et al. (2020) described the research training processes and outlined steps to ensure a productive research relationship. Further, Burke and Prieto (2019) recommended that researchers make the training environment socially engaging so that research assistants can increase their research self-efficacy and, ultimately, increase their motivation to participate in future research activities.

### **Current Study**

Although lab manual templates can be found as open-access resources (e.g., SIPS Products [improvingpsych.org]), exemplars of lab manuals vary in tone, organization, and content. As a starting point, the current study primarily examined lab manual content, while also noting commonalities in organization and tone (reserving a fuller conversation about best practices and recommendations for student-centered tone and organization to the General

Discussion). Thus, we identified and summarized the types of information that are typically included in laboratory manuals of psychology research labs involving undergraduate research assistants. Knowing common themes can be useful for those who wish to develop a lab manual or revise their existing manual. Subsequently, these more complete manuals can provide crucial resources in the recruitment, training, and retention of the next generation of psychology researchers.

To our knowledge, this is the first systematic approach to examining the contents of psychology lab manuals and identifying common themes amongst them. Below, we summarize our process, from collecting and selecting lab manuals for our analyses, to articulating the analysis strategy, and ultimately to synthesizing our results into common themes. Finally, we discuss the implications of incorporating these common themes into a lab manual for both student and faculty researchers.

## **Method**

### **Collecting and Selecting Lab Manuals**

We solicited lab manuals from researchers by sending emails to the American Psychological Association (APA) Division 2 (The Society for the Teaching of Psychology) Listserv and by posting our request on the Division 2 Facebook page (which has more than 22,000 members) and Twitter [now X]). Finally, we searched Twitter for posts about lab manuals. These solicitations and searches led to a variety of shared and publicly available lab manuals, such as those posted by researchers on GitHub and Open Science Framework (OSF).

Our aim for this project was to provide an overview of themes in lab manuals that would be most pertinent to researchers who wanted to create a lab manual for their own psychology lab, in which they would work directly with undergraduate researchers. As such, our inclusion

criteria were relatively broad to allow for resources that contained sufficient and helpful information about how to direct a psychology research lab working with students. In total, we received and/or found 15 resources. The first author reviewed the source materials to determine those resources that met inclusionary criteria, which was confirmed by the last author. Of the 15, we excluded 5 resources due to insufficient information, such as stand-alone contracts and applications. We broadly defined a lab manual as a document that provides information on standard laboratory procedures, policies, and information that are necessary for members of the lab to know. We excluded several documents that did not meet these criteria including an application to work in a laboratory, an agreement document for undergraduates to sign before working in the laboratory, and notes from an introductory lab meeting that includes the roles within the lab and a brief overview of the research process. Of the 10 remaining resources, 9 were formatted as lab manuals and 1 was a detailed PowerPoint presentation. The faculty researcher who provided the presentation described using slides to discuss various opportunities and responsibilities of working in a research lab (like a lab manual). Although this resource was not formatted as a manual, the PowerPoint contained enough information to be a standalone document, even without the researcher's commentary, to fit our broad inclusionary criteria. As such, we felt that other researchers would benefit from its inclusion in the analysis. For brevity, we will refer to all 10 resources as lab manuals moving forward.

### **Sample Size**

Sample sizes for qualitative analysis vary depending on the research context and question (Malterud et al., 2016; Sandelowski, 1995). Unlike quantitative research, which may use a combination of effect size, alpha, and statistical power to determine sample size, no predetermined requirements guide the number of observations required for qualitative research.

Rather, qualitative approaches strive to have enough observations to achieve either informational redundancy or theoretical saturation (Sandelowski). A recent systematic review of published qualitative studies found that most studies reach saturation with 9-17 observations/interviews (Hennink & Kaiser, 2022). Those numbers are meant to be descriptive and not prescriptive, as some research questions require much fewer observations to achieve theoretical saturation.

Subsequently, we determined that our 10 lab manuals, many of which have very detailed information, were sufficient to achieve our means. Beyond relying on the content of the lab manuals themselves, we also relied on our personal experience as directors of research labs with undergraduate students (first, second-to-last, and last author), and as undergraduate students participating in research (second, third, and fourth authors) to determine that the contents of the 10 lab manuals captured the range (i.e., saturation) and overlap (i.e., redundancy) of information typically expected in such a resource.

