Undergraduate Research:

An Exploratory Study of Undergraduate Research at Research-Intensive Universities

BY

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THESIS

Submitted as partial fulfillment of the requirements
for the degree of Doctor of Philosophy in Educational Psychology
in the Graduate College of the
University of Illinois at Chicago, 2021

Chicago, Illinois

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This thesis is dedicated to Scott, Sophia, and Henry

We can do anything we want to do if we stick to it long enough. Helen Keller

I know it has seemed like a lifetime
but I made it.
Never lose sight of your dreams
because you too will make it.
And I will be by your side every step of the way
just as you were by mine.

Love, Mom
AKA Tracy Sikorski, PhD
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ACKNOWLEDGMENTS

First, thank you to my work colleagues. I can't possibly thank you all personally, but know that if our paths crossed while I was the director of OSSR, you likely heard about this project. Your time and comments were always appreciated. Second, Russ, your expert advice got me across the finish line. And to my participants, thank you for your Zoom patience during a year when we were all quite literally "Zoomed out."

I also want to express my deepest appreciation to my committee members for sharing their time, advice, experience, and guidance on this project. Each member played a critical role in this journey. Celina – for your discerning thoughts on higher education; James – for your insights on undergraduate research; Michael – for your expertise on qualitative methodologies.

A special word of gratitude to Kim and Sarah. Each of you played such a pivotal role in this accomplishment that I could not have possibly done it without you. You believed in me when others didn't. You gave me hope when at times I felt hopeless. Each of you spent countless hours being my mentor, my colleague, and my friend. Words cannot adequately convey how grateful I am and forever will be.

Finally, my kids. You have given me infinite hours on this journey. Henry – your smile gives me life and helps me approach each day anew. Sophia – your kind and caring ways are unparalleled, and your endless love propels me every day. Scott – you have so much faith in me even when I don't have faith in myself. You three are forever my biggest cheerleaders, and this accomplishment is as much yours as it is mine.

PREFACE

I once had the opportunity to talk with a faculty member who worked with undergraduates on his research projects. One day, I asked the PI about the role of the undergraduates on his project. He remarked that the undergraduates could really only be useful for entering the data that was collected into databases. I asked him why he used them in such a limited capacity, and he said they didn't have the skills necessary to do anything else and that it took too long to teach them how to participate more fully. His funding was specifically to work with undergraduates interested in research, so his statement began to make me wonder about how and why students and faculty members engage in undergraduate research programs.

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SUMMARY

An exploratory study of undergraduate research programs at select research intensive universities was conducted. Semi-structured interviews were conducted with 30 administrators of undergraduate research offices to ascertain the goals, types of programs, and methods of assessing undergraduate research programs. This study also explored similarities and differences in undergraduate research programs among institutions and between STEM and non-STEM disciplines. Administrators were also asked to share the challenges that they experienced in delivering undergraduate research programs for students in non-STEM disciplines.

The goals of undergraduate research programs included improving educational outcomes, engaging students, and preparing students for getting a job post-graduation. The types of programs used by administrators to meet these goals included all-campus programs and peer programs. Administrators utilized a variety of methods to assess undergraduate research programs. Similarities and differences were identified in the undergraduate research programs among the institutions. Similarities in the programs included mentoring and inclusivity, while differences included the ways in which institutions defined undergraduate research and the institutional resources that were available. Similarities and differences also were identified among STEM and non-STEM fields. The primary similarity between the STEM and non-STEM fields was the importance of diversity, while the differences reported included the types of resources available as well as student and faculty recognition of students as members of the research community. The perceived challenges that participants reported included assessment and recruitment of non-STEM students.

Chapter 1: Introduction

This chapter begins with a background section that provides context for understanding the history of undergraduate research and critical thinking. The problem statement, purpose statement, and significance of the study follow the background section. The research questions, along with a series of definitions related to the study, conclude this chapter.

Background

Challenges for the 21st-century workforce require informational and technological literacy, the ability to respond to dynamic work environments, and the desire to engage on multiple levels. The National Education Association (NEA, 2012) argued that the work that today's employees are being asked to do has changed; it is less predictable, more analytical, and more interactive. For example, one employer reported that the skills assessed on his organization's employment exam were not industry specific; rather, the exam assessed the ability of applicants to think critically, to calculate accurately, and to reason logically. Kay of EDLeader21, said, "Today's students need critical thinking and problem-solving skills not just to solve the problems of their current jobs, but to meet the challenges of adapting to a changing workforce" (AACU, 2007, p. 5). However, developing students' critical thinking skills to accommodate an evolving workforce is not a new challenge to institutions of higher education.

In 1990, President Bush, in concert with all 50 United States (U.S.) governors, commissioned a report by the US Department of Education. President Bush and the U.S. governors argued that all students should be able to engage in critical thinking. In 1993, former President Clinton signed the Goals 2000: Educate America Act, which set into place "(a) education goals, standards, and assessments; (b) state and local educational reform; and (c) workforce standards" (Stedman, Apling, & Riddle, 1993, p. ii). While the Goals 2000 legislation was specific to elementary and secondary education, members of the National Commission on Educating Undergraduates in the Research University discussed the evolving landscape of higher education at an inaugural meeting. During this inaugural meeting, members of the commission discussed the evolving landscape of higher education. They noted that an increasing number of students were accessing college; however, these students also brought with them new ideas about education and higher expectations of post-secondary institutions. Members further noted that even while the number of students graduating from college had increased, adjustments and modifications to outcome standards influenced the content and methods colleges used to teach students.

After the final meeting, the commission, which became known as the Boyer Commission, produced a report suggesting that institutions develop academic and social programs that would positively influence students' academic success (Boyer, 1998). The Boyer Commission further argued that students should be more responsible for engaging in their own learning. In return for students' active engagement in their learning, universities were to commit to providing inquiry-based learning, intellectual challenges, and creative development. The Boyer Commission suggested making research-based learning the standard method of improving critical thinking and meeting the essential goals of higher education (Ennis, 1985; Giancarlo & Facione, 2001; Resnick, 1987).

Critical thinking can be defined as (a) an unending search for knowledge, (b) an approach to problem solving that emphasizes thought-provoking dialogue and new perspectives, and (c) the ability to apply analytical and logical thinking to problems. As a component of learning, Brownell and Swaner (2009) suggested that critical thinking includes integrating and developing ideas while also considering the value of those ideas alongside the ideas of others. Applying the recommendations of the Boyer Commission for research-based learning provides an opportunity for institutions to improve the critical thinking skills of students while also preparing them for 21st-century work. One way of integrating research-based learning into higher education is through undergraduate research programs.

Undergraduate research has been considered a high-impact academic and educational practice. Kuh (2008) argued that a positive relationship exists between participation in educationally purposive activities, such as undergraduate research, and student learning outcomes. Undergraduate research also represents an opportunity to recruit students, to enhance student persistence rates, and to develop community. However, institutions of higher education have focused only minimally on undergraduate research programs across varying disciplines.

Traditionally, institutions supporting undergraduate research opportunities have focused on science, technology, engineering, mathematics (STEM), and the hard sciences--i.e., institutions where research activities naturally support undergraduate research. However, clear differences have been observed when implementing undergraduate research programs across STEM and non-STEM disciplines (e.g., social sciences). Auchincloss et al. (2014) attempted to define these differences in undergraduate research programs, but the “dimensions” that they identified were heavily influenced by a STEM model. Within undergraduate research programs in STEM fields, (a) research often occurs in a laboratory setting, and therefore students must possess and maintain a working knowledge of laboratory practices relevant to their disciplines; (b) research is hypothesis-driven; (c) methods are experimental; (d) results are empirically reported; and (e) research requires that students have supervision and guidance while working with laboratory materials, supplies, and equipment.

In contrast to STEM research, research within other disciplines (a) often occurs within social contexts; (b) is often driven by research questions; (c) is comprised of diverse research methods whose results often are characterized by values and attitudes; and (d) provides students with increased autonomy in completing their research projects. Even though institutions of higher education have implemented undergraduate research programs for a wide variety of purposes (e.g., improving student learning outcomes, increasing retention rates, increasing graduation rates), only minimal research has been conducted focusing on the role of undergraduate research as an approach for developing critical thinking skills among students in non-STEM disciplines.

Problem Statement

While undergraduate research programs have been used by colleges and universities to engage students and develop critical thinking skills, little if any research has been conducted to examine current undergraduate research programs at colleges and universities to determine what type of undergraduate research programs exist within the non-STEM disciplines. A review of literature conducted by The Reinvention Center, Stony Brook (2001) found that unequal opportunities were available for undergraduates to conduct research within various disciplines. For example, only 25% of respondents reported that students from disciplines within the social sciences participated in undergraduate research programs.

Differences also exist in the types of undergraduate research programs between STEM-related disciplines and the non-STEM disciplines. However, because the majority of research studies that have been conducted on undergraduate research programs have been conducted among STEM-related disciplines, researchers have a limited understanding of the types of opportunities available for non-STEM students. The researcher of this dissertation found that in a review of literature from 2006-2016, of more than 200 studies related to undergraduate research programs, only 32 studies were related to participation in undergraduate research programs in non-STEM disciplines. As a result of the lack of research, there has been difficulty identifying the type of undergraduate research in which students in non-STEM disciplines have participated.

Besides a few studies that examined undergraduate research in non-STEM disciplines, most of the research designs employed to conduct non-STEM studies have been plagued by substantial methodological limitations. What Works Clearinghouse (WWC) is an Institute of Education Sciences review board that evaluates the methodologies of various research studies and provides educators and administrators with evidence-based strategies. Their review process applies specified criteria in order to evaluate the components of research studies, such as the sample selection process, the intervention, the data collection process, and the data analysis process. Manuscripts that are not eligible for inclusion are those whose designs are not assessed across time (i.e., pre/post questionnaires) or do not include a comparison group to assess the effectiveness of the intervention. Furthermore, a review of the research literature revealed (a) an over reliance on questionnaires to measure the effectiveness of interventions as well as (b) a distinct absence of specific research questions to focus the studies.

Larger, random samples support the ability to generalize results, and small samples influence the ability of researchers to disaggregate data by gender, majors (when appropriate), race and ethnicity, and GPA--all variables that can strongly influence learning outcomes. The incorporation of comparison groups helps establish causal relationships between interventions and outcome variables rather than merely showing associations or correlations between participation and outcome variables. However, adequate sample sizes (Cuthbert, Arunachalam, & Licina, 2012; Fair, 2007; Falconer & Holcomb, 2008) and a lack of comparison groups

(Ciarocco, Lewandowski, & Van Volkom, 2013; Downey, 2013) characterized one limitation of studies focusing on non-STEM undergraduate research.

In addition, questionnaires (many of which were researcher-developed) were the primary method of assessment used in non-STEM studies investigating undergraduate research. Self-reported data when using questionnaires present a challenge as a method of assessment because responses are limited to participants' perceptions of their behaviors, knowledge, and attitudes. Language barriers and difficulty understanding the context both of the questionnaire items as well as the response scales can lead to (a) variations in responses (and therefore different interpretations of responses), (b) missing data, and (c) low response rates--all of which can influence the results.

Finally, research questions did not drive many of the non-STEM studies, making it difficult to identify relationships among variables under investigation. The authors did not specify the variables of importance within the research questions, and in most instances, the authors could not establish relationships between participation in undergraduate research programs and improved learning outcomes. When the authors included research questions, these questions often reflected components of the institutional program rather than being driven by theory, resulting in studies that were evaluative instead of empirical, even when research questions and data seemed to drive the research process. As a result, the generalizability of the findings to the research community is limited, and the results have limited usefulness to administrators and institutions seeking to build programs of undergraduate research.

The implication of limited research on undergraduate research programs in non-STEM disciplines includes difficulty in designing, implementing, and assessing high-quality programs of undergraduate research. In addition, the availability of limited research studies makes replication challenging; however, replication is necessary to validate and generalize findings. Finally, the availability of limited research studies makes future empirical study difficult. Without a historical context within which to ground future empirical research, identifying relationships between participation in undergraduate research programs and improved learning outcomes is difficult.

Purpose Statement

Therefore, the purpose of this study is to (a) identify and examine the goals, types, and methods of assessing undergraduate research programs at select research-intensive universities; (b) compare and contrast institutional and disciplinary similarities and differences in undergraduate research programs; and (c) examine the challenges administrators face in developing undergraduate research programs specifically in non-STEM disciplines. To achieve this purpose, the researcher (1) identified R1 institutions with a commitment to undergraduate research programs; (2) examined undergraduate research programs and catalogue their goals, types, and methods of assessment; (3) analyzed the institutional and disciplinary similarities and differences among undergraduate research programs; and (4) analyzed the challenges administrators face in developing, implementing, and assessing undergraduate research programs. This study draws on the current literature base in STEM undergraduate research fields to characterize the goals, program types, and methods of assessment of undergraduate research programs. It further draws on the high-impact practice framework developed by Kuh (2008) (a) to analyze similarities and differences among undergraduate research programs, to (b) to understand how undergraduate research programs can contribute to the development of critical thinking skills and, in response, (c) to explore solutions that can lead to improved outcomes.

Significance of the Study

Current methods of improving student learning include high-impact practices, such as undergraduate research that focuses on actively engaging students. High-impact practices have been characterized by a collaboration between industry leaders and educational institutions and represent an important strategy in meeting the changing demands of 21st-century work; however, while undergraduate research programs as a high-impact practice may improve critical thinking outcomes, minimal empirical evidence exists to suggest that undergraduate research improves critical thinking outcomes. Because most of the empirical evidence exists primarily in the STEM disciplines, even less evidence exists to suggest that undergraduate research improves critical thinking skills among students within non-STEM disciplines.

As a result, the significance of this study is evident in three specific ways. First, this study is significant because it will benefit the workforce by helping to prepare future employees who have participated in non-STEM research programs. Participating in these research programs enables employees to develop skills identified as essential for 21st-century work--more specifically, critical thinking skills, communication, and teamwork.

Secondly, this study is significant because institutions devote substantial resources to high-impact practices--specifically, undergraduate research practices. Institutions have developed campus offices, funded faculty research projects and student research awards, and made curricular adjustments to incorporate undergraduate research. As such, institutions will benefit by allocating their resources in a more effective and efficient way towards programs that have demonstrated success.

Finally, this study is significant because it will impact students in the non-STEM disciplines by helping to define more clearly and specifically the characteristics of an effective research experience. Consequently, students will have a better understanding of the specific activities in which they are engaging as well as the outcomes they can expect as a result of their participation. In addition, more clearly defining the roles of students and faculty members in undergraduate research will help faculty members increase their understanding of program objectives as well as their ability to develop assessments that align with these objectives.

Research Questions

The following research questions will guide this study:

RQ1: What are the goals, types, and methods of assessing undergraduate research programs at select research universities?

RQ2a: How are undergraduate research programs similar and different at select research universities?

RQ2b: How are undergraduate research programs similar and different among programs in STEM disciplines and non-STEM disciplines at select research universities?

RQ3: What challenges do stakeholders at these institutions face in developing, implementing, and assessing undergraduate research programs for students in non-STEM disciplines?

Definitions of Important Terms

For the purposes of this study, the following terms are important and will be defined as follows:

21st-century skills – “skills such as problem-solving, critical thinking, communication, collaboration, and self-management” (Pellegrino & Hilton, 2012, p. 1).

21st-century work – new idea of work that has displaced traditional paradigms of rigid, highly specialized, simplified, and standardized work practices in favor of teams, with decentralized decision-making, constantly evolving, and globally bound (Stuart, 1999).

Critical Thinking (CT) – "Purposeful, self-regulatory judgment which results in interpretation, analysis, evaluation, and inference, as well as explanation of the evidential, conceptual, methodological, criteriological, or contextual considerations upon which that judgment is based" (Facione, 1990, p. 3)

Code – "a word or short-phrase that symbolically assigns a summative, salient, essence-capturing, and/or evocative attribute for a portion of language-based or visual data" (Saldaña, 2016, p. 4).

Community of Practice – the mutual engagement in a joint enterprise with a shared repertoire (Wenger, 1998).

Engagement – "the amount of physical and psychological energy that the student devotes to the academic experience" (Astin, 1984, p. 298).

Full-time Equivalent (FTE) – "a unit that indicates the workload of an employed person in a way that makes workloads or class loads comparable across various contexts" (https://en.wikipedia.org/wiki/Full-time_equivalent).

High-impact Practices (HIP) – Educationally purposeful activities beyond a student's ordinary course of study that students actively engage in to impact their learning (Kuh, 2008).

Identity – a feeling of belong, the meaning of one's experiences (Wenger, 1998).

Mentoring – "Long term and intense, a close, meaningful relationship that is formal or informal and occurs in academic or professional contexts" (Mullen & Klimaitis, 2021, p.21).

Research Intensive Institution (R1) – Used by the Carnegie Classification of Higher Education to designate institutions that engage in the highest levels of research activities.

Retention – "For all 4-year institutions, percentage of full-time, first-time bachelor's (or equivalent) degree-seeking undergraduates from the previous fall who are again enrolled in the current fall" (n.d.). Retrieved December 1, 2019, from https://nces.ed.gov/ipeds/TrendGenerator/app/answer/7/32.

Social Sciences – "A branch of science that deals with the institutions and functioning of human society and with the interpersonal relationships of individuals as members of society" Social Science. (n.d.). Retrieved December 1, 2019, from https://www.merriam-webster.com/dictionary/social science.

STEM – An acronym representing the disciplines of science, technology, engineering, and mathematics.

Text Excerpt – a portion of data that is coded (Saldaña, 2016).

Transfer – "the use and application of skills and knowledge" (Pellegrino & Hilton, 2012, p. 15).

Undergraduate Research (UR) – "An inquiry or investigation conducted by an undergraduate student that makes an original intellectual or creative contribution to the discipline" (CUR, 2012, as cited in Rowlett, Blockus, & Larson, 2012, p. 2).

Chapter 2: Literature Review

This literature review chapter first examines the construct of critical thinking, its role in higher education, and its importance for 21st-century work. Next, this chapter presents a review of the theoretical framework of engagement and the role of high-impact practices and their corresponding characteristics. This chapter then discusses the relationship between engagement, high-impact practices, and critical thinking. Finally, this chapter presents an analysis of research on undergraduate research within both STEM disciplines and the non-STEM disciplines and assessment practices. It closes with methodological limitations of the research base.

Critical Thinking

Critical thinking has a long history, originating arguably with Socrates, who believed that individuals should question commonly held beliefs and distinguish those that are logical and reasonable from those that are undisciplined and irrational (Palmer, 2001). Dewey (1933) defined critical thinking as "active, persistent, and careful consideration of any belief or supposed form of knowledge in the light of the grounds that support it, and the further conclusions to which it tends" (p. 9). This definition formed the foundation of critical thinking scholarship until Ennis (1962). Ennis sought to further refine the concept of critical thinking by establishing criteria for making judgments (e.g., determining the reliability of statements, identifying problems, determining contradictory statements). This enabled psychology and educational researchers to begin to measure relationships between critical thinking and variables of interest. However, since the work of Ennis, controversy has existed in the field of critical thinking. First, scholars have not agreed on a clear and precise definition of critical thinking, and secondly, scholars have not reached a consensus about whether critical thinking should be considered a subject-specific set of skills or a generalized cognitive set of skills. While Sternberg

(1986) has argued that commonalities and a degree of overlap exist among the fundamental concept of critical thinking, the differences are worth exploring further.

Critical Thinking Debates. Scholars in the fields of philosophy, psychology, and education have widely discussed and debated critical thinking. Dewey (1933); Facione, Facione, and Giancarlo (1996); Ennis, (1985); Paul, Elder, and Bartell, (1997); and Lipman (1995) argued that critical thinking is comprised of personal attributes, such as determination, problem-solving, and self-reflection. These same scholars argued (a) that these personal attributes are innate, affective characteristics and (b) that despite possessing the cognitive ability to think critically, individuals also require motivation to engage in critical thinking. These personal attributes came to be known collectively as "dispositions" (Ennis, 1985). Conversely, other critical thinking scholars argued that critical thinking is comprised primarily of cognitive skills and strategies (Halpern, 1998; Pascarella & Terenzini, 1991; Sternberg, 1986). Sternberg (1986) suggested that "the agreements outweigh the disagreements… the major differences are in how broadly or narrowly the construct is… rather than what they view as the core" (p. 4). In 1987, the American Philosophical Association commissioned a group of education, philosophy, and cognitive psychology experts to define "critical thinking." In a landmark report, these experts concluded that critical thinking is two-dimensional (Facione, 1990), suggesting that it is comprised of not only dispositions but also cognitive skills and strategies. As a result, scholars argued these skills could be taught and assessed. This new definition moved critical thinking from a theoretical position to an empirical one--i.e., one that researchers could measure. Table 1 outlines the most prominent of these definitions. For the purposes of this study, the most appropriate definition is Facione's (1990), in which he recognizes both the dispositional and cognitive dimensions of critical thinking.

Table 1

Definitions of Critical Thinking

Theorist	Definition
Siegel (1980)	An "ability to assess claims and make judgments on the basis of reason, and who understands and conforms to principles governing the evaluation of the force of those reasons" (p. 8).
Sternberg (1986)	The "mental processes, strategies, and representations people use to solve problems, make decisions and learn new concepts" (p. 3).
Facione (1990)	Theoretically as "an argument or set of statements, one of which forms a conclusion implied or justified by the others" and operationally as "development and evaluation of arguments" (p. 275).
Pascarella and Terenzini (1991)	An "individual's ability to do some or all of the following: identify central issues and assumptions in an argument, recognize important relationships, make correct inferences from data, deduce conclusions from information or data provided, interpret whether conclusions are warranted based on given data, evaluate evidence or authority, make self-corrections, and solve problems" (p. 118).
Ennis (1992)	"Reasonable, reflective thinking that is focused on deciding what to believe or do" (p. 14).
Lipman (1995)	"Skillful, responsible thinking that facilitates good judgment because it relies upon criteria, is self-correcting, and is sensitive to context" (p. 39); advocates cultivating cognitive skills.
Paul, Elder, & Bartell (1997)	Strong critical thinking in which an individual has developed self-criticism, an ability to construct strong opposing positions, and ability to reason dialectically and multi-logically.
Halpern (1998)	The "use of those cognitive skills or strategies that increase the probability of a desired outcome...Critical thinking is purposeful, reasoned, and goal-directed" (p. 450).

A second disagreement exists among critical thinking scholars that is more relevant to the investigation and application of critical thinking in educational settings. Scholars have disagreed about whether students learn critical thinking skills as a generalized cognitive skill or as subject-specific knowledge. Specifically, critical thinking includes a spectrum of skills that "permit individuals to process and use new information and communicate effectively; reason objectively and draw conclusions from various types of data; evaluate new ideas and techniques efficiently; become more objective about beliefs, attitudes, and values; evaluate arguments and claims critically; and make reasonable decisions in the face of imperfect information" (Michael, 1975a, as cited in Pascarella & Terenzini, 1991, p. 114-15).

However, based on contrasting research, Pascarella and Terenzini (1991) have suggested that subject-specific knowledge, rather than generalized cognitive skills, forms the baseline of intellectual structure critical to the formation of advanced critical thinking skills. Winter, McClelland, and Stewart (1981) concur, and their study on the integration of content indicated a statistically significant relationship between the integration of course materials and the development of critical thinking skills. Experts from the APA panel, in a report written by Facione (1990), argued that critical thinking consists of more than generalized cognitive skills; in fact, they argued that subject-specific knowledge contributes to effective critical thinking. Specifically, they argued that one must understand the specific norms and practices within a domain to effectively engage in critical thinking. Furthermore, they acknowledged that the function of a liberal arts degree is to develop background knowledge to serve as a foundation for critical thinking. This disagreement is especially salient to the role of critical thinking in higher education because students pursuing liberal arts degrees must be prepared to work in a variety of career fields and apply critical thinking skills acquired across a variety of academic domains.

Critical Thinking in Higher Education. Critical thinking is a central goal of education (Giancarlo & Facione, 2001). However, Resnick (1987) argued that, as school exists now, it is difficult to embed critical thinking skills into formal classroom instruction. Resnick further argued that because of the (a) "ever-expanding enterprise of schools" (p. 16) and (b) the new, economic value of education, students learn in a vacuum, independent of socialization, tools, and field-specific knowledge, which makes traditional classroom learning an ineffective tool for fostering critical thinking. Other problems associated with attempting to embed the teaching of critical thinking skills within the traditional classroom setting include (a) the use of didactic approaches in current higher education instruction, even when learning occurs in small groups; (b) academic work is often completed individually and expert practices are taught without explanation and in isolation from the course content; and (c) large, lecture-style classrooms are not conducive to deep learning (Terenzini & Pascarella, 1991).

Resnick (1987) has argued that the most effective way to develop critical thinking skills in students is to engage them in intellectual work that includes reasoning and reflection, with reflection defined as "the process which underlies the ability of learners to compare their own performance, at both micro and macro levels, to the performance of an expert" (as cited in Collins, Brown, & Newman, 1988, p. 3). Terenzini and Pascarella (1991) agreed, further suggesting that being a member of a collegiate environment with opportunities to engage with faculty members leads to intellectual development. Critical thinking is essential for students because it allows students to think logically, make decisions, learn to frame problems, and solve problems--each of which is a core cognitive strategy identified by Facione (1990). In other words, when students think critically, they form judgments and then challenge their assumptions. In closing, Sternberg (1986) argued that making critical thinking a focus of post-secondary education is essential because critical thinking influences all domains of life, including society, science, the social sciences, education, and work.

Critical Thinking and 21st-Century Work. Participation in a global, democratic society is predicated on the members of its population possessing the ability to think critically.

Walters (1986) described the importance of critical thinking in achieving and maintaining an effective and just social system:

> First, public policy is made by an informed and educated citizenry, which has carefully evaluated a variety of opposing arguments and viewpoints before coming to its collective decision; second, that alternative perspectives are examined with an open-minded tolerance, even if not ultimately agreed with. (p. 234)

The ability to think critically is essential to the survival of a democratic society that is inclusive and can successfully and peacefully resolve disagreements created by fear, mistrust, and cultural differences.

However, critical thinking is not only important for the successful functioning of a global democratic society; it is also important for 21st-century work. According to Nussbaum (2004), a global world demands “a world community to work on the solutions to urgent problems” (p. 44). Work in the 21st-century is carried out in a global, technologically diverse world. This type of world creates the need for thinking that exists beyond rote memorization of facts. Nussbaum further argued that critical thinking skills are necessary in order to successfully communicate ideas and to manage changes related to diversity and interconnectedness both quickly and effectively. The skills to participate in a global world cross the boundaries of difference and require adaptation, whether in the workplace, community, or other areas of social life.

According to Islam (2016), critical thinking skills in the workplace are the foundation of science, essential to promoting creativity and enhancing language skills. The American Association of Colleges and Universities (AACU, 2007) reported that 81% of employers believe that critical thinking is an important learning outcome for college students; however, the AACU report unfortunately also indicated that only 6% of college seniors had demonstrated proficiency in critical thinking skills and that only a slightly higher percentage were prepared to participate in a global workforce. Because an increasingly higher percentage of the workforce holds bachelor's degrees, which has led to a more competitive workforce (Brundage, 2017), exhibiting critical thinking skills for college graduates is becoming more crucial than ever.

Assessment of Critical Thinking. Several assessments have been developed to measure critical thinking skills as well as the attitudes necessary for critical thinking. One such assessment is The California Critical Thinking Disposition Inventory (CCTDI), developed by Facione and Facione (1992), which measures the use of specific critical thinking attributes. These attributes, which include items such as asking questions, non-judging and acknowledging biases, capacity to engage in transfer and analysis, self-confidence in one's thinking skills, and reliability were found to be significantly related to openness to experience and ego-resiliency, a concept defined by Block and Block (1980) as one of resourcefulness, flexibility, and engagement with one's environment. Using the CCTDI, Colucciello (1999) reported that the learning styles (defined as the way meaning is made and knowledge is constructed) of 100 senior baccalaureate-nursing students were not significantly related to critical thinking dispositions; however, Colucciello also reported that a self-reflective learning style was significantly correlated with self-confidence and open-mindedness. Laird (2005) later found that students who participated in at least one diversity course scored significantly higher on the CCTDI than their peers who did not participate in a diversity course. Also, perhaps not surprisingly, participation in the diversity course was significantly correlated with self-confidence and open-mindedness. These findings are important because work in the 21st-century requires "global knowledge and habits of self-criticism" (Nussbaum, 2004, p. 42).

In addition to the CCTDI that measures dispositions, other methods of assessment also have been created to measure abilities and strategies associated with critical thinking skills, such as problem solving and analysis. These include the Cornell Critical Thinking Tests (Ennis et al., 1971) and The Watson-Glaser Critical Thinking Appraisal (Watson & Glaser, 1980). King, Wood, and Mines (1990) found a significant correlation between the two tests when completed by freshmen and seniors. While these methods of assessment have been found to measure skills and strategies associated with critical thinking, they are based on the assumption that there is a correct answer to every problem on these assessments. However, some problems are more complicated than others, and a multiple-choice response cannot always capture the variety of responses that may result from approaching the problem from different perspectives (Sireci & Zenisky, 2006).

Theoretical Framework

The theoretical framework for this research study consists of three essential components: (a) engagement, (b) high-impact practices, and (c) critical thinking. Each of these concepts is described in the sections that follow.

Assuming that one can teach critical thinking skills and strategies to students, and assuming that students have the attitudinal disposition to think critically, it then becomes important to understand how students engage as they develop critical thinking skills. Engagement is derived from a constructivist theory of learning, which suggests that individuals construct meaning from the various ways in which they engage in activities that lead to desired learning outcomes. In their efforts to develop and expand constructivist learning theory, Astin (1984), Chickering and Gamson (1987), and Kuh (1991) all argued that the more individuals engage, the more they learn. They further argued that learning is influenced by participation in specific, educationally purposeful activities that have been empirically and positively linked to desired learning outcomes. Therefore, engagement in these specific types of educational activities can lead to critical thinking. However, several fundamental assumptions of engagement must be met for the development of critical thinking to occur. Pomerantz (2006) identified the following fundamental assumptions:

1. "Learning is preeminent" (Pomerantz, 2006, p.141). The purpose of participation is to improve learning outcomes. Therefore, the goals of every educational activity must first focus on the desired learning outcomes.
2. "Learning requires action on the part of the learner and results in change to that learner" "Pomerantz, 2006, p. 141). Engagement is the active participation by students in the learning process and is central to the idea of developing critical thinking.
3. "Similar types of learning occur throughout campus, both inside and outside the classroom" (Pomerantz, 2006, p. 141). As long as students engage in educational activities, learning will occur.
4. "Students engage in a series of behaviors in the process of achieving those learning outcomes" (Pomerantz, 2006, p. 141). These behaviors include self-reflection, and the motivation to use the skills, strategies, and attitudes they have been taught throughout their educational experience.

High-Impact Practices. As a result of the research that has been conducted on engagement, Kuh (2008) identified co-curricular and curricular activities that would improve student-learning outcomes identified as important by employers, faculty members, and accreditation agencies. The desired learning outcomes that Kuh and others focused on included critical thinking, global awareness, personal responsibility, and social responsibility. The activities in which students engaged that could lead to these outcomes became known as high-impact practices (Kuh, 2008). High-impact practices are educationally purposive activities, and through effective high-impact practices, Kuh argued that students are better able to understand the relationship between educational coursework and the workplace environment, a core outcome of utilizing critical thinking skills. Therefore, the primary purpose of high-impact practices is consistent--i.e., teaching students how to critically think by engaging in educationally purposeful activities.

What are high-impact practices? Kuh (2008) identified 10 different types of high-impact practices. One example of a high-impact practice is writing-intensive courses, the focus of which is to provide writing instruction that develops argumentative and communication skills while also allowing students to be creative and take ownership of their writing. Many writing-intensive courses focus on work-related writing, teaching students how to write in a variety of styles (Grzyb, Snyder, & Field, 2018; Leggette, McKim, Homeyer, & Rutherford, 2015).

A second example of a high-impact practice are learning communities (Kuh, 2008). Learning communities are comprised of two or more thematically similar courses in which a cohort of students studies interdisciplinary content from multiple perspectives. These theme-based courses focus on helping students with self-expression and understanding the perspectives of others. Additional examples of high-impact practices similar in nature to learning communities include common intellectual experiences, collaborative learning, and diversity and global learning studies (Kuh). In addition to these thematically similar high-impact practices, other examples of learning communities include residential programs that feature out-of-class activities as well as learning communities organized around student attributes, such as academic majors, or historically underrepresented groups (Tinto, 2003; Zhao & Kuh, 2004).

Other high-impact practices include first-year experiences, service and community-based learning, and internships (Kuh, 2008). These practices often reflect similar collaborative and experiential approaches to learning as well as exposure to diversity and self-reflection (Bringle & Hatcher, 1996; Chizhik, 1998; Felten & Clayton, 2011; Smith & Wertlieb, 2005). A final example of a high-impact practice is undergraduate research programs. Undergraduate research programs seek (a) to bridge curricular and co-curricular opportunities with career preparation and graduate school as well as (b) to improve learning outcomes that are associated with participation in high-impact practices (Beckman & Hensel, 2009; Zydney, Bennett, Shahid, & Bauer, 2002).

Characteristics of high-impact practices. High-impact practices display six specific characteristics that foster critical thinking, global awareness, and personal and social responsibility. According to Kuh (2008), these characteristics include (a) substantial time and engagement, (b) significant interactions with faculty members and mentors, (c) increased exposure to diversity, (d) frequent feedback, (e) opportunities to work in diverse settings, and (f) opportunities to engage in life-changing activities.

The first characteristic of high-impact practices is substantial time and engagement. Kuh (2008) found that students achieved improved learning outcomes when they participated in high-impact practices for a greater length of time. For example, in their study on alumni perceptions of their academic experiences, Bauer and Bennett (2003) indicated that the more time alumni reported participating in research activities, the greater the benefit they perceived. However, operational definitions as well as the precise characteristics and activities that constitute "substantial time" and "engagement" have not been fully agreed upon among researchers. Nevertheless, studies on high-impact practices and outcomes have consistently reported favorable results, regardless of whether students participated in these activities during the summer, during a semester, or during an entire academic year; therefore, it has been difficult to define precisely the characteristics and activities that constitute “substantial time” and “engagement.”

The second characteristic of high-impact practices is significant interactions with faculty members and mentors. Interactions with faculty members and mentors have been one of the most frequently investigated characteristics of high-impact practices, and they are positively related to improved learning outcomes (Cuthbert, Arunachalam, & Licina, 2012; Guinness, 2012; Horowitz & Christopher, 2013). This particular high-impact practice provides an especially robust opportunity for students to engage with faculty members in small-group settings focused on specific content areas, and it allows students to develop meaningful relationships that can link to later opportunities. This community of practice approach to high-impact practices suggests that students who interact with experts in a shared domain during an extended period of time eventually become experts (Lave & Wenger, 1991).

The third characteristic of high-impact practices is that they must create a learning environment where students are exposed to diversity. While underrepresented groups experienced greater benefits after participating in high-impact practices, Kuh (2008) found that these groups were less likely to participate in high-impact practices. Finley and McNair (2013) extended Kuh’s findings to the participation of specific underrepresented groups and found that African American students did not engage in high-impact practices as frequently or as long as their traditionally represented peers. According to Brownell and Swaner (2009), the reasons are unclear why some groups experienced high-impact practices differently than did others, although the environment seems to play a role. Researchers have confirmed that high-impact practices provide opportunities for students to engage with individuals who are different and therefore bring unique perspectives to the conversation, such as students, faculty members, and peers with diverse backgrounds as well as community organizations. This exposure provides opportunities to think differently about circumstances and characteristics that constitute problems, the nature of problems, and creative methods of solving problems.

The fourth characteristic of high-impact practices is frequent feedback. Feedback provides a communication loop in which students can receive feedback from a variety of sources as they participate in high-impact practices. Frequent feedback provides multiple opportunities for students to reflect on their work and to make immediate adjustments as needed. Frequent feedback is also important because it can affirm, negate, or redirect the path that students take. However, while much of the research literature on high-impact practices has suggested that frequent feedback is critical to the success of students, these studies also have failed to capture the more specific mechanisms by which feedback influences student outcomes. When these mechanisms were generally indicated, they were most frequently found in writing-intensive courses as a component of the course (Bourelle, 2015; Nussbaum et al., 2018; Trojan, Meyers, & Hudson, 2016).

The fifth characteristic of high-impact practices is that they offer students opportunities to work in diverse settings. This characteristic allows students to build deep and meaningful learning experiences as well as critical thinking skills. Found most often within service learning, internships, first-year experiences, and opportunities to work in diverse settings, these high-impact practices (a) deepen connections between students, their community, and their learning (Young & Maley, 2018); (b) deepen their understanding of transnational social movements (Anderson, 2017); and, according to Hackett (2016), (c) allow them "to observe the collective categories of learners in order to support and encourage students to explore their social experiences in ways that are racially inspiring and liberating" (p. 1). These diverse settings provide students with opportunities not only to learn how to adapt to different environments but also how to apply the skills they have learned within these different settings. Diverse settings also offer students new and different perspectives that can challenge their assumptions and commonly held beliefs.

The sixth characteristic of high-impact practices is that they should be life-changing. Studies on high-impact practices have indicated that when students participated in internships related to their academic fields of study, their perceptions of their leadership skills improved as well as their interpersonal skills and ability to work in a group setting (Duncan, Birdsong, Fuhrman, & Borron, 2017; Marsh et al., 2016). For high-impact experiences to be life-changing, they should help students learn more about themselves, help students learn more about the values that are important to them, and present opportunities to participate in experiences that benefit individuals who are different from them. High-impact practices that are life-changing help students develop a perspective about their role in the global world as well as their responsibility to improve society.

Assessment of high-impact practices. In 2001, the first survey of college student engagement was released: The National Survey of Student Engagement (NSSE). The NSSE survey asks students to indicate how much time they spend engaging in specific activities. It also measures students' perceptions of the campus environment in different areas (e.g., intellectual challenge, involvement in diverse and enriching educational experiences, the degree to which they engage in active and collaborative learning) as proxies for their participation in high-impact practices. The activities identified by the NSSE survey form the foundation of the most commonly measured "Benchmarks of Effective Educational Practice" (Pascarella, Seifert, and Blaich, 2009, p. 5).

Several studies sought to validate the benchmark indicators of the NSSE against measures of student learning. Carini, Kuh, and Klein (2006) sought to determine the relationship between NSSE benchmark items and academic performance, as measured by the RAND and GRE. They reported a statistically significant correlation between higher-order thinking and performance on the RAND and GRE. They also reported a series of behaviors significantly correlated with RAND scores. For example, receiving prompt feedback from faculty members was partially and significantly correlated with RAND scores both for first-year students and seniors. In a study conducted in 2008, Pascarella, Seifert, and Blaich sought to validate the NSSE by estimating the extent to which the NSSE can predict student change across time (2009). In this study, Pascarella et al. used data from 1,426 first-year students who also participated in the Wabash National Study of Liberal Arts Education (WNSLAE), which assessed critical thinking skills, among other traits and skills that have been associated with a liberal arts education.

Campbell and Cabrera (2011) tested the construct validity of NSSE benchmark indicators and found that the NSSE benchmark indicators lacked reliability and validity as indicators of engagement. Campbell and Cabrera conducted a confirmatory factor analysis and reported that the five benchmark indicators were not independent measures of engagement. However, their analysis did indicate that the five benchmark indicators were interrelated. Campbell and Cabrera also reported that of the five benchmark indicators, "enriching educational experiences" was the only indicator that had a statistically significant effect on cumulative GPA.

In addition to Campbell and Cabrera's (2011) work, other researchers also have noted problematic concerns related to the validity of the NSSE as a measure of engagement. More specifically, Porter (2011) argued that many of the items on the NSSE have not been empirically linked to theory and that the constructs have not been independently confirmed as being related to engagement. Porter argued that items on the NSSE are subject to interpretation by respondents and questioned the reliability of student self-reported responses. Despite uncertainty about whether engagement is significantly related to learning outcomes, the NSSE is still one of the primary measures of engagement.

Relationships among Engagement, High-Impact Practices, and Critical Thinking

High-impact practices are educationally purposive activities that have been positively linked to improved learning outcomes. However, improved learning outcomes require that students be actively engaged in the process of learning and therefore the onus of learning is placed on the student. In attempts to link engagement to student outcomes, researchers began to develop measures of accountability. A review of the literature on high-impact practices suggests that (a) critical thinking skills improve after students participate in high-impact practices and (b) the ways in which students engage in specific high-impact practices differ across the various types of high-impact practices.

Scholars have argued that critical thinking skills improve after students participate in high-impact practices. Zilvinskis, Masseria, and Pike (2017) reported that engagement in high-impact practices was positively correlated to student self-reported learning gains. Tsui (1999) also reported that critical thinking was a positive outcome of participation in a high-impact practice. Specific to high-impact practices, Kilgo, Ezell Sheets, and Pascarella (2015) reported that critical thinking was significantly correlated with participation in undergraduate research but was not with to participation in other types of high-impact practices. In addition, Gellin's (2003) meta-analysis of high-impact-type practices did not indicate a significant correlation between faculty interactions on critical thinking skills (Gellin, 2003). However, research studies indicating relationships between high-impact practices and critical thinking have been sparse.

However, considering GPA, retention, and graduation as proxies of learning, slightly more evidence exists to suggest that a relationship between these variables and high-impact practices does not exist. For example, Johnson and Stage (2018) reported (a) no correlation between high-impact practices and four-year graduation rates when institutional selectivity types (most selective, moderately selective, and least selective) were aggregated and a (b) statistically significant negative correlation between student participation in high-impact practices (freshman seminar, learning community, and group work) and six-year graduation rates for most selective institutions. Webber, Krylow, and Zhang (2013) found that participation in research/capstone projects was not statistically significantly correlated with cumulative GPA during either freshman or senior years. Acknowledging that most research reports have not indicated that high-impact practice play a statistically significant role in higher education, Kuh and Kinzie (2018) argued that these practices first must be implemented effectively, and in return, they will exert an evidence-based statistically significant influence on all students. Kuh and Kinzie noted that the fidelity with which high-impact practices are implemented is critical in providing specific learning environments that will foster student engagement. If these high-impact practices are not implemented with fidelity, the results may lead to research studies in which high-impact practices are shown to be ineffective.

The different ways in which students engage in specific high-impact practices differ across the various types of high-impact practices. For example, service-based and community learning have been classified as field-based learning--i.e., learning in which students partner with community organizations to apply what they have learned in classrooms to real-world applications (Alderton & Manzi, 2017; Brown, 2017). Young and Maley (2018) argued that the purpose of these types of programs is to deepen the connection between classroom learning and the service-learning experience. However, in contrast to non-classroom-based high-impact practices, writing-intensive courses focus on learning within the classroom. Within writing-intensive courses, students engage differently. For example, some writing-intensive courses focus on application to real-world problems (Bourelle, 2015; Snyder, Nielson, & Kurzer, 2016), while other writing-intensive courses focus on scientific writing to build argumentative skills (Trojan, Meyers, & Hudson, 2016; Welsh, Shaw, & Fox, 2017). Similarly, undergraduate research also provides opportunities for students to learn argumentative skills while providing them opportunities to engage with actively contested questions and use empirical methods to solve important problems.

Interdisciplinary high-impact practices include learning communities and first-year seminars and experiences. These types of high-impact practices focus on engagement across common themes and are found in residence halls, academic departments, and honors programs. According to Matthews et al. (1996), learning communities consist of two or more interdisciplinary courses that bring together students who hold diverse perspectives. In contrast, first-year seminars and experiences provide students with opportunities to participate in small-group discussions but are often focused on the development of skills and competencies necessary for their continued success. While learning communities can occur at any time during students' time on campus, Kuh, Cruce, Shoup, Kinzie, and Gonyea (2008) found that seniors participated in learning communities at a higher rate than did first-year students. Despite differences in the type of high-impact practices in which they participated, students still perceived and experienced greater personal gains and learning outcomes after participation (Finley & McNair, 2013; Kuh, Cruce, Shoup, Kinzie, & Gonyea, 2008; Zilvinskis, Masseria, & Pike, 2017). The relationship between critical thinking, engagement, and undergraduate research programs is less clear. While undergraduate research programs have been positively correlated with critical thinking, engagement is predicated more specifically on the manner in which students participate in activities (Kilgo, Ezell Sheets, & Pascarella, 2015). Collectively, the results of these research studies suggest that while institutions have implemented high-impact practices, they have designed and implemented them differently, and as a result, students engage in them differently.