### **Analysis Plan and Coding Strategy**

We followed the guidelines for conducting thematic analysis in psychology research outlined by Braun and Clarke (2012). We took an inductive (i.e., bottom-up, data-driven) approach to our analysis. That is, we wanted to create the themes from the codes that originated directly from the data; we did not want to force codes to fit into predetermined boundaries. In line with the outlines offered by Braun and Clarke, authors read the lab manuals once through for a general overview, created codes, derived themes from the codes, then labeled each code with a theme to allow for consensus. Below, we described the process in more detail.

First, two coders read through the lab manuals to gain a general overview and familiarity with the topics, without taking any notes. Then, both coders reread and summarized key points of the same lab manual by generating codes using words and/or short phrases that captured those

key points. Afterwards, the coders presented their initial codes to the experienced lab directors (the first and last authors) to be reviewed for general completeness. Working iteratively, the project team discussed and came to a consensus on the appropriate level of detail for the codes. For example, one coder initially generated substantially fewer codes than the other coder for this first lab manual. At the initial check with the experienced lab directors, the coders came to a consensus regarding the level of detail to which the codes should be created. The idea was not to discuss the content of the codes themselves; but, to ensure a general understanding and agreement about the level of detail for which the codes would reflect the manuals. Following these discussions, the coders were asked to re-code this first manual and send it to the experienced lab directors again. After consensus was reached, the coders independently coded the remaining 9 lab manuals, without further consultation with each other or the experienced lab directors.

Next, the coders compared their results to create one extensive list of codes for the lab manuals. They combined similar codes to reduce redundancy in the file and removed certain codes that were deemed to be not pertinent and/or idiosyncratic to specific labs/contexts (e.g., cleaning instructions for a lab microwave). They also jointly revised the list to replace vague codes with more clarity (e.g., a code of “process” noted by one coder turned into “research process” after their discussion). Then, the coders jointly created themes from the comprehensive list of codes, providing a name and definition for each theme.

After the coders created the themes, they independently assigned each code to an appropriate theme, with the understanding that one code could be assigned to several themes. When one code fit under more than one theme, the coders labeled the code with themes in decreasing order of relevance (i.e., the first theme assigned to the code would be seen as most



representative of that code). Next, the coders discussed any codes on which there was disagreement. The coders resolved their differences by explaining their decisions. Any unresolved differences were then forwarded to the experienced lab directors to serve as tie breakers. Overall, there was high inter-rater agreement between coders, even prior to the coders meeting to resolve differences (78% of the codes [123/158] had matching themes assigned to them). After all discussion and tie-breaking, all codes were assigned to matching themes.

## **Results**

### **Descriptives**

Among the lab manuals we reviewed, six came from labs led by women Principal Investigators (PIs) and four came from labs led by men PIs; five came from assistant professors, three from associate professors, and two from full professors. Additionally, the research areas varied: four social psychology, two social-developmental psychology, two cognitive-neuroscience, one cognitive psychology, and one cognitive-developmental psychology. Seven of the lab manuals came from labs established within universities located in the United States, two were from universities in Canada, and one from a laboratory based in Italy. Additionally, four labs were at R1 universities, three were at large, public universities, one was at a regional university, one was at a small liberal arts college, and one was at a small, global university.

### **Themes**

Based on our analyses, we created 10 themes. Nine themes included focused content; whereas a tenth theme served as a miscellaneous category for including necessary content that did not fit neatly elsewhere. Below, we present the themes in one possibly logical order as they would appear in a lab manual. Each section includes the theme's name, frequency of occurrence in parentheses, definition, and illustrative example(s). We note that many of the frequencies

exceeded the number of lab manuals, which simply meant that elements of this theme occurred in several places. Relatedly, we believe we achieved informational redundancy and theoretical saturation, as most lab manuals included many of the same key points, making much of the information recurrent from one manual to the next. For detailed examples and specific codes associated with each theme, see Tables 1 and 2 of the Supplemental Material (Lilley et al., 2024).

### ***1. Lab Philosophy and Direction (n = 47)***

This theme refers to the ideas, goals, and environment of a research lab that influence what the research intends to accomplish. Establishing both the lab mission and philosophy are important preliminary steps to equip all lab members (including undergraduate research assistants, graduate level students, and faculty) to play an essential role in contributing to the lab. The lab's mission and philosophy affect its goals, and this will, in turn, determine the lab's future direction.