Undergraduate Research Programs

The first structured undergraduate research program in the United States can be traced to the Massachusetts Institute of Technology (MIT) in 1969. Future programs were slow to develop, but the California Institute of Technology developed the Summer Undergraduate Fellowship program in 1979, followed by the National Science Foundation Research Experiences for Undergraduates (REU) program in the 1980s. In 1984, a group of chemistry professors interested in undergraduate research founded the Council on Undergraduate Research (CUR), and by 1987, the National Conference on Undergraduate Research (NCUR) hosted its first annual conference for undergraduates. A merger of CUR and NCUR was completed in 2011, creating an organization that (a) directly engaged with students in their undergraduate research programs and (b) brought together faculty members and students from STEM disciplines and non-STEM disciplines to collaborate and conduct scholarship. CUR (2012, as cited in Rowlett, Blockus, & Larson, 2012) has defined “undergraduate research” as “an inquiry or investigation conducted by an undergraduate student that makes an original intellectual or creative contribution to the discipline” (p. 2). Undergraduate research programs have been further conceptualized as a student-focused way of bringing research and teaching together, with students actively involved in the production of knowledge (Brew, 2013, p. 604). Because undergraduate research programs have become increasingly common and are integral to student success, a shift has occurred from faculty-led research to student-driven research. Willison and O'Regan (2007) suggested that this shift actually exists on a continuum and covers all scholarly activities in which students may engage. However, because definitions of undergraduate research programs exist on a continuum, the precise activities, policies, and procedures that constitute undergraduate research programs have been difficult to identify and measure.

Types of Undergraduate Research Programs. Scholars have identified different types of undergraduate research programs (Kremer & Bringle, 1990; McDorman, 2004; Multhaup et al., 2010). Kremer and Bringle (1990) defined three types of undergraduate research programs: (a) a teaching type, (b) a technician type, and (c) a colleague type. McDorman (2004) identified three types of undergraduate research programs: (a) a faculty-driven type, (b) a faculty-modeled type, and (c) a student-driven type. Finally, Multhaup et al. (2010) also identified three types of undergraduate research programs (a) a traditional type, in which students assist with the research of a specific faculty member; (b) a consultant type, in which highly motivated students engage in projects supervised by a faculty member; and (c) a joint-creation type, in which faculty members and students work together on a research project of joint interest. While these authors noted different titles for each of the types of undergraduate research programs, similarities in the characteristics they describe exist across the different types (see Table 2).

Table 2

Types of Undergraduate Research Programs

Faculty-led Programs	Student-driven Programs	Faculty-mediated Programs
Technician type (Kremer & Bringle, 1990)	Colleague type (Kremer & Bringle, 1990)	Teaching type (Kremer & Bringle, 1990)
Faculty-driven (McDorman, 2004)	Student-driven (McDorman, 2004)	Faculty-modeled (McDorman, 2004)
Traditional type (Multhaup et al., 2010)	Consultant type (Multhaup et al., 2010)	Joint creation type (Multhaup et al., 2010)

The first type of undergraduate research program is the faculty-led research program. These undergraduate research programs often include a range of activities and a range of mentorship responsibilities. While some scholars have argued that students lack sufficient scholarly breadth and depth to contribute substantively to faculty-led projects and that large amounts of time must be devoted to developing students' research abilities (Gates, Teller, Bernat, Delgado, & Della-Piana, 1998), students are still qualified to participate in a wide swath of activities when working on these projects. Faculty-led undergraduate research programs typically exhibit the following characteristics: (a) the research questions and projects are already clearly defined, (b) the project is controlled by a faculty member, and (c) outcomes are generally focused on project outcomes and not outcomes as they relate to student participation. Even though these research projects can be sophisticated and complex, students can still actively participate in them. Multhaup et al. (2010) argued that students can (a) conduct in-depth literature reviews in which they identify relevant literature and synthesize it according to its relevance to the project at hand, (b) collect and analyze data and make judgments about the evidence or the lack thereof, (c) prepare manuscripts for publication and thus contribute to the creation of new knowledge, (d) receive critiques of their work that lead to opportunities for self-reflection, and (e) learn the process of scientific investigation and in so doing become future expert members of their respective content-specific disciplines. The skills they learn can be identified as critical thinking skills, and after developing these skills, students can apply them in other areas of life.

The second type of undergraduate research program is the student-driven undergraduate research program. Student-driven undergraduate research programs are programs of research fully designed and conducted by students. Students maintain autonomy and control over the direction of their projects, are responsible for completing their projects, and are responsible for dissemination efforts. Faculty members serve as advisers to students, providing feedback throughout their projects and acting as conduits to other faculty investigators with common research interests (Linn, Palmer, Baranfer, Gerard, & Stone, 2015). In this type of undergraduate research program, students present the results of their research efforts at conferences and other forums for critique. Examples of this type of undergraduate research program include capstone projects and honor college experiences. Access to these selected programs typically is limited, and participation is highly competitive (Cartrette & Melroe-Lehrman, 2012; Falconer & Holcomb, 2008; Garcia & Wyels, 2014; Kobulnicky & Dale, 2016; Kolber, Janjic, Pollock, & Tidgewell, 2016).

The third type of undergraduate research program is the faculty-mediated research program. This collaborative approach to undergraduate research programs is often developed as a course-based undergraduate research experience (CURE) in which faculty members and a team of students work together to develop and complete research projects. Provost (2016) contended that course-based programs enable more students to participate, thereby broadening the participation of students in undergraduate research experiences, even in the face of limited resources, such as faculty time. Examples of large-scale CURE-designated programs include the Genomics Project (Burnette & Wessler, 2013; Harrison, Dunbar, Ratmansky, Boyd, & Lopatto, 2011; Jordan et al., 2014) and projects funded by the Howard Hughes Medical Institute (Kozeracki, Carey, Colicelli, & Levis-Fitzgerald, 2006; Maton, Domingo, Stolle-McAllister, Zimmerman, & Hrabowski, 2009). Despite the prevalence of these types of programs, Spiro, Feltovich, Jacobson, and Coulson (1991) argued that situating these research programs within courses is dangerous because they are "highly decontextualized" and that "simplified knowledge promotes understanding that is rigid, incomplete and naïve" (as cited in Choi & Hannafin, 1995, p. 53).

Minimal scholarship has been conducted evaluating differences in the types of undergraduate research programs. Research studies on undergraduate research programs in STEM disciplines were abundant in the research databases. However, studies in which researchers measured characteristics of specific types of undergraduate research programs have been conducted infrequently. Linn, Palmer, Baranger, Gerard, and Stone (2015) reviewed studies of student-driven research programs and faculty-mediated experiences in STEM disciplines and reported that when students engaged in student-driven programs, they were more likely to persist and continue to graduate school than students who participated in faculty-mediated programs. Linn et al. argued that these findings were the result of students' identifying as scientists and feeling like they were members of the research community. In a similar study, Gilmore, Vieyra, Timmerman, Feldon, and Maher (2015) interviewed participants in student-driven programs, and students responded positively in response to the opportunity to lead their own research. Students reported that "it was a really great experience..." and "it was a completely independent study… I learned so much" (Gilmore, Vieyra, Timmerman, Feldon, & Maher, 2015, p. 850). In a study in which students participated in a collaborative research program, Stoeckman, Cai, and Chapman (2019) found that students experienced learning gains in several areas, including understanding how scientists think, understanding laboratory techniques, and interpreting research results. In another CURE study, Brownell et al. (2015) asked students what it means to think like a scientist and identified themes (e.g., using the scientific method, developing hypotheses, being skeptical of data) among students' responses. These themes included "thinking critically and thinking through all possibilities" as well as being "skeptical and critical of data" (Brownell et al., 2015, p. 33). In this study, Brownell et al. (2015) also reported a significant positive change across several of the identified themes when analyzing students' responses from the beginning of the course to the end of the course. Students can actively participate in these types of undergraduate research programs by engaging in diverse learning teams, building upon pre-existing knowledge to advance new questions, actively questioning each other, and displaying openness to different ideas and ways to proceed. It is critical within this type of undergraduate research program that all students actively participate to maximize their learning and reduce free-rider effects.

While research studies have been conducted primarily on undergraduate research programs in STEM fields, research studies on undergraduate research programs in non-STEM disciplines have been conducted less frequently. Even though many of the research studies on undergraduate research programs in non-STEM disciplines included limited information about the type of program students participated in (e.g., faculty-led, student-led, etc.), detailed information was frequently omitted, such as (a) the levels of autonomy the students' experienced, (b) opportunities for students to contribute to the project in an original or meaningful way, and (c) the role the student played in the research program (Casey, Wormington, & Oleson, 2012; Cuthbert, Arunachalam, & Licina, 2012; Fair, 2007; George, 2012; Guinness, 2012; Kruse & Taylor, 2012; Mace, Woody, & Berg, 2012). For example, Kruse and Taylor (2012) sought "to discuss pre-service teachers' perceptions of the benefits and challenges surrounding their involvement in a faculty-led qualitative research study" (p. 38). In research studies where research questions were not available, but enough information was available to ascertain whether students or faculty members led the project, these studies focused more on the actual outcomes of the project rather than outcomes related to student participation or who led the project (Guinness, 2012; Pyne, Scott, O'Brien, Stevenson, & Musah, 2014).

However, in one instance, a study by Wollschleger (2019) identified three key points related to the type of undergraduate research program in which students engaged. First, based on course evaluations, Wollschleger reported that students in a sociology course increased their methodological competence after participating in a faculty-mediated project. Secondly, he reported a statistically significant difference in students' course evaluations in multiple areas from the first year to subsequent years as he revised the course (e.g., connections between course assignments and objectives, the degree to which students learned the course content, the extent to which course objectives were met). Third, he found that students responded positively when asked to describe their activities and how they engaged with community organizations. The students said they "loved how practical this work was and that someone is benefiting from our work…" and "working with an actual organization made it real" (Wollschleger, 2019, p. 321). This study is important because it supports the argument that undergraduate research programs in the non-STEM disciplines have many different characteristics (e.g., they engage in community-based projects, they employ collaborative approaches, they engage in quantitative research, etc.), and it is important to treat them differently than undergraduate research programs in STEM disciplines.

Davis and Wagner (2019) reported that motivation was a factor in predicting the reasons why students in STEM disciplines and students in non-STEM disciplines participate in research. For example, students in STEM disciplines were motivated by intellectual interest, while students in non-STEM disciplines were motivated by sheer determination. While Davis and Wagner declined to expand on the nature of these results, they suggested that differences in students' motivation for conducting research vary by discipline. However, the absence of research on undergraduate research programs within non-STEM disciplines makes it difficult to identify the differences that exist between undergraduate research programs in STEM disciplines and non-STEM disciplines. Within the research studies that have been conducted, the characteristics of the approaches are treated as extraneous variables, irrelevant to the outcomes of the study. Therefore, because existing research has failed to adequately explore the characteristics of undergraduate research programs within the non-STEM disciplines, these characteristics must be operationalized so that researchers can assess the relationship between undergraduate research program characteristics and outcomes.

Outcomes Associated with Participation in Undergraduate Research Programs. Providing undergraduate research programs has been considered an effective high-impact practice because these programs have been shown to increase student retention, graduation rates, engagement, teamwork, communication skills, and critical thinking skills (Kuh, 2008). Other positive outcomes that have been associated with student participation in undergraduate research programs include preparing students for graduate school and careers in their chosen fields (Bauer & Bennett, 2003; Kremmer & Bringle, 1990; Russell, Hancock, & McCullough, 2007), increased

GPA and increased graduation rates (Kinkel & Henke, 2006), improved critical thinking skills (Bauer, 2001; Hunter, Laursen, & Seymour, 2008), improved interpersonal and intrapersonal skills (Bauer & Bennett, 2003; Hunter et al., 2008; Seymour et al., 2004). Further outcomes of participating in undergraduate research programs include students expressing gratitude for the experience of working on research projects and reporting the research experience to be very instructive (Althubaiti, 2015; Hurd & Vincent, 2006; Jaarsma et al., 2009), disseminating the results of research projects, and mentoring (Brewer, Dewhurst, & Doran, 2012; Horowitz & Christopher, 2013; Kruse & Taylor, 2012; Potter, Abrams, Townson, Williams, & Wake, 2010; Pyne, Scott, O'Brien, Stevenson, & Musah, 2014; Singer & Zimmerman, 2012). These outcomes are applicable across all disciplines, including STEM disciplines and non-STEM disciplines. However, much of the available research on undergraduate research has been conducted within STEM disciplines.

Studies within STEM disciplines have investigated specific topics related to participation in undergraduate research programs, including career and graduate school pathways, critical thinking skills, research skills, and overall student engagement and participation. Lopatto (2007) reported that participation in an undergraduate research program increased the interest of students in STEM disciplines in attending graduate or professional school after their undergraduate studies. Lopatto reported that 87% of respondents planned to further their STEM education, while only 4.5% planned to discontinue future STEM studies. Taraban and Logue (2012) also reported that a large number of students participating in STEM CUREs were more likely to be motivated to attend graduate schools or other professional schools after graduation. Within STEM disciplines, Brownell and Kloser (2015) identified critical outcomes as the ability to think like a scientist and the ability to use the tools of scientists. Likewise, Dolan and Johnson

(2010) reported links between participation in undergraduate research programs and the development of research skills and academic literacy, and Taraban and Logue (2012) found that students in STEM disciplines reported higher self-efficacy as a result of prior academic successes.

In addition to positive outcomes associated with participation in undergraduate research programs within STEM disciplines, researchers also have reported positive outcomes associated with participation in undergraduate research programs within non-STEM disciplines. For example, Partridge and Sandover (2010) measured creative and intellectual contributions to research and reported that students acquired skills that were not anticipated, such as the ability to solve problems and learn independently. Cooley, Garcia, and Hughes (2008) reported that students within social science disciplines favored participating in integrated research projects through their coursework and in-class projects more than participating in paid and volunteer research programs. Fechheimer (2011) used institutional data to measure GPA and found that students who participated in an undergraduate research program reported a statistically significant higher GPA than students who did not participate in an undergraduate research program. Caputo's (2013) dissertation looked at engagement of commuter students; Rogers and McDowell (2015) identified completion rates of students who had participated in university-wide research programming using institutional data; and Taraban and Logue (2012) measured student ability as it related to research skills achievement. In each of these studies, researchers found positive outcomes as a result of participating in undergraduate research programs. However, across all of the research studies conducted on undergraduate research programs within non-STEM disciplines, the relationship between these positive outcomes and participation in undergraduate research is unclear due to inconsistencies in how outcomes were defined within the studies, a critical difference between STEM and the non-STEM disciplines.

A lack of clarity about the desired outcomes within studies in non-STEM disciplines limited the usefulness of these studies in terms of reviewing the research literature. For instance, Ciarocco, Lewandowski, and Van Volkom (2013) reported a statistically significant difference in students' attitudes towards statistics as well as their perceptions of their statistical skills between (a) the experimental group after their participation in an experimental research course and (b) the control group that did not participate in the research course. However, the researcher did not provide clarity about how these statistical skills were defined. The research study was unclear in defining "research perceived utility" and "research skills/abilities," which therefore limited the value of the study despite the use of a control group. Downey (2013) provided a table of items used to define and measure students' knowledge of research procedures. Following are two examples of items that measured students' knowledge of research procedures: "The activities of human subjects researchers are carefully monitored by independent parties" and "Human subjects researchers think a lot about the tools…"). However, several of the questionnaire items contained subjective adverbs such as "carefully" or "a lot." Several additional questionnaire items relied on textbook definitions, which only requires students to recall information and does not provide evidence of having developed higher-order thinking skills.

Additional challenges were evident within studies conducted on undergraduate research programs in non-STEM disciplines in terms of the ways in which researchers defined outcome variables. For instance, George (2012); Horowitz and Christopher (2013); and Hostetter, Sullenberger, and Wood (2013) all measured "research skills" but in different ways. George assessed changes in research skills at two points in time using a questionnaire, while Horowitz and Christopher measured "research skills" using student reflections completed at the end of a research methods course. Horowitz and Christopher also assessed growth in research skills using the end-of-course grades. Unfortunately, as Hostetter et al. noted, the grades were not significantly different for the group receiving the intervention, therefore bringing into question the effectiveness of the intervention.

A study conducted by Brewer, Dewhurst, and Doran (2012) provides another example of inconsistency in defining outcomes. These researchers compared student and faculty perceptions of student achievement in several areas (e.g., student preparedness, skill development). They reported statistically significant differences between student perceptions of the research experience and faculty perceptions of the research experience. Specifically, students reported being more prepared to participate in the research experience. However, faculty members reported that students' skills were enhanced through participation in the research experience. Differences in how students and faculty members reported their experiences can be the result of researcher-developed (i.e., non-validated) questionnaires as well as variables that are not clearly operationalized. Therefore, it is critical that questionnaires are included as appendices within research reports for external review and analysis when researchers are using self-designed questionnaires to assess outcomes.

Another challenge associated with studies of undergraduate research programs in non-STEM disciplines is related to the variables that were measured. Throughout studies conducted on undergraduate research program within the non-STEM disciplines, the primary outcomes were student perceptions of their skills and their perceptions of their experiences. Of particular note is the Cooley, Garcia, and Hughes (2008) study measuring favorability of five different types of student participation. Cooley, Garcia, and Hughes found that students who were paid to conduct research and research courses were rated very favorably while in-class projects and research volunteering had the lowest favorable ratings. However, these favorability rankings are not surprising given that paid research work would seem to be preferable over schoolwork among college students. The findings could have been more revealing if the investigators explored specific factors that contributed to these ratings.

In addition, only a small selection of studies reported differences in perceptions at distinct points in time (e.g. T1, T2, T3) (Casey, Wormington, & Oleson, 2012; Downey, 2013; Fair, 2007; George, 2012; McKinney & Busher, 2011; Singer & Zimmerman, 2012; Whipple, Hughes, & Bowden, 2015), and statistical significance was reported only for a small number of studies (Casey, Wormington, & Oleson, 2012; Downey, 2013; Fair, 2007; Singer & Zimmerman, 2012; Whipple, Hughes & Bowden, 2015). For instance, Whipple et al. (2015) reported a statistically significant change in students' self-evaluation of their competencies in three areas: (a) use of statistical software, (b) data entry, and (c) evidence-based practice. Overall, Whipple et al. found that students reported a more positive attitude towards research and perceived that they learned more research skills from the beginning of the course to the end of the course. Another example is a study by Casey et al. (2012), who reported a statistically significant difference in student comfort and confidence in two areas: (a) collecting data and (b) evaluating and providing feedback from T1 to T2.

Of particular note, Singer et al. (2012) compared student responses to a questionnaire at the beginning of a course with their responses to the questionnaire at the end of the course. Questionnaire items focused on student perceptions of attainment of desired course outcomes (e.g. writes clearly, uses discipline-specific language, learns from new information). Singer et al. found statistically significant differences in several areas that are particularly noteworthy because some of the outcome variables included important 21st-century workforce skills (e.g., expressing ideas clearly, bringing new insights to problems, and troubleshooting problems). In contrast to the studies above, a study by Downey (2013) indicated a statistically significant decrease in student performance on a research methods assessment from T1 to T2. The reason for this finding was unknown to the researchers; however, they reported that students completed the research methods assessment one week after the initial lecture, and a noticeable amount of time passed before retaking the research methods assessment in Week 10.

Finally, unclear relationships between the development of critical thinking skills and generalized cognitive knowledge or subject-specific knowledge have influenced the ways in which undergraduate research programs have been implemented in the non-STEM disciplines. Undergraduate research programs function as a form of apprenticeship through which the "learning of skills and knowledge is embedded in the social and functional context of their use" (Collins, Brown, & Newman, 1988, p. 2). Within the STEM disciplines, this relationship is not particularly surprising because researchers have found relationships between participation in undergraduate research and the critical thinking skills required to be successful in the 21st-century workforce. For instance, Banks, Haynes, and Sprague (2009) found that pharmacy students reported obtaining clinical critical thinking skills after participating in a research experience. However, in the non-STEM disciplines, the relationship of critical thinking to undergraduate research is more difficult to ascertain because students engage in research outside the scope of their coursework.

Assessment of Undergraduate Research. Several national surveys have been developed to assess the effectiveness of undergraduate research. One national assessment is The Undergraduate Research Student Self-Assessment (URSSA) (Laursen, Hunter, Weston, & Thiry, 2009). The URSSA measures undergraduate research experiences and pathways for undergraduates that lead to scientific research careers. Specifically, the URSSA utilizes a four-point Likert scale, and items measure student progress toward becoming a scientist, personal/professional gains, and the ability to behave like a scientist. It was designed as an assessment tool to compare programs either within an institution or across multiple institutions (Weston & Laursen, 2017). It does not measure gains in critical thinking skills or how activities involved in research experiences influence student gains. Along with interviews, Thiry, Weston, Laursen, and Hunter (2012) used the URSSA to answer research questions related to professional and intellectual growth among students and differences in how novice and experienced researchers experience undergraduate research. These researchers reported that students who participated in undergraduate research across multiple years experienced growth in their ability to think and work like scientists. Multiple interview responses confirmed this finding; participants reported that “it takes time to develop” and that “at first, [analyzing data] was hard.” (p. 266). Stanford, Rocheleau, Smith, and Mohan (2017) also utilized the URSSA to compare learning gains among students in STEM disciplines with students in non-STEM disciplines. The authors reported no statistically significant differences in learning gains between these two groups.

A second national assessment is the Undergraduate Research Questionnaire (URQ). Utilizing the URQ, Taraban and Logue (2012) reported that GPA was a statistically significant predictor of students’ inclination to participate in research and that students with higher GPAs experienced greater benefits (e.g., development of lab skills, received mentoring from faculty members, development of skills related to the research process) from participation in research programs. However, a large percentage of participants (67%) were enrolled in STEM disciplines and the study was not program-specific, nor did it report on individual outcomes. The Taraban and Logue study is particularly relevant because Taraban and Logue reported a statistically significant difference in research experiences among college majors. They reported that biology students engaged in more research hours, spent more hours in the lab, and had significantly more faculty meetings than psychology students. Taraban and Logue argued that these findings are the result of a commitment to research, although they do not articulate whose commitment (e.g., institution, faculty members, or students).

A final national assessment is the Survey of Undergraduate Research Experiences (SURE), developed by Lopatto (2004). This method of assessment is related to the educational experiences of students in STEM disciplines. In his study, Lopatto found that participants (n = 1135) gained in 20 areas, including the ability to (a) analyze data, (b) understand primary literature, and (c) make assertions requiring supporting evidence. While the participants attended a range of institution types (n = 41), including research institutions (n = 19), more than half of the participants were from Howard Hughes Medical Institute (HHMI) programs, and less than 5% of all participants represented non-STEM disciplines. In his STEM-based survey, Lopatto also reported that 0.4% of all participants indicated they did not plan to enter a non-science career after college, and more than 40% of participants indicated that their career plans included attending medical school or entering a doctoral program in biology. Lopatto concluded that these findings demonstrate that participants responding to this survey are high-achieving students who likely would have reported learning gains without participating in a research program. Although the SURE assessment is used to measure educational experiences of students participating in undergraduate research programs within STEM disciplines, adapting it for use in undergraduate research programs in non-STEM disciplines would require a clear definition of learning gains and the factors that constitute research as they pertain to the non-STEM disciplines.

Methodological Limitations

Several methodological limitations were found in studies within the research literature. In a 2020 article by Haeger et al., the authors found significant gaps existed in the research design of studies on undergraduate research. In addition to the gaps discussed below, Haeger et al. found the majority of articles on assessing undergraduate research focused solely on student outcomes and "only 12% (n = 35) of articles focused on diversity, inclusion, or representation of traditionally underrepresented populations" (p. 65).

First, researcher-developed questionnaires have been the primary instrument used to conduct studies on undergraduate research programs. In some instances, investigators have used open-ended items as a follow-up to these questionnaires (Brewer, Dewhurst, & Doran, 2012; Fair, 2007; George, 2012; Irving, 2011; Whipple, Hughes & Bowden, 2015). When open-ended items have been utilized, researchers could have provided more thorough assessments of outcomes if the responses were analyzed more thoroughly. However, in many instances, the responses to open-ended items were not supplied or were not critically analyzed. In addition to using self-reported data, the administrator of the questionnaire in many instances was the faculty member responsible for the instruction of the class. Particular attention should have been paid to the fact that the educators and researchers developing the interventions were also administering the questionnaires. In several instances, the questionnaires were completed as components of the course, so while there may have been a high response rate, participants may have felt compelled to respond.

Secondly, inadequate sample sizes may have limited research studies on undergraduate research programs. Adequate sample sizes are one way to reduce sample bias and to provide internal validity. Pyne, Scott, O'Brien, Stevenson, and Musah (2014) explored the role of undergraduates as mentors and as researchers. Their qualitative study provided a quality description of students' experiences, even though they used a small sample size (n = 3). Similarly, the Kruse and Taylor (2012) conducted a participant-observer case study of three music students. Kruse and Taylor acted both as researchers and investigators to provide a quality reflection of the experiences of student researchers. With the exception of research studies that used institutional data, this researcher found only six non-STEM studies with sample sizes greater than 100, and more than half (n = 32) of the studies reviewed included sample sizes of fewer than 40.

Third, the absence of studies using a comparison group may have limited the strength of the research base. Comparison groups provide a method of strengthening the findings of research studies. Many of the studies' participants self-selected as research participants; however, comparison studies could have provided contrast. Only one study, Ciarocco, Lewandowski, and Van Volkom (2013) utilized comparison groups. What is significant about their study is that students who participated in the experimental research course did not perceive greater research attitudes or skills and abilities than students enrolled in the control lecture-style course. This study would have been enhanced by administering open-ended questionnaire items to explore the perceptions of students about their research skills and abilities.

Fourth, the absence of research questions and hypotheses may have limited the ability of research studies to provide valid and reliable results. Specifically, fewer than half of the studies reviewed were driven by hypotheses, research questions, or clearly stated objectives. Of those studies, only two drew explicitly on accepted models of undergraduate research (e.g., Falconer & Holcomb, 2008; Whipple, Hughes, & Bowden, 2015).

Summary

Participating in undergraduate research programs is a high-impact practice. Undergraduate research has been defined very broadly, and the characteristics of such programs are diverse. While scholars have attempted to provide complete and specific definitions of the types of undergraduate research programs, studies exploring these programs have not adequately determined the influence that their characteristics may have on participation. Secondly, despite research studies that detail positive outcomes associated with participation in undergraduate research programs within STEM disciplines, these same outcomes have not been established among undergraduate research programs within non-STEM disciplines. In addition to the absence of relationships between characteristics of undergraduate research programs and participation, the relationship between the characteristics of undergraduate research programs and critical thinking also has not yet been established with the non-STEM disciplines. Finally, while assessments of undergraduate research programs have been conducted, they are primarily found within STEM disciplines, and outcomes were aggregated at the institutional level rather than the individual level. This proposed study seeks to explore how the goals, types, and methods of assessment of undergraduate research programs are defined and how challenges in non-STEM disciplines act as barriers to the development of critical thinking skills.

Research Questions

The following research questions will guide this study:

RQ1: What are the goals, types, and methods of assessing undergraduate research programs at select research universities?

RQ2a: How are undergraduate research programs similar and different at select research universities?

RQ2b: How are undergraduate research programs similar and different among programs in STEM disciplines and non-STEM disciplines at select research universities?

RQ3: What challenges do stakeholders at these institutions face in developing, implementing, and assessing undergraduate research programs for students in non-STEM disciplines?

Chapter 3: Research Methods

A review of the research conducted during the past 10 years revealed that more than 200 studies and reports have focused on outcomes associated with participation in undergraduate research. However, of these 200-plus research studies, only 32 were related to undergraduate research experiences in non-STEM disciplines. The purpose of this study was to (a) identify and examine the goals, types, and methods of assessing undergraduate research programs; (b) analyze institutional and disciplinary similarities and differences in undergraduate research programs; and (c) identify and examine the challenges that stakeholders at these institutions face in developing, implementing, and assessing undergraduate research programs for students in non-STEM disciplines. In order to accomplish this purpose, the following research questions guided this study:

RQ1: What are the goals, types, and methods of assessing undergraduate research programs at select research universities?

RQ2a: How are undergraduate research programs similar and different at select research universities?

RQ2b: How are undergraduate research programs similar and different among programs in STEM disciplines and non-STEM disciplines at select research universities?

RQ3: What challenges do stakeholders at these institutions face in developing, implementing, and assessing undergraduate research programs for students in non-STEM disciplines?

To answer these research questions, the researcher (1) identified undergraduate research programs and cataloged their goals, types, and methods of assessment; (2) identified the characteristics of undergraduate research programs by institution and by STEM and non-STEM disciplines; and (3) described the challenges to developing, implementing, and assessing undergraduate research for students in the non-STEM disciplines.

Undergraduate research programs within non-STEM disciplines are interesting to study because (a) existing scholarship does not comprehensively define the characteristics of undergraduate research programs and (b) existing scholarship does not identify how the characteristics of undergraduate research programs may influence learning outcomes. The researcher explored the current literature base in STEM undergraduate research fields to characterize the goals, types, and methods of assessment of undergraduate research programs. This researcher used Kuh's (2008) high-impact practice framework to analyze challenges that can lead to improved outcomes among undergraduate research programs within non-STEM disciplines. Defining the characteristics of undergraduate research programs within non-STEM disciplines allows administrators and scholars to develop a cohesive structure for assessing, replicating, and empirically studying undergraduate research programs within the non-STEM disciplines.

This chapter introduces the research methodology for this study. This chapter presents the research method as well as reasons why a qualitative design is most appropriate. This chapter then describes the data collection methods, the participants, and the data analysis procedures. The chapter concludes by presenting a description of the role of the researcher and ethical considerations; a discussion of trustworthiness, validity and reliability; and the study's benefits and limitations.

Methodology

A qualitative design--specifically, an inductive approach--was used to answer the research questions. The researcher identified patterns and themes found in the data and then used those patterns and themes to identify and describe the goals, types, and methods of assessing undergraduate research programs. The researcher also examined institutional and disciplinary similarities and differences among undergraduate research programs as well as the challenges associated with developing, implementing, and assessing high-impact undergraduate research programs for students in non-STEM disciplines. The patterns and themes were derived from multiple data points, and thus the researcher was able to derive a set of findings of the items under investigation that can move the field forward in a substantive way.

In qualitative studies, researchers seek to answer research questions by identifying themes and patterns within the data. When using a qualitative design, researchers often establish categories; however, qualitative research allows for revisions to these categories as new observations make additional themes and patterns known. This iterative research approach provides researchers with greater flexibility in coding data and also allows researchers to make stronger connections among the various elements of the study (Maxwell, 2005). In this study, the researcher sought to examine undergraduate research programs. While undergraduate research programs may appear to be different across disciplines and institutions, this study was grounded in the existing literature, and it was expected that there would be consistency in their underlying structural components. The existing literature was used to establish the initial categories and subcategories, and as the data analysis continued, categories and subcategories were revised. The categories provided the building blocks for the patterns and themes that subsequently emerged.

Qualitative designs also utilize multiple methods of data collection. Yin (2018) argued that using multiple methods provides a comprehensive research strategy. Examining multiple points of data not only provides an opportunity for triangulation and data validation, but also allows researchers to provide a more complete and detailed description and subsequent analysis of the phenomenon under investigation. In this research study, the researcher collected data from multiple sources. These data included (a) institutional demographic data; (b) web content, such as images and text; (c) interview responses; and (d) field notes from the interviews. While this type of qualitative approach may limit the ability to generalize the findings to larger populations due to its interpretative nature, multiple data points can strengthen and validate the conclusions.

While theory is often presented as a mainstay within quantitative literature, theory also can guide qualitative studies in such a way as to acknowledge or define central propositions of the phenomenon under investigation. Merriam (1998) argued that “theory is the structure, the scaffolding of the study” (p. 66), and Creswell and Poth (1998) argued that as a study progresses, theory evolves. In this study, the central propositions of undergraduate research were explored. Categories, themes, and concepts were integrated, revised, and refined (Stake, 1995; Yin, 2018) to better understand these propositions. For example, students enter diverse career fields that are frequently unrelated to their collegiate programs of study. While high-impact practice characteristics may be critical to improving learning outcomes for all students, additional characteristics specific to students within the non-STEM disciplines may emerge as a result of this investigation. Remaining open to the interpretation of the data and the evolution of theory allows the field to move forward in a way that is useful to stakeholders.

Qualitative research is non-linear, is naturally exploratory, and uses words and images to make sense of phenomena under investigation. In qualitative studies, research questions often begin as broad areas of interest, and the way a research question is written drives the appropriate design and methods. However, research questions can become clearer and more focused as the study progresses, and qualitative research that utilizes systematic data collection and organization to explore the phenomenon under investigation can complement its subjective nature. Therefore, a qualitative research method is appropriate for this exploratory study, which seeks to understand how undergraduate research programs have been defined.

Participants. Data were collected from a purposive sample of research-intensive (R1) institutions that met the inclusion criteria for this study. Research universities typically are characterized by large student bodies, and their core mission includes both teaching and research. González (2001) described the purpose of research universities in this way: "The distinct mission of the research university… is to introduce students to research, to inspire in them a passion for discovery" (p. 1624). Undergraduates act as an audience for the distribution of scholarly material. In return, faculty members can learn from students through the accidental collusion of ideas. As a result, faculty members at research universities are the link between teaching and research and can provide students with additional opportunities to engage with them beyond the formal setting of the classroom. Therefore, because of this link, research universities are the focus of this study. According to the Carnegie Classification website, 131 institutions within the U.S. have been classified as R1 universities.

Sample Selection. For this study, the researcher first determined whether each R1 university was a member of the Council of Undergraduate Research (CUR). Because the CUR is the leading organization on undergraduate research, a CUR institutional membership represents a commitment by the institution to undergraduate research. Of the 131 R1 universities, 81 institutions had a CUR institutional membership. Next, the researcher searched the websites of these 81 institutions to identify content related to undergraduate research. The websites were examined to identify goals, types, and methods of assessing undergraduate research programs, and program administrator contact information was identified and documented. Directors of undergraduate research programs were then contacted via email. Out of 81 institutions, 33 administrators responded to the email request, which resulted in a 37% response rate, and 30 interviews ultimately were conducted. Three participants were unable to participate due to time constraints associated with the COVID-19 pandemic, and one audio interview could not be transcribed.

Data Collection Procedures. In this study, the researcher collected three different types of data: (a) demographic data, (b) Internet data, and (c) semi-structured interview data. The data collection procedures were well suited to answer the stated research questions.

Demographic data. The researcher collected demographic data from the National Center for Education Statistics (NCES) and the Integrated Postsecondary Education Data System (IPEDS) about the institutions that met the inclusion criteria and that were selected for participation in this study. The data collected included information about (a) governance/control of the institution (i.e., public or private), (b) institutional selectivity, (c) Pell Serving Institution (PSI) rates, (d) undergraduate enrollment, (e) graduation and retention rates, (f) institutional mission statements, and (g) degree of urbanization.

Internet data. The researcher collected Internet data. The specific type of data that was collected included Internet text and documents. The researcher examined campus-level undergraduate research office websites for data, and the researcher collected data to identify the (a) goals, (b) types, and (c) methods of assessment of undergraduate research programs. The researcher reviewed text found on institutional websites to contribute to a more complete understanding of undergraduate research programs. The researcher used the data collected as a confirmatory source of the data collected during the semi-structured interviews.

Semi-structured interviews. The researcher conducted semi-structured interviews with stakeholders of undergraduate research programs. The researcher contacted program administrators at the institutions that met the inclusion criteria and invited them to participate in individual semi-structured interviews. The semi-structured interview protocol is included in Appendix A. The interviews were designed to collect detailed, specific information and unique perceptions from the perspectives of participants related to undergraduate research programs. The semi-structured interviews focused on institutional characteristics of undergraduate research programs; (a) goals, (b) types, and (c) methods of assessment; and descriptions of the undergraduate research programs. In addition, the semi-structured interviews included a question about STEM and non-STEM differences in undergraduate research programs as well as perceived challenges in undergraduate research programs among the non-STEM disciplines. The requests to conduct additional interviews were terminated when the researcher determined those interview responses did not provide any additional useful information.

The interviews were conducted in English and were audio-recorded, and the researcher took notes during the interviews. The audio interviews were immediately transcribed via NVivo auto-transcription software. The researcher reviewed the transcripts for accuracy and the establishment of preliminary codes using qualitative data analysis software. Qualitative data analysis software tools are useful for efficiency, transparency, and consistency in data analysis (Zhao et al., 2016). Qualitative data analysis software tools can specifically help to (a) categorize and organize data, (b) develop codes and identify themes, and (c) build visual displays to highlight conceptual relationships (Woods et al., 2015). The researcher used NVivo to manage the categories and codes for each research question. These codes were revised as coding and data analysis continued.

Data Analysis. A methodical analysis of the data was conducted once the data collection had been completed. The data were thoroughly examined to identify themes and patterns as well as to compare and contrast undergraduate research programs. Following are the methods of data analysis that were used to answer the research questions. The detailed data analysis steps can be found in Appendix C.

The research questions were answered by first conducting a thorough examination of campus-level websites of undergraduate research offices and secondly by conducting semi-structured interviews with institutional undergraduate research program stakeholders. The researcher examined the collected data in the following categories: (a) goals, (b) types, and (c) methods of assessment used to evaluate undergraduate research programs. Next, the researcher examined the collected data as they related to similarities and differences among institutions and between STEM and non-STEM undergraduate research programs. Finally, the researcher examined the collected data to identify the challenges that stakeholders reported related to undergraduate research programs in non-STEM disciplines.

Data analysis consisted of a structural coding process. Saldaña (2016) suggested that structural coding is applicable when "a segment of data relates to a specific research question" (p. 98). ts are Specifically, this strategy worked well for this study because the semi-structured interviews were developed in alignment with the research questions. During the structural coding process, each file was initially coded to the interview question that it responded to (i.e., what are the goals- coded at goals; what is the full-time equivalent (FTE) - coded at FTE; what are the challenges - coded at challenges). Once all the files were coded, the researcher categorized the codes according to the RQs (i.e., goals, types, and assessments; institutional and STEM and non-STEM attributes; challenges).

Once the interviews were initially coded and analyzed, a second-cycle coding strategy was employed. According to Saldaña (2016), the goal of second cycle coding methods is to theoretically or conceptually develop the data. Specifically, Saldaña (2016) has suggested that the purpose of data analysis is to "not just to transform data but to transcend them" (p. 235) and that second-cycle coding provides the researcher with an opportunity to transform the data in such a way that allows conceptual development to occur. The second-cycle coding method that was employed in this study consisted of pattern coding. Pattern coding is useful for reducing the number of codes from the first-cycle coding method employed. During this stage of coding, the researcher began to identify (a) similarities and differences among institutions, (b) similarities and differences among STEM and non-STEM undergraduate research programs, and (c) challenges that program administrators identified.

Text excerpts, a portion of text that is coded (Saldaña, 2016), were reviewed and code titles were revised when applicable. As patterns were identified, codes were changed or text was coded at a second code. The text surrounding the code excerpt was also reviewed to ensure that the meaning of the excerpt was not misinterpreted and that recategorizing the text to a new code or category was appropriate. As a result of this process, some excerpts are coded at multiple codes and may be used to address more than one research question. For example, responses to the semi-structured interview question about methods of assessment were initially coded in the category relating to Research Question 1. However, during second-cycle coding, methods of assessment were identified as a challenge that undergraduate research program administrators experienced. Therefore, the excerpts within the initial assessment category (i.e., category RQ1) were also categorized as a challenge (i.e., category RQ3), and the text excerpt was coded at a second code. The initial code was not removed unless it was determined that it was miscoded. This iterative process continued until the researcher was satisfied that all text was appropriately coded and categorized to answer each of the research questions.

Collecting, organizing, and analyzing data in this way allowed for richer meaning-making and triangulation that was useful for future replication (Eisenhardt, 1989). Overall, the design of this study allowed for the findings to be described through a methodical, systematic process and provided an in-depth understanding that can be used for future research efforts (Yin, 1998).

Role of the Researcher, Ethics, Trustworthiness, Validity, and Reliability

Role of the Researcher. This project is of interest to me for a variety of reasons. First, as a professional who works in the field of higher education and a member of the Council on Undergraduate Research (CUR), my specific interest in this project is an outgrowth of my professional work. Currently, I direct an office of social science and humanities research and work closely with faculty members and their undergraduate researchers. As a result of my position, I have access to administrators of undergraduate research offices, and as a result of my membership in the CUR, I have contacts from various divisions of faculty working with undergraduates. In my position, I routinely observe faculty members who are discouraged because students do not always contribute in ways that faculty members intended them to. Conversely, I also hear students' reactions when they feel a research project is mundane or does not meet their expectations. As a CUR counselor, I see varying definitions of social science research applied and often wonder how this influences students' understanding of what it means to conduct social science research.

In addition, I am a manager responsible for hiring staff members into positions that do require the types of skills that participation in undergraduate research is supposed to provide. Over the years, I have reviewed hundreds of resumes, interviewed dozens of candidates, and hired several recent graduates from non-STEM fields. As a result of my position, I see the necessity for such workforce skills as well as how they can influence job satisfaction and job performance. My position has cemented my belief that critical thinking is an essential workforce skill and that participating in research experiences can provide students in non-STEM disciplines with these skills if undergraduate research programs are implemented properly. Within the context of this study, these experiences shaped how I perceived the skills of new graduates. As I progressed through this study, it was necessary for me to be aware of the biases I have and to frequently check that I was not letting these biases unduly influence my interpretation of participants' responses.

Ultimately, my role within this study was to identify and examine undergraduate research programs at various R1 institutions. To accomplish this goal, I interviewed various stakeholders who are involved in undergraduate research programs. My familiarity with R1 institutions and undergraduate research offices provided me with a unique perspective. Not only have my roles and responsibilities as a higher education administrator afforded me the ability to understand the inner workings of a research-intensive university (e.g., resource availability, the role of data in driving student programs, student-faculty relationships), but my role as a CUR counselor also has provided me with insights into the challenges encountered by undergraduate research administrators in designing, implementing, and assessing undergraduate research programs.

Ethics. An application to the institutional review board (IRB) was submitted for review and approval. Recruitment documents and informed consent documents were included in the application as well as a template of the semi-structured interview protocol. Participation in this study was voluntary, and all participants were 18 years of age or older. Data collection occurred throughout the spring and summer semesters of 2020. The proposed research design was approved as exempt under 45 CFR 46.104(d), posing less than minimal risk to human subjects because it was conducted in an educational setting and consisted of normal educational practices. The research did not begin until the IRB completed its review of the protocol and made a determination.

Trustworthiness. Lincoln and Guba (1982; 1985) have argued for the use of an audit trail to meet trustworthiness criteria. The audit trail includes several components that should be kept for the purposes of a confirmatory audit as well as possible secondary data analysis. The audit trail includes raw data and journals that document the stages of the data collection, coding, and analysis process. In this study, raw data in the form of audio recordings and interview transcripts were maintained as well as the researcher's field notes that were taken while the interviews were conducted and immediately following the interviews. Other audit documentation that was preserved includes time-stamped web pages and email communication with various stakeholders, including participants and consultants who were engaged throughout the process.

Validity and Reliability. In qualitative research, Yin (2018) has proposed that three conditions should be met to ensure reliability and validity. These conditions include using multiple pieces of evidence, maintaining an inquiry audit trail, and creating a database. In meeting these three conditions, researchers can apply the strategies of construct validity, internal validity, external validity, and reliability (Yin, 2018). Each of these issues is addressed in the sections that follow and the Research Study Alignment Table is found in Appendix B.

Construct validity (triangulation). Utilizing multiple pieces of evidence ensured that construct validity was achieved. Stake (1995) identified several types of triangulation that can be employed. Specifically, data source triangulation was employed in this study by collecting and analyzing various forms of data. The researcher collected and analyzed institutional demographic data; semi-structured interview data and interview field notes; and Internet data.

Internal validity (themes). The data analysis process was interactive and constant. Data underwent data reduction (i.e., data was transformed into more focused, organized representations) in which the researcher established conceptual frameworks, created effective research questions, conducted transparent sampling, and clearly defined mechanisms of recording data and preserving observations and discussions. These mechanisms included creating field notes, code sheets, and website visit summaries; drawing conclusions by connecting theories with evidence; noting patterns; identifying relationships between categories and codes; and building logical chains of evidence (i.e., an inquiry audit trail).