Lab manuals took many different approaches to establishing a lab philosophy. For example, one lab manual clearly outlined the mission and philosophy of the lab by stating their high standards for ethics, quality of research, and their focus on historically underrepresented groups. Another lab defined their mission and philosophy by stating a series of research questions they aim to investigate. To carry out accomplishing the goals of the lab, many manuals mentioned adhering to an agenda during lab meetings to complete research tasks efficiently. Similarly, other manuals suggested creating a calendar available for each lab member to view and edit as tasks are carried out.

Many lab manuals mentioned establishing a specific environment within the lab. For example, a common theme was the importance of creating a positive and dynamic lab environment that provides students with unique learning opportunities. The manuals illustrated

how some PIs strive to create an encouraging and understanding lab, where learning takes priority. Many PIs used this section to express their aim of creating a supportive atmosphere where students' professional and academic development is fostered. For instance, one lab manual mentioned cultivating diversity of thought from every lab member. Another lab manual even elaborated on the rights of research assistants and encouraged them to advocate for themselves in finding the lab that will contribute the most to their personal development.

## ***2. Expectations and Roles (n = 88)***

This theme refers to descriptions and specific responsibilities of various roles within a lab. In addition to outlining the responsibilities of undergraduate research assistants, most lab manuals included what can be expected of the PI. One manual explained that the PI would help train, guide, and support lab members within their lab duties and when it came to professional development and work-life balance. Another manual stressed the importance of everyone being invested in research. Clarifications on how the PIs and RAs work together were explained in some of the lab manuals. These descriptions ranged from the PI setting deadlines and coordinating work scheduled to the process of performance reviews for lab members.

Expectations for undergraduate RA tasks varied across manuals, but typically included attendance at lab meetings, time management skills, communication (mentioned here, but also a standalone theme), the ability to work independently, and ongoing professional development. A consistent pattern throughout this theme was collaboration. Although each lab member could work on assigned tasks individually, most research projects would require collaboration across multiple people. Therefore, teamwork was described as important to achieving high-quality research while also benefiting individual lab members who contribute.

## ***3. Communication (n = 82)***

This theme refers to the specific guidelines regarding communication both inside and outside of the lab. Lab manuals outlined the policies and processes for sharing ideas and data, the importance of asking questions, and task or project updates. These guidelines ensure that research is conducted efficiently, and lab members can learn while also communicating in a professional manner. As is often the case when learning new tasks, RAs could have questions, need assistance to complete a task, or make mistakes. The lab manuals laid out strategies to help RAs navigate these scenarios.

Some lab manuals shared policies on email etiquette, professionalism during lab meetings, and the importance of timely communication. Many manuals explicitly encouraged RAs to have open communication with the PI of the lab by setting up regular meetings and discussing goals both for themselves as developing professionals and for their assigned projects or assignments within the lab.

#### **4. *Ethics* ( $n = 31$ )**

This theme refers to the various aspects of ethics within the research process, including formal approval of Institutional Review Board (IRB) protocols and best practices to protect participants and the validity of the research study. Some manuals clarified that including information on ethical responsibilities with lab manuals helps to establish clear guidelines and expectations for all lab members.

Most lab manuals included information regarding the IRB process that must occur before a study can be conducted. More detailed explanations of the required documentation, rationale for the ethics process more broadly, and responsibilities of different parties (e.g., PI, undergraduate RAs) were also mentioned. For example, some lab manuals mentioned the Collaborative Institutional Training Initiative (CITI) modules that must be completed by all

researchers before applying for IRB approval. Other lab manuals discussed OSF materials and the importance of transparency during the research process.

### ***5. Preparing for Research (n = 27)***

This theme refers to the process a lab undergoes to prepare to conduct research. Some of the steps in this process include developing research ideas, designing the experiment, understanding grant funding, undergoing training, completing preregistrations, and submitting an IRB application.

Many manuals emphasized that developing research ideas is a key component in preparing for research. In some instances, research ideas must be aligned with the funding for a lab. Grants can sometimes cover the expenses of research projects and activities, compensation for undergraduate research assistants, and even travel expenses. Therefore, the manuals highlighted the need to understand how the funding received for research is an important step in preparation for research in the lab. Other manuals emphasized the importance of fostering a lab environment in which ideas and opinions of each lab member are valued and in which collaboration is supported. The manuals explained that the ultimate goal in this step of the process is to clearly establish hypotheses, define suitable samples, and outline the detailed procedures of a study. Once the lab's research ideas were established, several lab manuals implied the next step is developing the experimental design. This step could include designing the study, explaining the rationale, defining the variables, and outlining the tasks that participants will complete. The PI was generally responsible for developing the experimental/study design, but other members of the lab could also provide input and feedback. Many of the lab manuals noted the importance of providing justification for the study design and emphasized the need to minimize risk to participants.