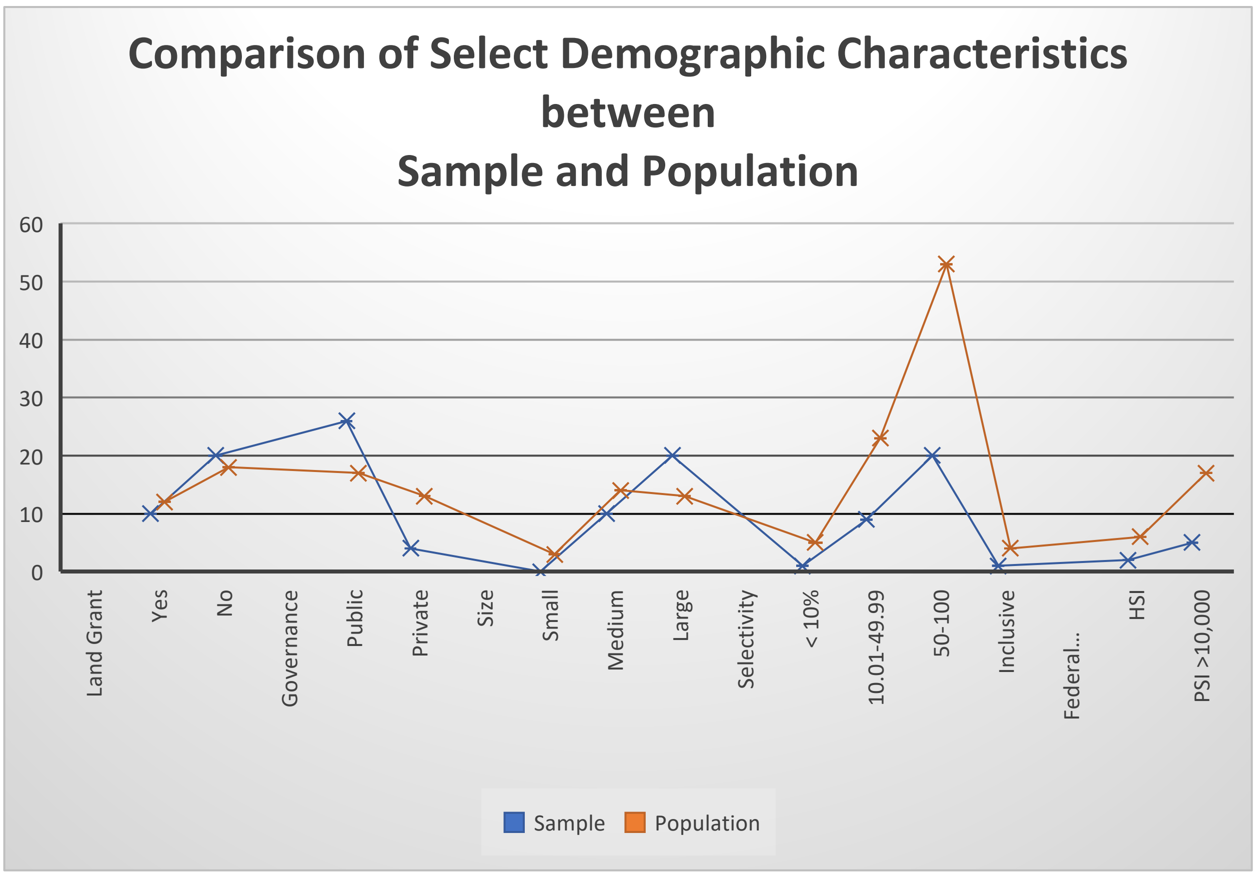
Reliability (protocols and databases). The data were recorded into a database that was constructed with preliminary categories. Data categories were created, and as data were coded, subsets of categories emerged, and these subcategories were further developed and refined. Clear rules and guidelines for coding data into categories were identified prior to data analysis so that an evidentiary chain could be established.

Benefits and Limitations

There were anticipated limitations to study completion. The first anticipated limitation was responsiveness to requests for interviews. This study was oversampled to ensure an adequate sample size. Of 81 requests for interviews, 30 institutional administrators participated and a 37% response rate ensued. However, differences in the demographic characteristics between the sample and the population do make it impossible to generalize the findings of the sample to the population. The demographic characteristics of the participating institutions are described more fully in Chapter 4. Figure 1 presents a comparison of select institutional, demographic characteristics between the sample and the population. Despite differences in the size, the number of Pell students, and selectivity of the institutions, the first-year-to-second-year retention rate average was 88% for both the sample and the population and the 6-year graduation rate average had a variance of one percent (i.e., 73% - sample; 72% - population).

Figure 1

Comparison of Select Demographic Characteristics between the Sample and the Population



A second anticipated limitation was time. Undergraduate research programs both in STEM disciplines as well as non-STEM disciplines are constantly evolving. Programs that may have been in place at Time 1 may no longer be relevant at Time 2; even more likely is that at Time 3, new programs may be in place that were not identified during the initial data collection phase of this study. This limitation was further impacted by the COVID-19 pandemic that began during Spring 2020. As a result of the pandemic, university campuses were closed and measures were implemented to bring about recommendations for social distancing. During this time, undergraduate research programs were paused or were converted to a virtual setting when appropriate. To respond to this limitation, the data collection timeline was compressed. Website data collection occurred during April and May of 2020 and interviews were conducted virtually during July and August of 2020.

Finally, qualitative methods come with interpretive assumptions. Minimizing the effect of the researcher's interpretations is necessary to assure readers that assertions are truthful. Researchers should provide readers with additional information to allow them to draw their conclusions and to alleviate possible sources of conflicting meaning. Whenever possible, the researcher provided (a) actual quotes from participants, (b) descriptors used to generate codes, and (c) a detailed description of the steps taken during data analysis.

Chapter 4: Findings

While undergraduate research programs have been used by colleges and universities to engage students and develop critical thinking skills, little if any research has been conducted to examine current undergraduate research programs at colleges and universities to determine the characteristics of undergraduate research programs within the non-STEM disciplines. Therefore, the purpose of this study is to (a) identify and examine the goals, types, and methods of assessing undergraduate research programs at select research-intensive universities; (b) compare and contrast institutional and disciplinary similarities and differences in undergraduate research programs; and (c) examine the challenges administrators face in developing, implementing, and assessing undergraduate research programs, specifically in non-STEM disciplines. The researcher collected data from multiple institutions. This included (a) institutional demographic data; (b) web content, such as text and documents; (c) supporting materials when available; (d) interview responses. The researcher identified patterns and themes found in the data and then used those patterns and themes to identify the goals, types, and methods of assessing undergraduate research programs. The researcher further examined institutional and disciplinary similarities and differences among undergraduate research programs and the challenges associated with developing undergraduate research programs.

Demographic Characteristics of the Participants

Undergraduate research program administrators at 30 research-intensive institutions were interviewed. A summary of the demographic characteristics of the participants follows. Of the 30 institutions, the governance of four institutions was private, and the governance of 26 institutions was public. Ten institutions were identified as land-grant institutions. Ten institutions had medium enrollment rates in which undergraduate enrollment was between 5,001 and 19,999. The remaining 20 institutions had an enrollment rate of more than 20,000 undergraduates. The first-year-to-second-year retention rates across the institutions ranged from a low of 73% to a high of 97%. The six-year graduation rate for participant institutions ranged from 40% to 94%. Twenty institutions had selectivity rates of greater than 50% (i.e., 1 out of 2 applicants are admitted), and one institution was identified as inclusive. Two institutions were classified as Hispanic Serving Institutions (HSI), and five institutions had more than 10,000 Pell-eligible students. The complete data table is available in Appendix D.

Findings

While collecting, coding, and analyzing the data to answer the research questions, themes emerged related to each of the research questions. The following sections present the findings of this study in response to each research question. The findings were derived from the participants' interview responses and the codes that were assigned to them.

RQ1: What are the goals, types, and methods of assessing undergraduate research programs at select research universities?

Goals of Undergraduate Research Programs. After collecting, coding, and analyzing the data to answer RQ1, three primary goals of undergraduate research programs emerged: (a) improving educational outcomes, (b) engaging students, and (c) preparing for post-graduation. Each goal was comprised of multiple codes, and each code was derived from one or more descriptors. Table 3 presents each goal that was identified by participants and the codes and descriptors assigned to that goal.

Table 3

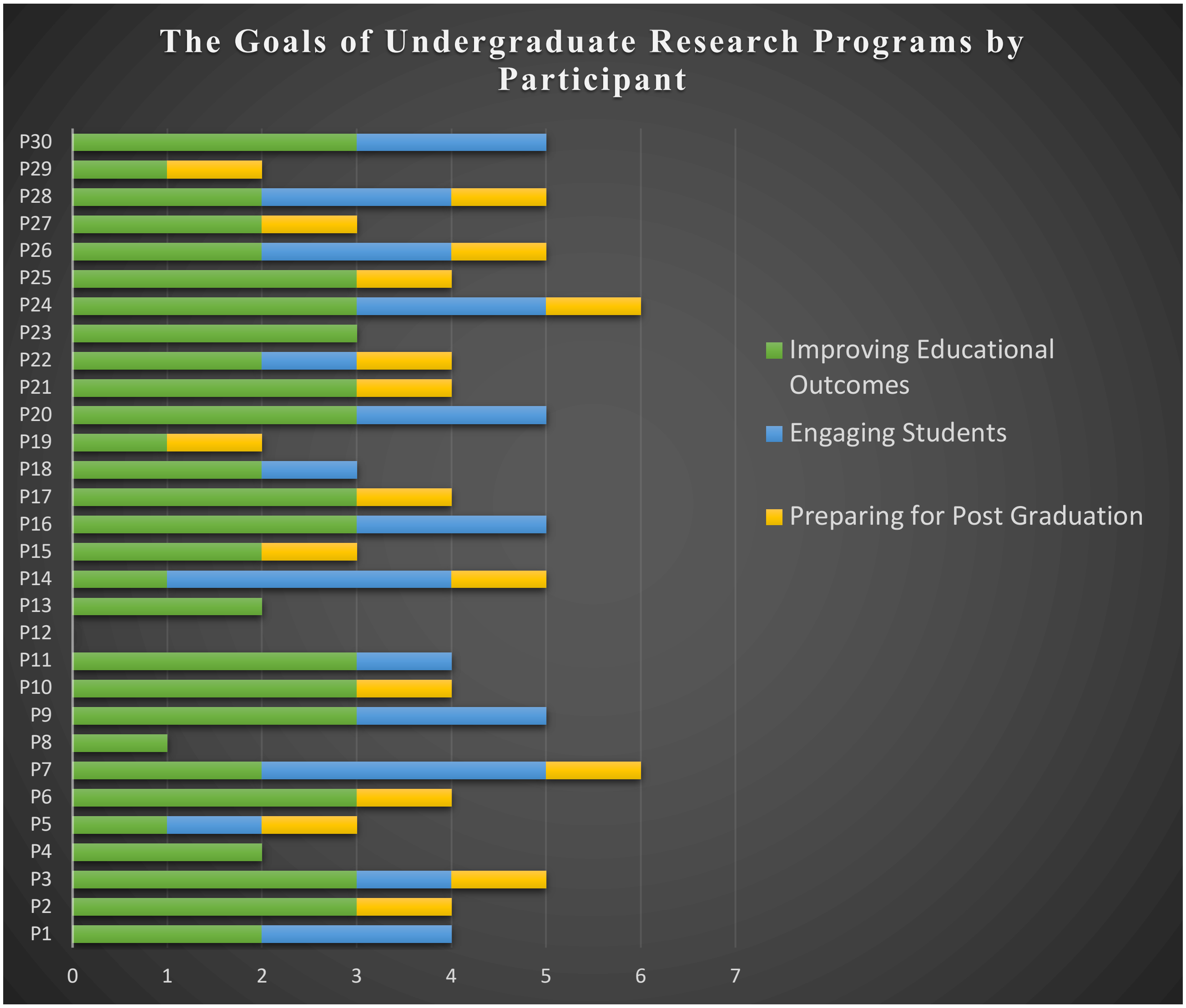
Goals of Undergraduate Research Programs

Goal	Codes	Descriptors
Improving Educational Outcomes	Critical Thinking	Evaluation
		Problem Solving
		Asking Questions
		Self-Directed
		Intellectual
		Learner
		Independent
		Reflection
	Communication Skills	Oral
		Written
		Present, Presenting, Presentation
		Writing
		Speaking
	Research Skills	Scholar, Scholarly, Academic
		Research
		Skill Gathering
		Scientific
	Retention	Graduation
		Retention
		GPA
Engaging Students	Building Relationships	Apprentice
		Relationships
		Connections
		Community
		Network
		Coach
		Guided
		Mentor
	Broadening Participation	Inclusive
		Access, Accessible
		Engage, Engaging
		Broadening
		Equity
		Equal
	Transforming Students	Meaningful
		Life-Changing
Preparing for Post-Graduation		Career
		Graduation
		Graduate School
		Transfer, Transferrable

When participants were asked to describe the goals of their undergraduate research programs, nearly all participants responded that more than one goal was important, and many identified more than one goal as important (e.g., improving educational outcomes – critical thinking, communication skills, research skills). Figure 1 displays the number of codes for each goal that were reported by participants.

Figure 2

The Goals of Undergraduate Research Programs by Participant

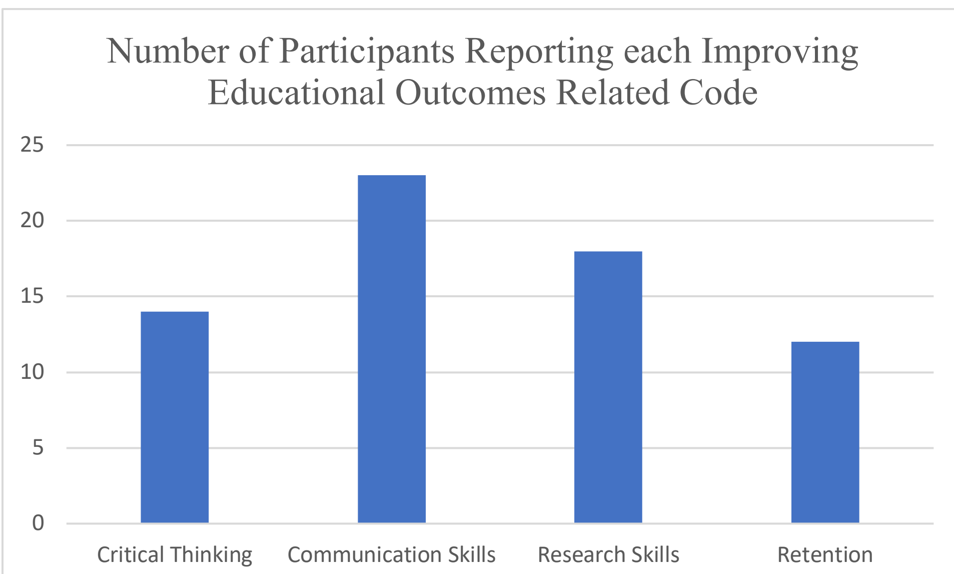


Note: This figure displays by participant the number of codes related to each goal that participants identified as important for their undergraduate research programs.

<u>Goal 1: Improving educational outcomes</u>. Participants identified the importance of (a) developing and using critical thinking skills, communication skills, and research skills as well as (b) improving retention rates as important to improving educational outcomes. Figure 2 shows the number of participants indicating the importance of these four educational outcomes for their undergraduate research programs.

Figure 3

Number of Participants Reporting each Improving Educational Outcomes Related Code



First, 14 participants reported the importance of developing and using critical thinking skills. Participants who reported critical thinking as a goal described critical thinking as asking questions, solving complex problems, and critically evaluating information. Other skills related to critical thinking that these participants identified included skill gathering and understanding cause and effect. Participants claimed these skills also helped students to apply what has been learned to real-world problems and issues and to become global thinkers. Participant 9 expanded on that thought: "It certainly is my goal… to have them make an intellectual contribution to the project… because the value of these kinds of projects is critical to learning critical thinking skills." Participant 2 went further and said, "We hope that it [undergraduate research] engenders intellectual curiosity."

Second, 23 participants reported the importance of developing and using communication skills. According to these participants, the development of communication skills included not only the everyday use of verbal and written skills but also the presentation of data and the communication of research findings to the scholarly community. These participants also said that being able to communicate effectively is essential to successful participation in the professional environment. Several participants also identified the importance of communication skills in developing students' confidence and self-efficacy as students put themselves into new and uncomfortable positions (Participant 20, Participant 21, Participant 23, and Participant 30). Ultimately, communication skills were important because they contributed to students' growth and their ability to connect with the academic and professional community. Participant 18 described communication skills as students learning to become resilient even in the face of failure.

Third, 18 participants reported the importance of developing and using research skills. According to these participants, research skills included creating a research plan, conducting research, and presenting research findings. Participants described students' research skills as existing on a continuum, where students may learn the language of scholarly research or students may learn common methods of conducting research in their specific discipline. The ultimate goal is that students engage fully in the research process. Participants said that as students applied their experiences to meet the standards in their field, they develop expertise and can begin to view themselves as experts. Participants reported that the real value of these research skills allows students to transfer that knowledge to what it means to work in the real world. Participant 3 told the researcher that they "hope that our students are actually using the experience [in undergraduate research] to benefit them in the long run."

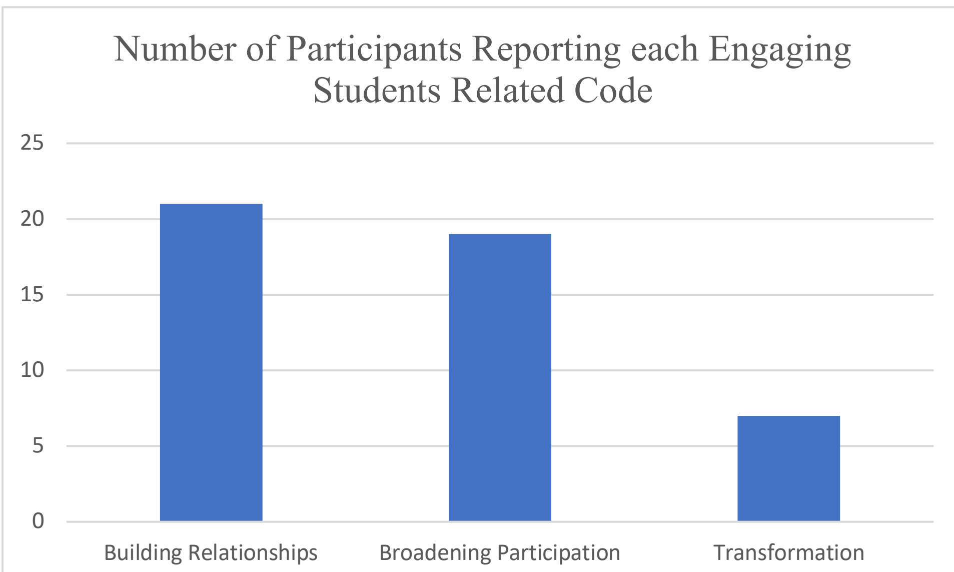
Finally, 12 participants reported retention measures as an educational outcome. Retention measures included measuring graduation rates, GPA, and other quantitative measures of academic performance. While participants reported retention as a goal of participating in undergraduate research, they primarily utilized it as an assessment tool for their externally funded undergraduate research programs.

These excerpts seem to point to the goal of improving educational outcomes for students who participate in undergraduate research while they are students. Participants may not have explicitly identified the relationship between an undergraduate research experience and student coursework, but the underlying tone of their responses suggested it, especially as they discussed retention efforts. Participants' responses pointed to the importance of these skills in preparing students for 21st-century work. Participants were candid when they responded that they hoped students would be able to transfer the communication skills and critical thinking skills they learned during their participation to their post-baccalaureate careers. Participants seemed to realize the value of undergraduate research as more than just a co-curricular experience, as more than just improving students' daily academic performance, as more than just preparing for a job. Rather, participants' responses pointed to the importance of developing skills for life, for participation in a global society, for becoming a member of a community.

Goal 2: Engaging students. Participants identified the importance of (a) building relationships, (b) broadening participation, and (c) transforming students as important to engaging students. Figure 3 shows the number of participants that referred to each code as important to their undergraduate research program.

Figure 4

Number of Participants Reporting each Engaging Students Related Code



First, 21 participants identified the importance of building relationships to engage students. To build relationships, participants declared that students had to engage in networking. Networking involves working with and supporting others who are interested in doing the same type of work (Participant 14). According to participants, networking allows students to form stronger relationships with faculty members and form connections at the university. As students create collaborations and build their networks, they begin to see themselves as members of the research community. Participant 14 said, “The reverberating effects of these connections is that research stops being transactional and becomes personal.” One participant described the relationships as pivotal to student success and said that if students fail to build relationships with faculty members, they miss an opportunity (Participant 2).

Second, 19 participants reported the importance of broadening participation by all undergraduates. To broaden participation, participants reported that undergraduate research and creative activities should be accessible to all students and that all undergraduates should be encouraged to participate. Several participants said that the goal is for every student to participate in undergraduate research and reported a campus commitment to research for everyone (e.g., Participant 1, Participant 4, Participant 13, Participant 23). This commitment to undergraduate research stems from the core mission of the research university. As identified by the mission statements of participating institutions, the core functions of the research university are teaching and research. Through broadening participation, research universities can engage students in the fabric of the research university. Participant 7 stated that “if we are not involving undergraduate students in the core of our mission as a university, we are being negligent in that way.”

Third, 7 participants reported the importance of transforming students. To transform students, participants reported that students should be engaged in the undergraduate research experience. Students develop an appreciation for discovery as they participate in undergraduate research experiences, and according to Participant 4, they have “transformational experiences when they realize what they are capable of doing.” Participant 8 elaborated on the importance of student transformation, reflecting on its relationship to student learning. Participant 8 said that undergraduate research experiences that are "sufficiently rich can transform the motivation [of students] and that when their motivations are transformed, they can perceive the extent of their own learning" (Participant 8). For these participants, student transformation is the goal of engaging students in undergraduate research. The experiences engage, add value, and cultivate a depth of understanding needed to make a positive difference in the world that are fundamental to students' "evolution as researchers" (Participant 4).

Participants reflected on the importance of undergraduate research programs as a mechanism for engaging students. However, based on the excerpts, participants indicated that they did not believe engaging students in and of itself to be sufficient for building relationships and transforming students. Participants believed that mentoring was an important component of engaging students and that mentoring was the critical link to building relationships between students and faculty members. Mentoring allowed students to engage in the academic functions of the university and build these relationships. In turn, these relationships formed the foundation of learning and led to student transformation. Based on participants' responses, the quality of the mentorship was critical to the relationship-building process. However, based on the responses, it is unclear how effective these undergraduate research programs are for building relationships for students in non-STEM fields as participants identified challenges in finding mentors for these students.

Goal 3: Preparing for Post-Graduation. A final goal of participating in undergraduate research programs that participants reported is preparation for post-graduation. Eighteen participants reported post-graduation preparation as an important goal. Post-graduation included preparation for career and graduate school and a focus on the transferability of skills, specifically soft skills such as teamwork, professional communication, and organizational skills. Participant

26 reported that the skills learned as a result of participating in undergraduate research are important because they "contribute to the kind of non-linear thinking skills that meet the demands of the 21st-century job market." However, while more than half of participants identified career and graduate school preparation as a goal of participating in undergraduate research, many of the responses did not draw specific parallels between the undergraduate research experience and non-research-related careers. Participant responses were vague and often simply referred to "professional skills" or "further training" (e.g., Participant 2, Participant 3, Participant 28).

Types of Undergraduate Research Programs. After collecting, coding, and analyzing the data to answer RQ1, two types of undergraduate research programs emerged: (a) all-campus programs and (b) peer programs.