Preregistration was a common theme in the manuals. Preregistration could include the sharing of hypotheses, predictions, procedures, and sample size onto a public platform, like the OSF. The manuals suggested that quality and ethical adherence of a study could often be predetermined by undergoing the preregistration process. To maintain ethical research conduct involving human subjects, the lab manuals highlighted the fact that a lab must also submit an IRB application in preparation for conducting research. The theme of ethics was detailed in the previous section.

#### ***6. Conducting Research (n = 165)***

This theme refers to the specific tasks and processes that occur when conducting research within a given lab. Of all themes, this one appeared most often and contained many details that were relatively similar across research labs; however, this was also where most manuals included details on tasks RAs would complete in the lab. The most common steps outlined across the lab manuals were creating the stimuli or other study materials, collecting data, analyzing data, and sharing the research with others through research presentations or manuscripts, in addition to the steps outlined in the previous theme of preparing for research. Manuals also included specific technologies necessary to undertake different parts of the research process such as platforms to design and collect data (e.g., Qualtrics), and data management and analysis (e.g., Microsoft Excel, Statistical Package for the Social Sciences).

Although not every RA participates in the manuscript writing process, some lab manuals introduced the contents and process for writing a research manuscript. Overall, the information on conducting research within each lab manual can provide RAs or those considering joining the research lab with a general idea of what all is involved in the research process and sometimes additional information on how to accomplish certain tasks.

### **7. *Presenting Research* (n = 26)**

This theme refers to the processes and expectations for sharing research with others in the lab, with others in the discipline, and with the public. Sharing research in a presentation format is also a way for researchers to receive feedback on their projects and their hone scientific communication skills.

Some lab manuals mentioned that presentations are given informally, such as when lab members take turns sharing their progress during regularly scheduled lab meetings. Lab meetings were also described as a venue for practicing and improving presentations before they are shared with a wider audience (e.g., research conference). Several lab manuals referred to these opportunities as a means of improving and developing professionally. More in-depth information on the different presentation formats (i.e., oral presentations and poster presentations) at research conferences was included in some lab manuals as well as authorship guidelines for research presentations and how these differed from manuscript authorship.

### **8. *Networking* (n = 7)**

This theme refers to developing professional relationships inside and outside of one's own institution. These new connections could lead to future research opportunities and career development.

The manuals noted that networking often occurs at research conferences with other professionals within the same discipline; however, interdisciplinary collaborations can be formed at such conferences as well. Additionally, the manuals indicated that another avenue for networking is connecting with academic communities, which are often maintained in a virtual space (e.g., social media, webinars, listservs). Some lab manuals also mentioned collaborating with others in the same lab or across labs at the same university as opportunities for networking.

**9. *Benefits of Undergraduate Research (n = 68)***

This theme refers to the development of skills that improve academic and professional outcomes for undergraduate research assistants. Many lab manuals noted the transferable skills that an undergraduate RA gains during their time in the lab. For example, using research software, improving presentation skills, and learning to collaborate in an academic and professional manner were some of the skills most often mentioned. Other mentioned examples included the role of PI mentorship and professional work experience. As noted by some of the manuals, mentorship can lead to academic advising, career advising, letters of recommendation, and increased opportunity for networking.

This theme overlapped with many other themes in the lab manuals. For example, the benefits of mentorship were often mentioned alongside the importance of communication with a research mentor. As emphasized by various lab manuals, open conversations about career goals and goals for a student's time as an RA are important aspects in helping students experience the full benefits of being an RA.

**10. *Miscellaneous (n = 25)***

This theme refers to several codes that did not fit explicitly into the themes, but nonetheless registered as critical to include. As an example, some lab manuals included information on paying for conferences, work-study, preparing theses, and postdoctoral fellows. While these topics are not applicable to every lab (i.e., some labs do not have postdocs), we thought they were valuable to include because students who read these lab manuals can still benefit from learning more about academia in this way despite the information not being immediately relevant to them in their current position. Similarly, although not every lab can provide funding, open conversations about finances are important, especially for students who



need to make difficult financial decisions during their undergraduate years and those who plan to pursue graduate study in the future. Finally, some lab manuals mentioned the importance of celebrating success. Despite this not being an explicit topic across all 10 manuals, we thought that this content was important to build morale and improve cohesion within the lab (see *1. Lab Philosophy and Direction*).