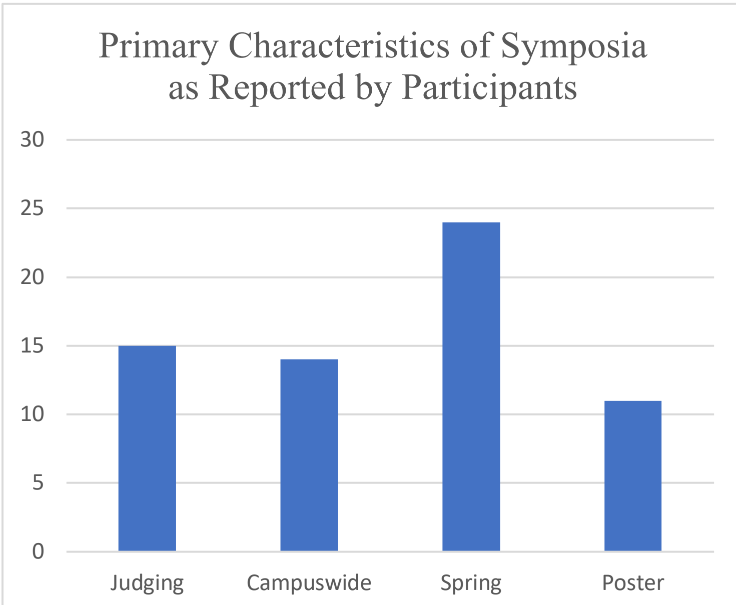
Participants were asked what types of undergraduate research programs they employed to meet their stated goals. Participants reported two types of all-campus programs: (a) workshops and courses and (b) symposiums. According to participants, both types of undergraduate research programs are multi-purpose. They both introduce students to undergraduate research as well as supplement undergraduate research experiences. They provide support and resources to institutional partners. They provide undergraduate researchers with access to the academic community. These programs facilitate achieving the institutional goal of engaging all students across all disciplinary areas.

Type 1: All-campus programs. Participants reported two types of all-campus programs: (a) workshops and courses and (b) symposiums. The first type of all-campus program that participants reported consisted of workshops and research courses. As described by participants, workshops and courses consisted of (a) stand-alone programs and (b) programs parallel to participation in research activities. The stand-alone workshops and courses generally covered introductory material, such as defining research, an introduction to grant writing, and career planning tools. The content of programs that were parallel to participation in research activities included an introduction to research and preparation for future participation in research activities, such as reading the scholarly literature, writing in a scholarly manner, and presenting the research. Participant 18 reported that the workshops and courses of this type were "wraparound support for undergraduate researchers." The duration of all of the workshops and courses varied from a single instance to summer sessions to year-long experiences. It was apparent from the participants' responses that the purpose of the workshops and courses was to scaffold students' experiences. Participant 23 described their approach as a triangle, the widest point being initial exposure to research and progressing until they reach the top of the pyramid, indicating that students are fully participating in the research process.

The second type of all-campus program that participants reported was symposiums. Participants were asked how the symposiums contributed to their goals, and participants responded that symposiums provided an opportunity for all students to participate in the cycle of research. The purpose of the symposiums was to encourage undergraduate researchers to engage with the university community through the sharing of their scholarly and creative work. Many of the characteristics of the symposia were similar across the participants, including primarily being offered in the spring and including judging of presentations. Figure 5 below identifies the primary characteristics of the symposiums as reported by participants.

Figure 5

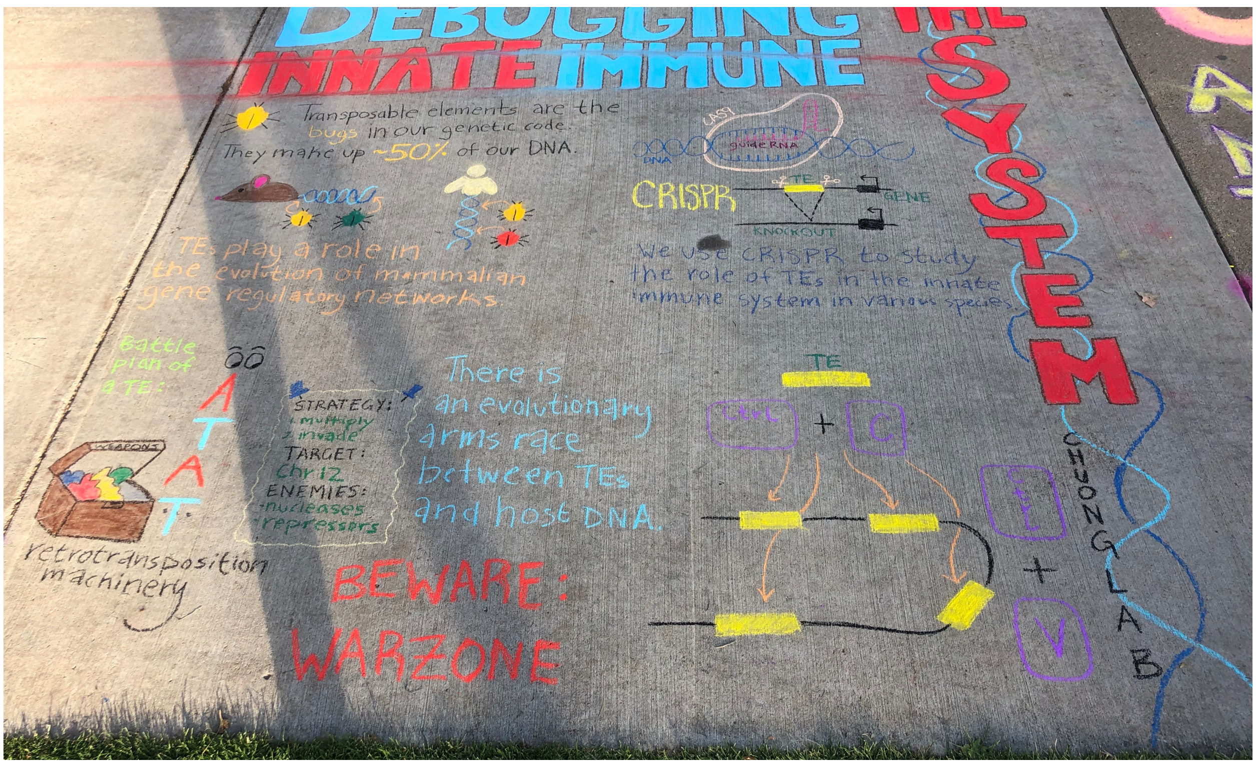
Primary Characteristics of Symposia as Reported by Participants



The most notable point that participants reported about the symposia was their inclusiveness. The symposia were composed of diverse types of dissemination, including posters, oral presentations, video presentations, and architectural models. Other ways of presenting creative activities included options for students to create art installations, poetry readings, film screenings, demonstrations, and prototypes. Participants reported that the symposia were opportunities to celebrate and produce thinkers, creators, and experimenters. The diversity of the symposia encouraged the active participation of STEM and non-STEM students. Participants reflected on some of the creative methods they used to encourage students to participate. One method was featured talks, which are designed to be short, accessible, creative, and engaging. One participant described a sidewalk symposium in which students used chalk art to explain their projects. The colorful nature of the presentations, the ongoing demonstration of the project by the students, and the location of the event (in the school square) were described by Participant 20 as a "provocation for those passing by to engage in dialogue." Figure 6 is an example of a chalk art project presented during the sidewalk symposia.

Figure 6

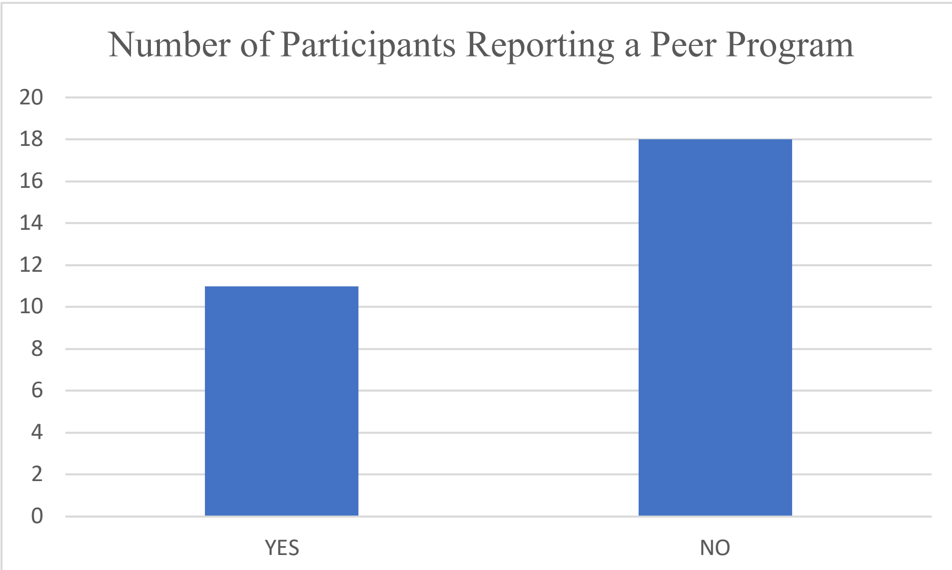
Sidewalk Symposia Chalk Art Project



<u>Type 2: Peer programs.</u> The second type of undergraduate research program that participants reported was peer programs. Eleven participants reported having peer programs. Figure 6 shows the distribution of peer programs across all participants.

Figure 7

Number of Participants Reporting a Peer Program



When discussing peer programs, two areas of interest emerged: (a) characteristics of peer programs and (b) the benefits of all peer programs. Participants reported three characteristics of peer programs. The first characteristic of peer programs was the role of peer leaders as campus ambassadors of undergraduate research. Peer leaders answered questions, gave presentations, and staffed tables at orientation and recruitment events. One participant noted that peer leaders taught research classes. The second characteristic of peer programs was that peer leaders had to have substantial experience in undergraduate research. Participants reported that peer leaders were students who already had conducted research, already had presented their work, and already had participated in advanced training. The third characteristic of peer programs was that peer leader positions were competitive. Specifically, Participant 24 said, “It’s a highly coveted position… they [students] had to have at least one to two years of research, solid research experience… had to be in UROP and then even more."

Participants reported several benefits to both new and continuing undergraduate student researchers who participated in peer programs. The first benefit of peer programs was that they provided leadership opportunities to students who already had engaged in research. Several participants reported that these leadership opportunities help students build confidence. The second benefit of peer programs that participants reported was that they provided peer leaders an opportunity to refine the skills they learned when they were participants. Participants often referred to peer leaders as "peer instructors." These peer instructors taught classes and conducted workshops, thereby reinforcing their own skillset. The third benefit of peer programs that participants reported was that they provided an opportunity for new student researchers to see a vision of themselves in their peers. As a result, peer leaders recruited new student researchers and acted as mentors to new student researchers, contributing to "building a community of student scholars" (Participant 28).

The most notable point regarding the types of undergraduate research programs is not what the participants reported about the types of programs they hosted or whom the participants engaged with; rather, the most notable point is what the participants disclosed about the types of programs they did *not* host and the departments they did *not* engage with. Participants were asked if there were any disciplines they typically did engage with or did not engage with. Participants responded that they engaged with traditional STEM programs, such as engineering, biology, and psychology (lab-based). They reported specific efforts to engage with music and theatre programs. They also disclosed that they did not engage with business programs despite their best efforts. However, participants only remarked on traditional social science programs (e.g., sociology, anthropology, communication) after being specifically pressed. The participation of the social sciences seemed to be an afterthought among participants, who responded with comments such as “oh, yeah…” and “of course.” Even more remarkable than the responses related to the programs that participants engaged with were their responses as they related to the types of programs they did not have. Participants were asked about the goals, types of programs, and methods of assessing programs and whether they were differentiated for specific academic disciplines. Participants responded more often than not that their programs were for all students. When pressed if they differentiated between STEM and non-STEM disciplines, participants could quickly point to STEM-based undergraduate research programs on their campus. They spoke of McNair Scholars, NSF REUs, NIH, HHMI, and other home-grown opportunities. However, participants affirmed they did not offer programs or were not aware of programs that were specific to non-STEM students. Based on the excerpts, one was left with the overall feeling that the social sciences did not have an undergraduate research presence on campus and that non-STEM students, unless they were honors students, were invisible.

Methods of Assessing Undergraduate Research Programs. Participants utilized a variety of methods to assess their undergraduate research programs. Participants used rubrics to assess posters and conference presentations, research proposals, and mentor-mentee relationships. Another method of assessing undergraduate research programs was the review of student journals and student reflections. Another participant identified the use of focus groups to gather information about their undergraduate research programs. Using these methods, participants sought to collect data from students about confidence, critical thinking, and satisfaction. Through the collection of institutional data, several participants reported tracking retention and graduation rates. However, the data were imperfect at best because participants indicated that tracking student participation in undergraduate research programs was difficult.

Participants also identified surveys as a method of assessing their undergraduate research programs. Participants noted using the Survey of Undergraduate Research Experiences (SURE), the National Survey of Student Engagement (NSSE), and other pre-intervention and post-intervention surveys developed by their respective institutions. However, participants noted that the surveys they utilized did not necessarily meet the specific needs of their undergraduate research program, and therefore they discontinued use of them. What is consistent across all of these efforts is that, in most instances, participants did not have specific information to share about their assessment efforts, and descriptions of what they were assessing were vague. While administrators sought feedback on the effectiveness of their undergraduate research programs, few, if any, administrators engaged in a consistent, rigorous assessment of their undergraduate research programs.

It is worth noting that a few participants had substantively evaluated their undergraduate research programs. The participants reported that they evaluated their programs through a quality enhancement plan (QEP), were nominated and/or won the Council on Undergraduate Research's Campus-Wide Award for Undergraduate Research Accomplishments (AURA), and/or had received other regional or national recognition for their programs. To provide details of their assessment plans would make it impossible to maintain the confidentiality of their participation in this study.

RQ2a: How are undergraduate research programs similar and different at select research universities?

<u>Similarities between Undergraduate Research Programs</u>. The primary similarities that emerged between undergraduate research programs were mentoring and inclusivity. Participants were not asked specific questions about these two themes, but rather these themes emerged after coding and analyzing the participants' interview responses.

<u>Similarity 1: Mentoring</u>. In this study, mentoring was one similarity that was found among undergraduate research programs. Institutions used mentors to build relationships and to meet their goal of engaging students. Two central themes around mentoring emerged: (a) the role of mentors and (b) the quality of mentors. First, participants described the process of mentoring as guided learning and teaching. Participants stated that faculty mentors oversaw student work with varying degrees of student autonomy. According to participants, the role of the mentor was to be an expert and to teach the undergraduate student researcher what research looked like for their disciplinary field. Mentors and mentees acted as partners in their research and set goals for the experience. Participant 22 reported that this type of mentoring consisted of more than just advising students. Participant 22 went on to say that mentoring had to be intentional in that the mentoring consisted of a structured plan. Participant 22 indicated that members were passionate about their students so that "students can engage more significantly in their education."

A second point that emerged as it related to mentoring was the importance of high-quality mentors. Participants were not asked what constituted a high-quality mentor, but upon further analysis of their responses, the researcher found that participants believed high-quality mentors consisted of faculty members who demonstrated a consistent pattern of being good mentors and who were consistently accountable to students and undergraduate research programs. Participants asserted that high-quality mentors were important because they led to successful and deep relationships with students. Participants also asserted that high-quality mentors were the key to students achieving that which they set out to achieve. Participant 8 verbalized that high-quality mentors were important because they positively impacted the experiences of student researchers. Participant 2 indicated that good mentors provided their students with proposal templates, making it easier for their students to see and understand the requirements of a successful research proposal. As a result of their importance, high-quality mentors were incentivized. Participants 10, 24, and 29 reported that their institutions issued awards to high-quality mentors. Participant 10 said, "[High-quality] faculty are the best represented… in terms of their students getting access to our funding."

As reported by participants, mentoring was clearly an important component of undergraduate research programs. Throughout the interviews, participants used the word "mentor" or "mentoring" 290 times. Participant 10 used the stem "mentor" 33 times, and Participant 7 used it 28 times. Twenty-seven of 29 institutions mentioned mentor at least once during their interview. Despite the importance of mentoring to the undergraduate research experience, participants did not specifically define what constituted a poor mentor. In addition, participants did not disclose the actions they took when students reported a poor or unsatisfactory mentor experience.

Similarity 2: Inclusivity. In this study, inclusivity was a second similarity that was found among undergraduate research programs. Institutions used inclusionary practices to broaden participation to meet their goal of engaging students. As a result of institutional commitment to broadening participation, participants reported the importance of including all students in undergraduate research experiences. Participant 19 reported they were "committed to research in all forms." This inclusivity was also apparent in the names of undergraduate research offices. Several offices were called (a) Office of Undergraduate Research and Creative Activities; (b)

Office of Student Scholarship, Creative Activities and Research; and (c) the Center for Undergraduate Research and Creative Activities. Even when undergraduate research offices were given less inclusive names (e.g., Office of Undergraduate Research [OUR]), participants reported that their programs served the entire campus. Inclusivity was also evident in the annual symposia, which were available to all students and not limited to specific disciplines; rather, these symposia were open to all types of research activities. Travel grant programs were available for students from all disciplines, and advisory boards were typically comprised of members from across the campus.

Differences between Undergraduate Research Programs. There were two primary differences among undergraduate research programs: (a) how undergraduate research was defined and (b) institutional resources.

Difference 1: Defining undergraduate research. Significant differences existed in how participants characterized undergraduate research when they were asked to define it. Participants were informed that the researcher was not looking for the textbook definition or a definition quoted from a policy document for undergraduate research but rather what they considered to be critical concepts related to undergraduate research. Specifically, participants disagreed on whether undergraduate research was making an original contribution to the disciplinary field or whether undergraduate research was defined by the outcomes students experienced as a result of their participation in undergraduate research programs. Four participants did not define undergraduate research within either of these frameworks; rather, they defined it as a co-curricular activity. Table 4 displays the specific excerpts in which participants defined undergraduate research. The excerpts displayed reflect actual quotes from the participants.

Table 4

Three Codes Used to Classify Participants' Definitions of "Undergraduate Research"

Code	Participant Number	Participants' Definitions of "Undergraduate Research" Excerpts
Process	P4	[Undergraduate researchers are] coequal participants in the research endeavor.
	P10	We leave it up to the students to justify in their proposal that what they're proposing meets that definition.
	P14	[Undergraduate research is] research assistants to faculty [working] on faculty research, not doing their own research, [it's] not students doing their own research.
	P15	[Undergraduate research is] not [something] necessarily new in my mind.
	P20	It's irrelevant whether or not [undergraduate research is] an original contribution or not.
	P22	We call it [undergraduate research] authentic rather than original research. But we're more interested in getting students to recognize and be part of a research process that is significant and an authentic research experience.
	P23	I think we do not have a clear definition [of undergraduate research].
	P27	[It's] collaboration, providing new or partially new information, sheer ability, and commitment.
	P28	They [students] are doing research whether or not they get anywhere. I think it's really dependent on the process.
	P29	The university itself doesn't support independent research.
	P30	The experience [undergraduate research] itself simply doing it is not enough. [It's] understanding the research and presenting.

Table 4 (continued)

Three Codes Used to Classify Participants' Definitions of "Undergraduate Research"

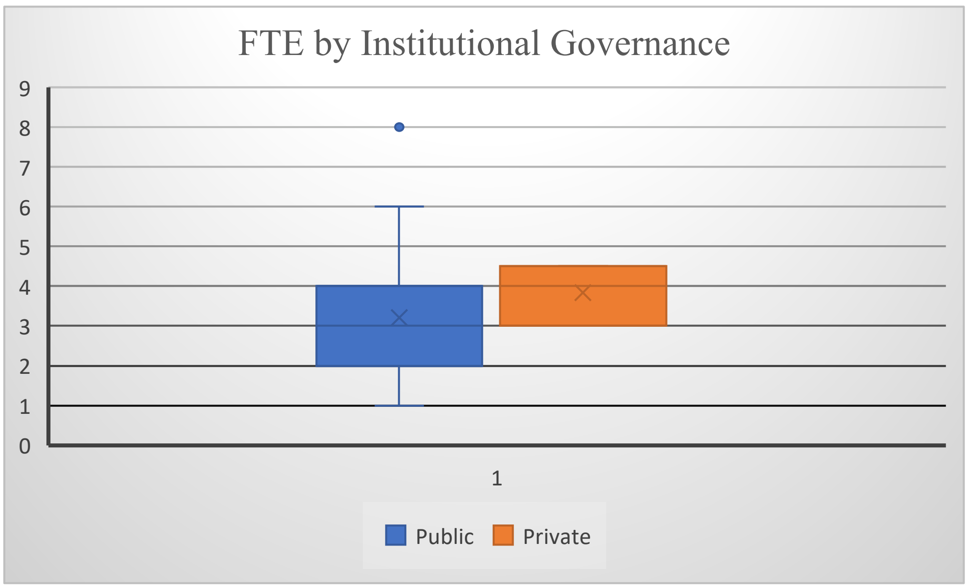
Code	Participant Number	Participants' Definitions of "Undergraduate Research" Excerpts
Original	P2	[Undergraduate research is] the creation of new knowledge.
	P3	[Undergraduate research is] making plans to ask questions and find answers.
	P5	[Undergraduate research is] the process of generating knowledge in your field.
	P6	[Undergraduate research is] contributing and creating your own unique, innovative idea to the public.
	P8	[Undergraduate research is] students seeking to do original work.
	P9	[Undergraduate research is] the process of generating and sharing knowledge or creative works.
	P13	[Undergraduate research] is the support of independent research.
	P16	[Undergraduate research is] the advancement of knowledge in any discipline.
	P17	Undergraduate research is about new inquiry.
	P18	We would like there to be a sense of ownership.
	P19	[It is not undergraduate research] unless there's a component that has a question.
	P24	[Undergraduate research is] when students are able to contribute something to that field.
	P25	[Undergraduate research is] when you're creating new knowledge.
	P26	[Undergraduate research is] when you're adding value to the field, to the broader context.
Other	P1	[Undergraduate research is] extra-curricular or co-curricular engagement in the research enterprise.
	P7	[Undergraduate research] typically needs to be out of an out-of-class experience.
	P11	[Undergraduate research is] things outside of the classroom.
	P21	Typically, when we are thinking about [undergraduate research], it is above and beyond your degree requirements.

For example, Participant 6 said, “Contributing and creating your own unique, innovative idea to the public.” Participant 26 said, “We think of innovation, discovery, and those types of things where the students are doing something to learn. You're adding value to the field, to the broader context.” These excerpts represented a focus on outcomes of the research project itself when defining undergraduate research. In contrast, other participants defined undergraduate research as engaging in the academic and creative life of the university. Participant 20 noted, “We articulate undergraduate research in terms of project outcomes. That’s the litmus. It's an original contribution. But really, the reason why we're all doing this… are learning outcomes.” Participant 20 went on to say, “So it’s irrelevant whether or not it’s an original contribution or not. It's irrelevant whether or not it was on a team. It’s irrelevant whether or not it was in a lab or the field or remote or any other aspect of it.” Other participants agreed that the process itself is what is significant. In further contrast to the academic way in which the above participants defined undergraduate research, others defined it simply as a co-curricular activity. According to these participants, undergraduate research was a co-curricular activity, one that occurred separate from the classroom and was above and beyond the degree requirements. Defining it in this way, therefore, disassociated it from the academic enterprise (Participant 7, Participant 11).

Difference 2: Institutional Resources. A second difference that emerged among the institutions was related to the availability of institutional resources. To ascertain differences in resources, in addition to asking participants how many full-time equivalent (FTE) personnel were assigned to their office, the sources of funding available to their office, and the reporting structure of the office, the researcher recorded the governance of the institution, the PSI rate, and other demographic characteristics. Among the participants, the number of staff and the workloads of the staff differed substantially. Figure 7 details the number of staff assigned to undergraduate research offices as it related to their governance (i.e., public, private).

Figure 8

FTE by Institutional Governance

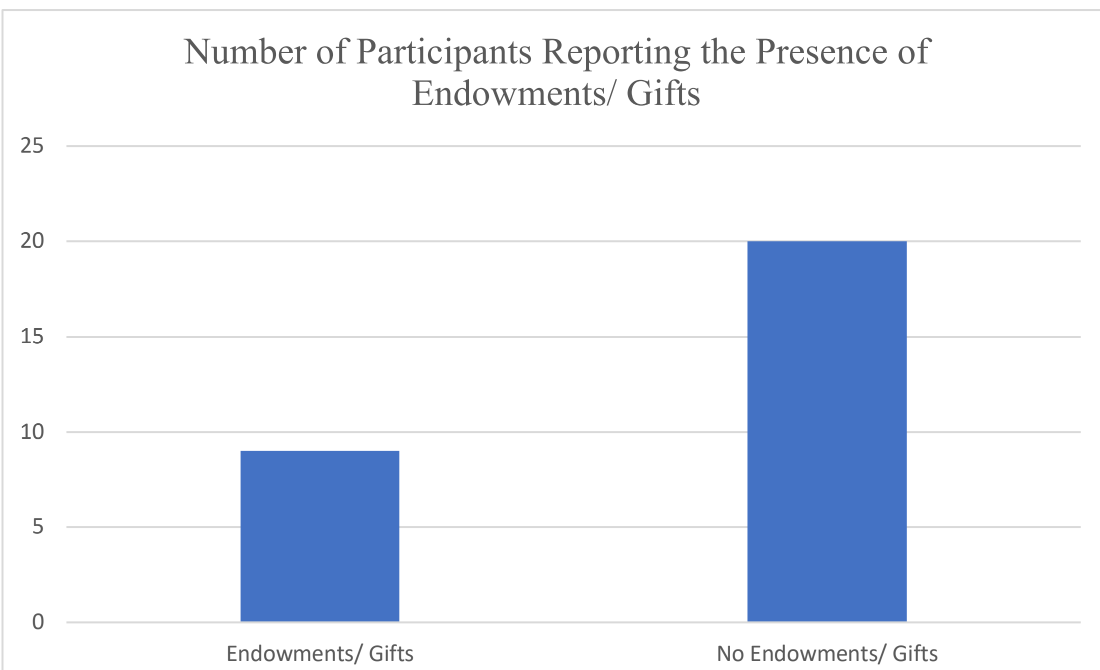


The average number of FTE reported by participants from public institutions (n = 21) was 3.22. Four institutions did not report the number of FTE. Among the public institutions, there were outliers. One participant reported an FTE of one and another participant reported an FTE of eight. The average number of FTE reported by participants from private institutions (n = 3) was 3.83. One institution did not report the number of FTE. Despite similarities in programming levels among offices, differences in FTE were reported by the participants. For example, Participant 1 indicated a staff of one, yet Participant 26 reported similar demographic characteristics and maintained a staff of four. The programming levels of both of these offices were similar, yet the responsibilities of the staff were very different given the level of staffing available to implement programs.

Another difference in resources that were evident pertained to the amount and types of funding available to administrators. The researcher followed up on the question of the source of funding and asked participants to describe in more depth the types of funding available. Nine participants reported having access to endowments or gift funds. Figure 8 details the number of participants that did and did not have access to endowments and gift funds.

Figure 9

Number of Participants Reporting the Presence of Endowments/Gifts



The importance of having access to funds of this type was not understated by participants. Participants said that funds of this type allowed for more robust programs, both for faculty members as well as students. Other participants indicated that they had limited access to institutional funds. In addition, some participants had access to work-study funds to support their programs. As a result of these differences in availability of funds, participants reported substantial disparity in the number of research awards, travel awards, and incentives that could be allocated and offered. Yet another difference in resources was apparent in the reporting structures of the offices. Several offices were led by executive leaders. These offices tended to have access to additional resources, such as marketing, recruitment, and general office support. However, offices that were staffed at the director level and below often did not enjoy the same level of access to these additional resources. The level of leadership represented a further strain on the capacity of the offices to offer programs and to negotiate access to financial resources and additional support.

Similarities and differences in undergraduate research programs could not be ascertained according to the institutional characteristics that the researcher recorded. However, after a thorough analysis of the participants' interview responses, similarities and differences among programs' characteristics could be better observed. For example, it was clear from the participants that all the institutions valued inclusive student participation in undergraduate research. However, the researcher identified differences in the resources provided by the institution to support undergraduate research programs even when the goals of undergraduate research, as reported by participants, were to broaden participation. Another difference noted by this researcher was the value that institutions placed on the role of mentors. The participants made it clear that mentoring was a critical component of undergraduate research programs.

However, the resources allocated to mentors (i.e., time, money, recognition) did not seem to support the importance of mentorship that participants described. The differences could not be directly traced to any one condition. For example, one might consider that these differences were minimized by presumed institutional wealth, but instead, similarities in resources were reported by participants among the wealthiest and poorest institutions.

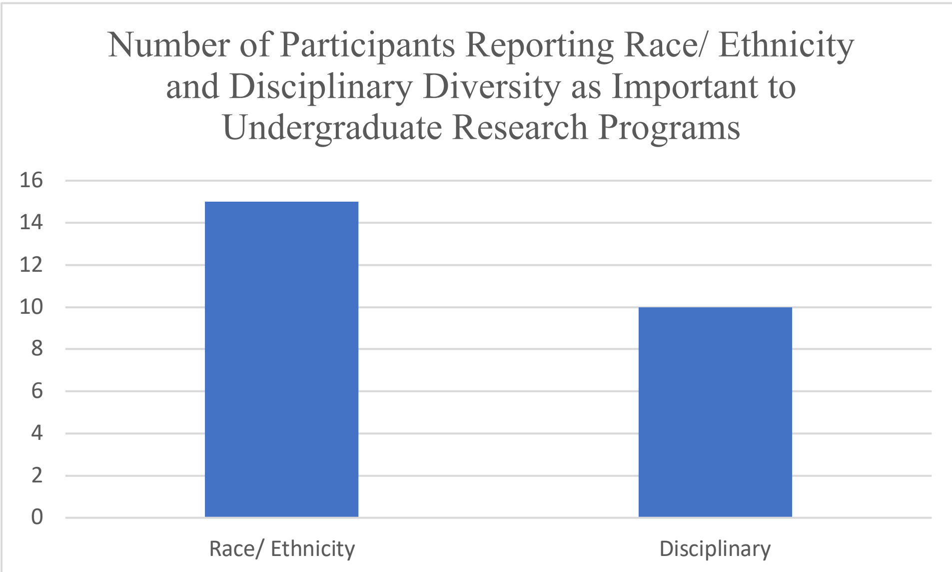
RQ2b: How are Undergraduate Research Programs similar and different among programs in STEM disciplines and non-STEM disciplines at select research universities?

Similarities among STEM and non-STEM disciplines. After collecting, coding, and analyzing the data reflecting similarities among STEM and non-STEM disciplines, the primary similarity that emerged was related to diversity. Participants were asked if they differentiated the goals, types of programs, or methods of assessment as they related to STEM and non-STEM disciplines. Specific similarities were not found in these areas. However, after coding the interviews and analyzing the resulting data, the researcher found that diversity was important across all programs.

Similarity 1: Diversity. Participants defined diversity as including race, ethnicity, and socioeconomic status. Participants also defined diversity across disciplinary areas, such as the inclusion of disciplines within the humanities and other non-traditionally represented disciplines. Figure 9 represents how many institutions considered disciplinary and racial/ethnic diversity as important to their undergraduate research programs.

Figure 10

Number of Participants Reporting Race/Ethnic and Disciplinary Diversity as Important to Undergraduate Research Programs



Fifteen participants valued racial and ethnic diversity in their undergraduate research programs, and 10 participants identified disciplinary diversity as being important. Several participants reported intentional efforts at awarding grants to students who were reflective of their diverse, institutional profile. For example, Participant 24 noted their partnership with diverse groups on campus, including Black and Latinx student organizations. Participant 27 said, "We are the 35th most diverse in terms of structural diversity in the states. We see a nationwide need to fit those demographics." Several participants indicated that they tracked diversity efforts among their undergraduate researchers. Participant 14 said they wanted to be sure that their programs were not just "another white program on campus." Ultimately, diversity efforts were important to participants so that students would see themselves reflected when engaging in their research experiences.

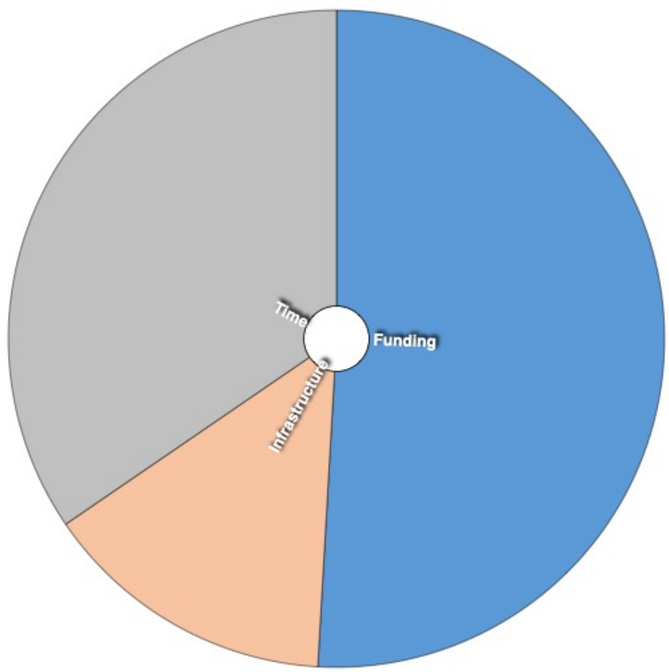
Participants also spoke of efforts to recruit students from diverse and underrepresented disciplines to participate in undergraduate research. They discussed their difficulties in recruiting students from underrepresented departments and programs, such as theatre, music, and business programs. Participants' recruitment efforts included meeting with departments that did not have a strong departmental culture of undergraduate research and making presentations during orientations. Participants mentioned that they invited faculty members from underrepresented departments to be members of their advisory boards and employed office staff from diverse educational backgrounds (Participant 3, 4, 7, 15). However, despite their best efforts, several participants disclosed the challenges that they faced in engaging non-STEM students in undergraduate research. These challenges included student and faculty negative perceptions as members of the research community and recruitment messages that were inclusive for all students (Participant 5, 15, 23, 29). These challenges are discussed later in this chapter.

Differences among STEM and non-STEM disciplines. The two primary differences that exist among STEM and non-STEM disciplines that emerged after analyzing the data were (a) types of resources and (b) identifying as members of the undergraduate research community. Throughout the interviews, participants consistently commented on these differences. As appropriate, the researcher followed up with additional questions.

Difference 1: Types of Resources. One difference that existed among STEM and non-STEM undergraduate research programs was the type of resources that were available. The three resources that participants identified as different between STEM and non-STEM research programs were funding, time, and infrastructure. Figure 10 presents a representation of how many times participants reported a difference in STEM and non-STEM resources across all coded text excerpts (n= 55). Across all participants (n = 23) who reported a difference in available resources, the figure demonstrates the extent to which accessing funding (n = 28) is different for STEM and non-STEM faculty when engaging students in undergraduate research.

Figure 11

Resources Identified as Different for STEM and non-STEM for All Text Excerpts



Participants reported that STEM undergraduate research programs tended to have more funding opportunities. They discussed the availability of grant-funded research projects that could support undergraduate researchers as members of a research team. In contrast, participants said that non-STEM undergraduate research programs lacked infrastructure and external funding to support undergraduate researchers as members of a research team. Participants also reported that non-STEM undergraduate research programs were more expensive to fund because of payments/incentives that are often provided to human participants as well as travel costs. On the other hand, in the STEM undergraduate research programs, participants reported that labs were staffed, and materials and equipment were readily available. The time commitment required by faculty members was another disparity in resources between STEM and non-STEM undergraduate research programs. Participants reported that non-STEM faculty members tended to have heavier teaching loads and more students in their courses. Participants said the heavier teaching loads and increased number of students inhibited their ability to mentor undergraduate researchers. One participant specifically said that mentoring undergraduate researchers was not incentivized. This participant referenced a lack of service recognition for non-STEM faculty members on promotion reports and tenure paperwork. Participant 10 reported that "STEM faculty were pretty good at this," referring to the ability of STEM faculty members to receive credit for mentoring undergraduate researchers. Another participant reported that STEM-based undergraduate research projects tended to be more closely related to a faculty member's own research, so they did not have to add anything to their already full plates. These differences influenced the ways in which faculty members and students engaged in undergraduate research.

Difference 2: Membership in the Undergraduate Research Community. A second difference that existed between STEM and non-STEM undergraduate research programs was membership in the undergraduate research community. Participants reported that inclusion in the undergraduate research community was important. However, the quoted excerpts from participants in Table 5 demonstrate that students in the non-STEM fields may not see themselves as members of the undergraduate research community; likewise, faculty members may not see these students as members of the undergraduate research community either.

Table 5

Identifying as a Member of the Undergraduate Research Community

	Student don't identify themselves as doing research		Faculty don't recognize students as researchers
P1	We've really tried to perpetuate that this is for everyone and it is representative of our institution.	P1	Regarding the undergraduate research office: Faculty are still adjusting and adapting to having an office there as a support for them, but also for their students.
P2	[It is] a little less obvious to students what the research really would look like in some of those fields [social sciences and humanities].	P3	Some of them [faculty] are of the mindset that it's not worth it because an undergraduate can't offer anything beneficial to their research. The culture at our institution is undergraduate students cannot be researchers.
P5	When students hear the Office of Undergraduate Research, they don't necessarily see themselves represented in that [name].	P4	Undergraduate research has historically been quite elitist. This is problematic for undergraduate students because it's just not what they do. We don't have a lot of strong departmental cultures in those disciplines that have traditionally supported undergraduate research.
P6	The biggest one [challenge is] where students are not yet sure of how they're able to find research opportunities.	P8	I think if you asked faculty about student research that they would immediately think of graduate students doing research. Undergrads are not in the picture.
P8	I think a lot of students are uncomfortable with that level of quantitative reasoning. I'm getting much more of a feeling that it's not really where the students' interest is.	P10	There's also a cultural aspect to this that the culture within many of the social science programs is not one of seeking out external funding and providing a lot of focus and providing a lot of credit, so to speak, for mentoring undergraduate students.

Table 5 (continued)

Identifying as a Member of the Undergraduate Research Community

	Student don't identify themselves as doing research		Faculty don’t recognize students as researchers
P11	Some social science students don't know that research opportunities exist for them.	P11	People just don't know. I don't know that undergraduate research is for social scientists. I think it kind of harkens back to the first point that students just don't know. I think that it's just the lack of awareness. I think that sometimes faculty don't know. I've had trouble in the past trying to find a mentor for a student in a social science area. I think it was just because they didn't really know what to do with the student.
P17	There is less student interest there. They just don't know what research is. They think research is those other people. They think it's boring.	P13	Some of them are not that good at trusting that students can help them.
P19	Our social science students often come just a little bit later to research than our STEM students do.	P16	Regarding engaging undergraduates to fulfill research openings: We will pay your students for you if you submit job descriptions to us and that is where we have found the win [in engaging students], especially in the humanities and social sciences.
P20	It [undergraduate research] sets them up into a dilemma of where they're faced with paralysis of confidence. The initial challenge and one of the biggest hurdles upfront are for students to even know that this kind of work takes place in all fields of study.	P22	We can't be treating undergraduate students as junior graduate students [who are expected to do research].

Table 5 (continued)

Identifying as a Member of the Undergraduate Research Community

	Student don't identify themselves as doing research		Faculty don’t recognize students as researchers
P21	Students don't always see themselves in it [undergraduate research].	P23	Faculty in disciplines that are not used to co-publishing and are not used to group research settings have a hard time wrapping their head around how they might be able to delegate tasks to students.
P22	[We're] trying to get more students to recognize undergraduates and recognize what they're doing is actually research. I don't know that students would be able to necessarily identify the fact whether or not there are social science or humanities.	P24	[The problem] is that most humanists, especially those who are in the performance area or creative expression or other fields, oftentimes don't see research fitting into their field or just don't see the relationship [to engage students in research].
P23	[We have to] set up programs and curriculum so that all students are exposed to what research is early on.	P25	[The challenge] is breaking that barrier and getting faculty to start thinking, you know, hey, I could use undergraduates and they can do research for me and we could collaborate.
P23	So a lot of students can start to see themselves as researchers and know that research is a challenging thing in their discipline.	P27	[The challenge] is trying to get the faculty to welcome in undergrad students.
P27	[Students] don't see much visible representation of research. First educating everyone, including the students, faculty, administrators that what you are doing is research.	P28	Regarding undergraduates working alongside faculty on research projects: One economist told me one time that his department thought it was unethical.

Table 5 (continued)

Identifying as a Member of the Undergraduate Research Community

	Student don't identify themselves as doing research		Faculty don’t recognize students as researchers
P29	They [students] think that research is only for people in STEM.	P29	They [faculty] think that research is only for people in STEM.
P30	It's hard to get those students [social science] attention amidst all the other things that are coming in their direction.	P30	[A challenge is] helping faculty see places where students can be more involved in their research productively. It [faculty research] tends to be more individual and leaning more towards the creative or different aspects of scholarship that I would say that traditionally those faculty have not engaged undergraduate students in the same way.

Participants observed that faculty members do not always recognize that students can be members of the undergraduate research community. Participant 3 said that non-STEM faculty members thought that “undergraduates can’t offer anything beneficial to their research.” Participant 13 also said that “some of them [faculty members] are not that good at trusting that students can help them.” Participant 28 disclosed that “an economist told me one time that his department thought it was unethical” to engage undergraduate researchers on faculty research projects. In contrast, participants remarked that STEM labs were actually dependent on the labor of undergraduates and that undergraduate student participation makes research projects financially possible. In addition, participants asserted that STEM research programs typically were comprised of teams of researchers, including post-doctoral associates as well as graduate students who could provide training and guidance across the project.

Participants also observed that students did not identify as being members of the undergraduate research community. Participant 3 said that in the STEM fields, students have a “different track of what those opportunities look like.” Participants indicated that students see visual representations of undergraduates participating in STEM-based research. These representations were found throughout campus buildings and when students “peeked into labs” (Participant 27). In contrast, participants alleged that non-STEM students often do not understand what research is or those research opportunities exist for them. They remarked that students believe non-STEM research can only be conducted in a lab and that it is “less obvious to students what research would really look like in some of their fields” (Participant 2).

Similarities and differences among STEM and non-STEM undergraduate research programs existed. While participants strove for diversity across disciplinary and student demographic characteristics, access to resources was a barrier to engaging non-STEM students fully in undergraduate research. However, more troubling than the inequity of resources between STEM and non-STEM undergraduate research programs was the cognitive dissonance that pervaded non-STEM undergraduate research programs. Among all participants, only six did not report a difference in how students and faculty members perceived undergraduate research community participation for students in the non-STEM disciplines (Participants 7, 9, 14, 15, 18, 26). Participants recognized the importance of undergraduate research in engaging students, but they also recognized the challenge of engaging all students in an equal and substantive way that truly would lead to the desired outcomes that participants reported.

RQ3: What challenges do stakeholders at these institutions face in developing, implementing, and assessing undergraduate research programs for students in non-STEM disciplines?

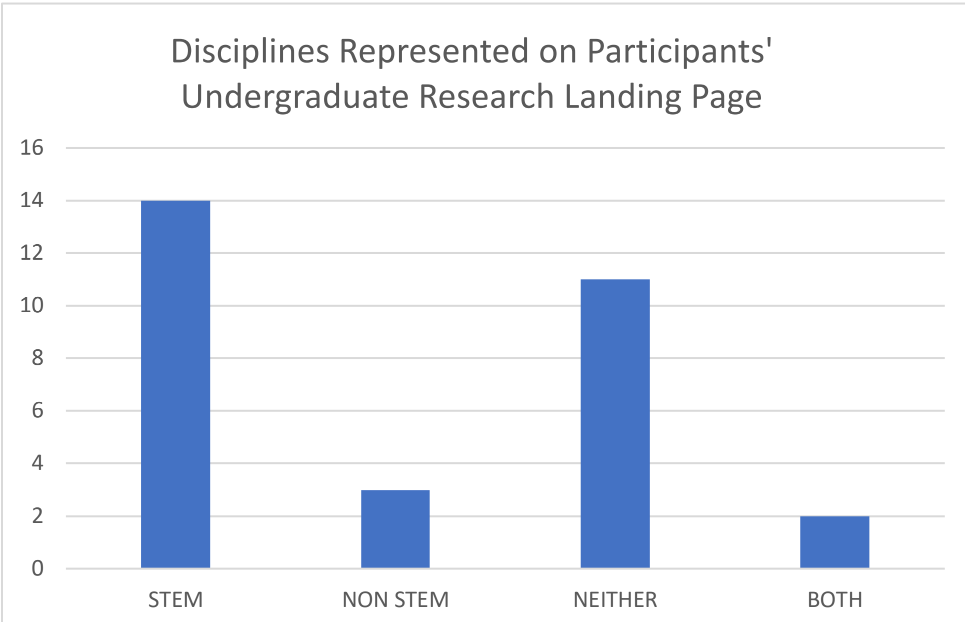
Challenges. Two primary challenges emerged after examining the data: (a) assessment and (b) recruitment of non-STEM students.