### **Discussion**

Overall, the psychology research laboratory manuals we reviewed covered a wide variety of topics but were fairly consistent in their coverage of key ideas including communication guidelines, expectations within the lab, the benefits of research experience, and most frequently, key steps for conducting research within that specific lab. Topics that were included, but may have received less attention, were preparing for the research process, the lab philosophy, ethics, presenting research at conferences, networking, and miscellaneous pieces of information, such as information regarding software programs.

The organization of each lab manual varied as well. Some lab manuals organized information sequentially across the research process, whereas other manuals organized the information with the most practical or relevant information first and less common topics later. When conducting the analyses for this paper, the table of contents in some manuals was a helpful navigational feature. Beyond the order of the information, PIs also adopted different ways to signal important information (e.g., bolded terms, headings, hyperlinks), reinforce foundational information (e.g., multiple instances of the same theme across different sections), and add complementary visual aids (e.g., screenshots, process diagrams). Thus, as with many textbooks for the same course, even commonly included topics were organized very differently across manuals.

Lastly, the lab manuals differed in tone. Although the creation and distribution of a lab manual in the first place may signal a PI's desire to be informative, that delivery could take on a tone from more perfunctory to more welcoming. As we did not operationally define and examine tone, its inclusion in this paper may be revealed by way of content. For example, an introductory statement or paragraph in some lab manuals notably emphasized a warm and inviting tone that could prepare students for the atmosphere or culture within the lab in much the same way that the tone and contents of syllabi can create a welcoming classroom environment (Harnish et al., 2011).

Moving beyond recurrent themes to absent or less-frequently included ones, many lab manuals lacked information on initiating involvement with the PI and lab. The process for joining the lab can be a big hurdle, especially for first-generation college students or students from underrepresented backgrounds. Making a high-impact practice such as research experience as an undergraduate more accessible would allow more students to benefit from this opportunity. However, most lab manuals were written for undergraduate students who were already working with a professor on a research project, or, at the very least, had indicated their interest in working with a professor to the extent that the professor has shared a copy of the lab manual with them. Therefore, PIs who are creating or revising their current lab manual may consider including information about how to join the research lab by approaching the professor, filling out an application, etc. Although beyond the scope of the current paper, it would be interesting to examine the different methods researchers use to recruit students into their labs, as this might affect the process by which students decide to join a research lab.

Other topics that may be included in future lab manuals as new technology is developed include the use of artificial intelligence (AI) in various research tasks, new software programs for

statistical analysis (e.g., R, JASP, Jamovi), new methods for presenting research, and new technology for conducting studies (e.g., physiological measures, survey software). Just as some lab manuals have guidelines regarding a professional online presence (e.g., social media use), lab policies will likely evolve in the future to stay current with the available platforms and changes in societal norms.

### **Limitations and Future Research**

This work is somewhat limited with regards to geographical representation. The considered materials came from the United States, Canada, and one from Italy. Additionally, we recognize that there were likely many lab manuals available for analyses that were not included in this study. However, we believe, based on our reading and analysis of the 10 lab manuals in the study, that we have largely covered the major topics to be included in psychology lab manuals (i.e., achieved theoretical saturation and informational redundancy). Having said that, it is likely that norms and procedures vary across other countries and cultures. As such, future research could strive to incorporate more varied cultural perspectives into the formation of lab manuals. Additionally, we followed the guidelines from Braun and Clarke (2012) for conducting thematic analysis in psychology research. According to our interpretation of their recommendations, we did not record inter-rater reliability ratings at that stage of data analysis where we created codes from the original documents. This information could have provided more clarity for our analytic procedures.

Furthermore, faculty who have created a lab manual may be likely to have larger research labs, higher research expectations, and higher research productivity. Faculty who direct smaller research groups and may only mentor one or two students at a time may not have codified their structure and processes in the form of a manual. Thus, we recognize that the information

presented in this paper may reflect practices of faculty at more research-focused institutions. Nevertheless, we hope the information is helpful for faculty at all levels and institutions who are considering the creation or modification of a lab manual.

Finally, though we intentionally limited our investigation to the contents of psychology lab manuals, we doubt that these themes are exclusive to psychology. Instead, other disciplines (e.g., biology, sociology) may use similar lab manual structure, despite differences in methodology, equipment, and technology. Future research can address this gap by examining lab manuals across disciplines. Discovering common and discipline-specific themes may be especially beneficial to both: a) students who are selecting a major and/or want to learn from multiple disciplines to shape a more well-rounded understanding of science; and b) investigators who join interdisciplinary collaborations to answer a research question from multiple perspectives but need to seek common ground in terminology and approach.

### **Teaching Implications**

Knowing *what* is typically included in a lab manual is just the first step. Researchers, especially those who are commonly teacher-scholars directing both classrooms and laboratories, are also likely interested in *how* the information is received by students. These manuals can serve as critical resources for students, especially those from underrepresented backgrounds, to learn more about the hidden curriculum that comes with higher education, and, more specifically, the research process. A student-centered lab manual should be designed to contribute to the students' knowledge base, tap into and focus motivational goals and passions, and emphasize research as a socially-shared endeavor (Alexander & Murphy, 1994). Nevertheless, lab manuals can sometimes feel like they are constructed with the purpose of delivering information in a one-way manner from the PI to subordinate researchers. As such, future research students may benefit

from additional empirical investigations examining the effective delivery of these common themes in a learner-centered way.

To this end, organization and tone can play a key role in centering the student experience in a laboratory manual. For example, maximally effective lab manuals should be organized to allow both general understanding (e.g., junior or aspiring research assistants looking to gain a more global understanding of interconnected aspects of the research process) and individualized learning relevant to specific roles and responsibilities (e.g., experienced research assistants choosing to read particular sections as a reference; Ivić et al., 2013). Respecting necessary limits in length and specificity (e.g., Mayer et al., 1996), lab manuals should incorporate information that emphasizes transfer from previous or concurrent coursework (e.g., concrete skills from research methods and statistical textbooks) and promote deeper learning of specialized processes (e.g., advanced statistical techniques and software applications; see Barnett & Cece, 2002; Tiruneh, 2018). Incorporating a table of contents can help learners navigate to specific and immediate relevant sections of the lab manual when necessary. Lastly, lab manuals should respect learners' cognitive limits by strategically adding visual aids, signaling important information, and limiting non-essential details (e.g., Castro-Alonso et al., 2021). Future templates and open-source lab manual materials would be most valuable to the extent that they were designed with these organizational principles in mind.

In a complementary way, researchers should consider how their manuals communicate tone. Learner-centered manuals should capture different types of motivation to engage in research such as catalyzing feelings of connectedness and competency and reducing feelings of doubt and misunderstanding (Keller, 1979). Thinking *like a scientist* starts with embedding the delivery of information into a larger context of the research community, allowing for and

respecting students' cultural backgrounds and personal experiences, and emphasizing a growth mindset that makes room for learning from mistakes (e.g., for reviews, see Albrecht & Karabenick, 2018, Willingham, 2021). With these elements, lab manuals can set the expectation that research happens in a socially-shared, collaborative environment both for the students as they learn about research, and alongside faculty as new knowledge is discovered through the research process. Although each PI has a unique voice and means by which to connect with their RAs, future researchers may want to include template language for more common themes (e.g., Ethics, Conducting Research) and create more tailored versions of miscellaneous elements that emphasize these with a welcoming tone (e.g., celebrating successes).

## **Conclusion**

In conclusion, the goal of this project was to analyze the most common themes within the psychology research lab manuals where undergraduate students are included in the research process. Our results may help to inform researchers who are looking to create a lab manual from scratch or to revise their current lab manual. As research lab mentors, we share the goal of providing students with experiences that will shape their career trajectories, whether that be through developing research skills, professional skills, or both. An effective lab manual can be a useful tool in our efforts toward this goal.

## **Disclosures**

### **Author Contributions:**

*Conceptualization:* Malin K. Lilley and Ho Phi Huynh

*Methodology:* Malin K. Lilley, Isabella Castellanos, Anastacia Wicks, Alena Raya, and Ho Phi Huynh

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*Writing:* Malin K. Lilley, Isabella Castellanos, Anastacia Wicks, Alena Raya, Dawn R. Weatherford, and Ho Phi Huynh

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None

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