Assessment. Participants reported that assessing undergraduate research was a challenge. Assessment efforts were hampered by traditional concerns (e.g., self-report, self-selection) as they related to surveys. However, despite nationally validated surveys of undergraduate research being available, there was an institutional component that created challenges. Participants reported a lack of access to quality data, an inability to effectively track students, and a lack of institutional commitment to assessment as barriers to assessment. Several participants disclosed that assessment occurred only when undergraduate research was externally funded as a condition of the sponsor. Other participants expressed dismay that despite wanting to conduct assessments, a lack of sufficient staffing impeded their efforts at doing so. Other obstacles to assessment included an inability to effectively track student participation in undergraduate research or a lack of access to student data. Participant 15 remarked, “We still do not have, as an institution, a highly developed culture of assessment.” Participant 23 compared this absence to “lip service… we want to have numbers, and they want to be data-driven… at the same time we have had budget cuts, and nobody wants to cut the services to students.” These challenges all contributed to an agenda that has not prioritized assessment.

Recruitment of non-STEM students. A second challenge that participants mentioned as it related to undergraduate research was the recruitment of non-STEM students. A review of the landing pages for participants’ websites showed that most landing pages featured STEM visual aids. Figure 12 indicates that nearly half of the participants only had STEM-based visual aids on their undergraduate research program webpages. In contrast, only five participants had either both STEM and non-STEM visual aids or only non-STEM visual aids. In most instances, the STEM visual aids included microscopes, white lab coats, glass vials, and lab equipment. One non-STEM webpage spotlighted a project that crossed disciplinary lines. A second landing page housed a video collage of students describing different social science-related research projects, and a third webpage shared a student’s experience working on a linguistics project.

Figure 12

Disciplines Represented on Participants' Undergraduate Research Landing Page



Participants also thought that the message that undergraduate research was for all students was fraught with barriers caused by unclear definitions of undergraduate research, limited resource allocation, and a limited institutional vision. Participant 3 said, "It is a challenge to have one message for the entire campus so they can all agree on the same thing." From the excerpts, it seems that participants were aware of three barriers to reaching these students: (a) how to define undergraduate research, (b) who exactly conducts undergraduate research, and (c) how to support undergraduate research. Participants also were aware of the difficulty of convincing non-STEM students and faculty members that undergraduate research was for them. Additionally, institutions have diverse stakeholders and many commitments on resources. Participant 15 specifically remarked on the obligation to share resources with other student programs. The sharing of resources required time to develop partnerships and relationships, and Participant 15 said that they "simply do not have it [time]." Finally, participants asserted that a top-down vision was necessary to successfully break through the barriers that do exist (Participant 3, 10, 15). Participant 17 said, "An [institutional vision would] cultivate an environment where everyone felt safe and empowered enough to speak." Overall, this challenge contributes to undergraduate research being opaque and impersonal. As a result, administrators and students are constantly forced to push through the noise of competing interests when trying to recruit students from non-STEM disciplines into undergraduate research.

Summary

A summary of the findings for each research question is presented in the table below.

Table 6

Summary of Research Findings

Research Questions	Findings
What are the goals, types, and methods of assessing undergraduate research programs at select research universities?	There are three goals of undergraduate research programs: (a) improving educational outcomes, (b) engaging students, and (c) preparing for post-graduation. There are two types of undergraduate research programs: (a) all-campus programs and (b) peer programs. There are limited formal methods of assessing undergraduate research programs.
How are undergraduate research programs similar and different at select research universities?	There are two similarities among institutions in their undergraduate research programs: (a) mentoring and (b) inclusivity. There are two differences among institutions in their undergraduate research programs: (a) the way in which undergraduate research is defined and (b) institutional resources available for undergraduate research programs.
How are undergraduate research programs similar and different among programs in STEM disciplines and non-STEM disciplines at select research universities?	There is one similarity among STEM and non-STEM disciplines in their undergraduate research programs: (a) importance of diversity. There are two differences among STEM and non-STEM disciplines in their undergraduate research programs: (a) the types of resources available and (b) perceived membership in the undergraduate research community.
What challenges do stakeholders at these institutions face in developing, implementing, and assessing undergraduate research programs for students in non-STEM disciplines?	There are two challenges stakeholders face in developing, implementing, and assessing undergraduate research programs: (a) assessment and (b) recruitment of non-STEM students.

The findings of this research study are important in that they indicate the following: (1) a clear, consistent definition of undergraduate research is necessary; (2) an appraisal of the resources for effective undergraduate research programs is necessary; and (3) a synergy among disciplines is necessary. First, a clear, consistent definition of undergraduate research is necessary. A clear, consistent definition of undergraduate research can lead to the operationalizing of variables and assessments, which can lead to more effective programs. Second, an appraisal of resources of effective undergraduate research programs is necessary to ensure equity among disciplinary areas. Institutions should think of these resources as an investment in the future. Quality mentoring requires faculty time, and the representation of this time commitment varies by institution. Third, synergy among disciplinary areas in undergraduate research is necessary. Recognizing that *all* students can be consumers and producers of undergraduate research will shift the focus from undergraduate research exclusively as a STEM-based experience to an investment in the global society. By developing in students the capacity to be resilient, confident, critical thinkers, institutions can begin to meet the challenge of preparing the 21st-century workforce.

Chapter 5: Discussion

While undergraduate research programs have been used by colleges and universities to engage students and develop critical thinking skills, little if any research has been conducted to examine current undergraduate research programs at colleges and universities to determine what type of undergraduate research programs exist within the non-STEM disciplines. Therefore, the purpose of this study was to (a) identify and examine the goals, types, and methods of assessing undergraduate research programs at select research-intensive universities; (b) compare and contrast institutional and disciplinary similarities and differences in undergraduate research programs; and (c) examine the challenges administrators face in developing, implementing, and assessing undergraduate research programs specifically in non-STEM disciplines. The researcher collected data from multiple sources. These data included (a) institutional demographic data; (b) web content, such as text and documents; (c) supporting materials when available; and (d) interview responses.

The researcher identified patterns and themes found in the data and then used those patterns and themes to identify the goals, types, and methods of assessing undergraduate research programs. The researcher also identified institutional and disciplinary similarities and differences among undergraduate research programs as well as the challenges associated with developing, implementing, and assessing undergraduate research programs. The researcher found three primary goals of undergraduate research programs: (a) improving educational outcomes, (b) engaging students, and (c) preparing for post-graduation; there were two primary types of undergraduate research programs: (a) all-campus programs and (b) peer programs; and there were limited formal methods of assessing undergraduate research programs. The researcher also found two primary similarities among institutions in their undergraduate research programs: (a) mentoring and (b) inclusivity. Likewise, the researcher found two primary differences among institutions in their undergraduate research programs: (a) the way in which they defined undergraduate research and (b) the institutional resources available for undergraduate research programs. The researcher also found one primary similarity among STEM and non-STEM disciplines in their undergraduate research programs: diversity. The researcher also identified two primary differences among STEM and non-STEM disciplines in their undergraduate research programs: (a) the types of resources available and (b) membership in the research community. Finally, the researcher found two challenges administrators faced in developing, implementing, and assessing undergraduate research programs: (a) assessment and (b) recruitment of non-STEM students.

Discussion

Identity. When participating in undergraduate research, students must feel some type of connection to the process in order to experience the benefits that are linked to participation. Identifying as a member of the research community is an essential component of that connection. However, participants reported that students in non-STEM disciplines did not identify as researchers. According to Wenger (1998), a community of practice is informed by a social theory of learning in which members actively engage in a community, thereby creating meaning from their experiences. Identity is a core component of a community of practice. Through active engagement in the community of practice, participants begin to identify as members of the community. Wenger has asserted that this identification changes participants through the process of learning. In a community of practice, members engage and contribute, the community refines its practices and invites new members, and the organization sustains the community by valuing it. Within the broader context of the community, affinity groups emerge and create knowledge unique to their community. In a research university, a research community of practice forms among members who engage in scholarly pursuits. Within the broader community of practice at research universities (composed of faculty members, post-doctoral associates, and graduate students), undergraduate students are invited to become participants. As they engage actively in undergraduate research and begin to identify as researchers, they become members of the community. The findings of this study indicated that there are differences in the ways that undergraduate students identify as researchers in STEM and non-STEM disciplines, and therefore this difference may impact how students participate in the research community.

Participants in this study reported that students in the non-STEM disciplines may not identify as researchers. In fact, one participant stated that when they hosted their undergraduate research tables at an orientation event, students would not visit. When asked to expand on why students did not visit the undergraduate research tables, this participant reported that students had told them anecdotally that research is something that they do not do. Rebutting students' perceptions of this type is important because identifying as a researcher is integral to becoming a member of the research community. Wenger (1998) has suggested that identity is formed through the "interplay of participation and reification of experiences" (p. 151). Wenger further explained that identity is solidified when one can demonstrate ways of knowing within the community. However, the process of knowing is not static, and therefore students must actively engage to continue to reconstruct what that knowing means within the community.

Wenger (1998) has asserted that mutual engagement among members is a necessary condition of a community of practice. Mutual engagement provides for understanding ideas that exist in the abstract as well as the collective negotiation of what it means to be a member of that community. However, study participants reported that faculty members in non-STEM disciplines may not consider students as members of the research community. Participants further reported that faculty members think that non-STEM students may not possess the skills to conduct rigorous, scholarly research. Participants reported that their own research is personal and individual, and therefore it does not lend itself to delegation. In contrast, students in STEM disciplines see visual representation of what it means to be a member of the research community. One participant referred to the posters, shadow boxes, and images of faculty members and students working alongside each other as indicators of faculty members' acceptance of undergraduates into the community of practice. One consequence of students in non-STEM disciplines failing to identify as researchers is that students may not fully enjoy the benefits of community participation. As previously stated, students must engage with other members of a community to identify as a member of that community. Wenger (1998) argued that engagement is a culmination of making meaning from practice and the reconstruction of that meaning across time. This social theory of learning builds upon the constructivist theory of learning, which forms the foundation upon which participation in undergraduate research is currently based. As noted in the scholarly literature, the idea of engagement is fundamental to the outcomes that are associated with participating in undergraduate research. These outcomes are possible through the intersection of engagement in a research community of practice. At this intersection, students are able to identify as researchers while they intentionally pursue educational activities and actively engage in the learning process.

All of the participants in this research study recognized the value of engaging undergraduate students in research. Participants recognized the outcomes associated with engagement, which include building relationships within the university community and transforming students. Participants also recognized other well-known benefits of engagement, which include improving retention rates, improving graduation rates, and developing critical thinking skills. Working toward developing a research community of practice requires the participation of all stakeholders. Students must claim ownership of what it means to be a researcher. Likewise, faculty members must be willing to recognize the contribution of students to the research community by sharing ideas and experiences. In addition, organizations must be willing to recognize communities of practice through aligning institutional vision, developing inclusive programs, and "directing energies to a common purpose" (Wenger, 1998, p. 186). These activities represent the key to students feeling a connection in order to experience the benefits that are linked to participation in undergraduate research.

Mentoring. Building relationships is one important outcome of undergraduate research. Critical thinking is also an equally important outcome of participation in undergraduate research, yet critical thinking as an outcome appears to be secondary to building relationships. Mentoring is the mechanism through which institutions have sought to build relationships between faculty and students. Mentoring can be defined as "Long term and intense, mentoring is a close, meaningful relationship that is formal or informal and occurs in academic or professional contexts" (Mullen & Klimaitis, 2021, p.21). All undergraduate research programs in this study required mentoring, described by participants as guided teaching and advising. Likewise, participants reported that mentoring was a core component of their programs. Mentorship was described as more than just oversight of a research project. Mentors are expected to guide students in academic and career decision-making. Mentors are expected to teach students what it means to do research in their discipline. Mentors are expected to actively engage with students and to be partners with students in the research experience. Participants affirmed the importance of quality mentorship. According to participants, quality mentorship is acknowledged through service awards for mentors. One participant described their Outstanding Undergraduate Research Mentor Award in which candidates were nominated by students and recipients were asked to be members of an advisory board for undergraduate research. Quality mentorship was also acknowledged through funding awards. Faculty received not only stipends for quality mentoring, but they also received research funds. These research funds allow faculty to continue to develop their research and continue to work with undergraduate researchers in this capacity. The importance of mentorship in the research enterprise cannot be overstated. Kuh (2008) identified mentoring as a key characteristic of a high-impact practice, and researchers described positive student outcomes associated with mentoring.

One of those outcomes associated with mentoring in undergraduate research is the building of relationships. In a 2012 study, Cuthbert, Arunachalam, and Licina reported on the experience of students in a sociology undergraduate research program and wrote, “Our relationship with lecturers was not just superficial. It was meaningful” (p. 9). One participant in this study acknowledged that the relationships that endure between faculty members and students have reverberating effects for students. The participant went on to suggest that participating in undergraduate research for students stops being transactional and becomes personal. Another participant asserted that mentoring builds stronger relationships with faculty members and allows students to make deeper connections at the university. The benefit of building relationships cannot be overstated. Carpi et al. (2017) found that students who experienced significant mentor relationships reported changes in their post-baccalaureate plans. These changes were especially pronounced for underrepresented students. However, mentoring is not just about building relationships. Mentoring is also about teaching and learning.

While the outcomes associated with mentoring are the same for STEM and non-STEM students, mentoring functions differently as a pipeline for STEM and non-STEM students. In the STEM disciplines, mentoring is a form of cognitive apprenticeship through which the "learning of skills and knowledge is embedded in the social and functional context of their use" (Collins, Brown, & Newman, 1988, p. 2). Participants in this study affirmed the role of a mentor in the process of students developing expertise in their disciplinary area. This expertise comes from the guided teaching of concepts and information by faculty members that drive student learning. In this way, Collins et al. argued that cognitive apprenticeship models contribute to the development of critical thinking skills.

Within the STEM disciplines, this relationship between critical thinking and cognitive apprenticeship is not particularly surprising. Students in STEM disciplines work alongside faculty members, post-doctoral associates, and graduate students in conducting research. In their work, faculty members make transparent for students the metacognitive skills they use when working on a research project. Students see not just the practice and the tools used in STEM-based research; they also see how to solve problems and carry out complex tasks. For STEM students, mentoring in undergraduate research functions as a pipeline to graduate school and careers in research. The National Science Foundation (NSF) Research Experiences for Undergraduates (REU) program is an example of how this pipeline functions. According to the NSF REU program solicitation, these programs are designed to engage students in meaningful ways in ongoing faculty research projects to interest students in careers in the research sciences.

However, in non-STEM disciplines, this relationship is less clear. As participants in this study reported, research in the non-STEM disciplines appears to be a little less obvious to these students. According to participants, students think that research occurs exclusively or primarily in a lab. However, the way that non-STEM-based research is conducted, the places where non-STEM-based research occurs, and the language that describes non-STEM-based research are all diverse. None of them can be explicitly linked to a single discipline of study. In contrast to the function of undergraduate research as a pipeline for STEM students to research careers, the function of undergraduate research for non-STEM students is as a pipeline for skills necessary for 21st-century work. Non-STEM disciplines tend to have a lower occupational specificity, defined by Roska & Levy (2010) as a condition in which career fields may not match specifically to a student's major course of study (i.e., sociology, communication, history). They go on to describe these majors of study as those that have "few, discernible vocational traits or clear occupational trajectories" (p. 390). In this way, when non-STEM students enter the workforce, they will need to draw upon the skills learned while participating in undergraduate research that may not have been directly linked to or learned in their major course of study. Therefore, the development of critical thinking skills as a function of mentoring is even more essential for success in the 21st-century workforce.

High-Impact Practices. Undergraduate research is widely considered a high-impact practice, yet the practice of undergraduate research typically lacks many of the characteristics of high-impact practices. This leads to the question of under what conditions should undergraduate research still be considered a high-impact practice. High-impact practices are composed of six characteristics that foster critical thinking, global awareness, and personal and social responsibility. According to Kuh (2008), these characteristics include (a) substantial time and engagement, (b) significant interactions with faculty members and mentors, (c) increased exposure to diversity, (d) frequent feedback, (e) opportunities to work in diverse settings, and (f) opportunities to engage in life-changing activities. Within the context of this study, participants noted characteristics of high-impact practices within their undergraduate research programs. They specifically identified (a) significant interactions with faculty members and mentors, (b) increased exposure to diversity, and (c) opportunities to engage in life-changing activities. Each of these characteristics is discussed in the following section.

First, participants identified significant interactions with faculty members and mentors as a core component of their undergraduate research programs. Participants indicated that mentoring was a core component of their programs, they discussed the roles of the mentor in undergraduate research, and they argued for quality mentoring. However, there is a final point that is salient to the discussion that has not been visited yet. In this study, participants identified faculty members and post-doctoral associates as fulfilling the role of mentors. In addition, participants indicated that graduate students can also fulfill the role of mentor. As a result, graduate students acted as both mentors and mentees. At research universities, this dichotomous positioning of graduate students is even more important. Utilizing graduate students to teach and train undergraduates is often seen as a cost-saving mechanism used by research universities. It is therefore important to remember that graduate students are still learning what it means to be members of the research community. They can help to scaffold learning for undergraduates, but the graduate students' learning must still be at the forefront of the mentoring exercise. Within the high-impact practice framework, defining what those significant interactions are and how they may be changed, depending on with whom the student is interacting, is necessary.

Second, participants identified diversity as important to their undergraduate research programs. Working in a global environment requires exposure to diversity, and the research university provides a unique opportunity to create those types of diverse interactions that high-impact practices consist of. There is diversity in race, ethnicity, discipline, and research methods.

There is diversity in the scope of research projects and how students choose to engage in the research activities. Participants in this study agreed about the importance of diversity. One participant described their efforts at engaging with multicultural units on campus, while another discussed the role of undergraduate research diversity initiatives on campus. Researchers have agreed that diversity in the college environment leads to the development of a pluralistic orientation (Jayakumar, 2008). These skills are essential to the development and application of a global worldview in which differences are valued. While members of the higher education community understand the importance of exposure to diversity for student researchers and 21st-century workforce success, it is also important to understand that research teams need to be founded on common goals, equal status, leadership support, and cooperation within the team to experience the positive effects that result from working in a diverse environment.

Third, participants in this study identified opportunities to engage in life-changing activities as an outcome of student participation in undergraduate research. They indicated that faculty mentors could provide life-changing moments for students. One participant remarked that they want students to have an experience that helps them find out what they are passionate about, and yet another participant remarked that they seek to develop in students a lifelong appreciation for discovery. One may argue that these life-changing moments are the basis on which the personal attributes at the heart of critical thinking are founded (Ennis, 1985). This is important because students must be motivated to learn, and motivation can flow from these transformational experiences. Through providing innovative and transformational learning opportunities for their undergraduate researchers, institutions can develop, deliver, and maintain a high-quality undergraduate curriculum that meets the needs of 21st-century students.

While participants may have described other high-impact practice characteristics in the context of describing their programs, their impact on the undergraduate research program itself was less obvious. Specifically, participants spoke of the variability in the duration of programs, including one-time workshops, seminars during the course of the semester, summer-long programs, semester-long programs, and programs offered concurrently with seminars. Some of the participants identified a specific number of hours per week in which students were engaged, while other participants did not. However, because the concept of "time" has not been operationalized, it is therefore impossible to determine which approach is the most effective one. Similar concerns exist with frequent feedback and opportunities to work in diverse settings. These characteristics have not been fully defined or operationalized within the undergraduate research community, and therefore it is a challenge to assess the effectiveness of these programs as a high-impact practice.

Next Steps

There is good news when it comes to the practice of undergraduate research. First, institutions are committed to the inclusion of all students in the practice of undergraduate research. This is important because the values of leadership influence the culture of an institution. Institutional policies are derived from these values and resources are allocated according to these values. Second, the goals of participation in undergraduate research are linked to 21st-century work. Engagement in meaningful educational activities is linked to positive student outcomes such as critical thinking, communication skills, and building relationships, all of which have been identified in this study as goals important to participants. Finally, mentoring is recognized as a critical component of undergraduate research. This is an important first step so institutions can begin to develop policies and procedures, especially for those in the non-STEM disciplines that support the time needed to provide quality mentoring and the amount of funding needed to support undergraduate research programs for all. Despite the positive news, the undergraduate research community has more work to do, both in practice and future research.

Recommendations for Practice

The first recommendation for practice is that program administrators at research universities should consider more specifically defining "quality mentoring." Defining quality mentoring could lead to policies that foster the more meaningful expression of mentoring practices. In turn, those mentoring practices can lead to the development of relationships, which in turn leads to student engagement and success. Policies that incentivize quality mentor participation would provide a mechanism for universities to apply credit to faculty members in their promotion and tenure paperwork as well as release faculty members from teaching obligations. In addition, defining quality mentoring provides a pathway for training graduate students and post-doctoral associates as they embark on their scholarly careers, which may include mentoring future undergraduate researchers. In a 2015 article, Shanahan et al. (2015) described the 10 best practices of undergraduate research mentors; however, these practices constitute only a first step. These practices need to be understood within the research institution environment. Failure to define quality mentoring not only impacts the ability of students in large universities to connect with mentors and build those critical relationships, but it also could negatively impact the trajectory of students' experiences on campus. Not only is quality mentoring necessary for strong relationships, but quality mentors also function as role models for underrepresented students on campus.

The second recommendation for practice is for university administrators at research universities to prioritize rigorous assessment of undergraduate research programs. This recommendation is critical for two reasons. First, as resources become scarcer and competition for those resources increases, allocating resources must be defensible to multiple stakeholders. Therefore, assessing undergraduate research programs to determine their effectiveness is necessary to continue to devote those resources to them. Secondly, to push the scholarly field forward, the undergraduate research community must know the characteristics of effective programs to develop and implement them. Stakeholders must be able to ascertain not only whether undergraduate research programs are effective at meeting goals but also why they are not meeting goals in order to make changes. In a 2020 study by Haeger et al., the authors found that assessment is being conducted, though through the use of indirect measures (i.e., focus groups, journals, questionnaires). However, through the utilization of such indirect measures, the allocation of resources and the development of effective programs remains difficult. Therefore prioritizing more rigorous assessment is necessary.

The third recommendation for practice is for stakeholders of undergraduate research programs to revisit their understanding and definition of undergraduate research. The undergraduate research community is divided regarding the focus of undergraduate research (a) as an outcome-based program or as a process-based program. Outcome-based undergraduate research programs focus on the product of the research project. Outcomes are easier to assess because the product of the research defines success. Research outcomes can be observed and measured. In contrast, process-based undergraduate research programs focus on student learning outcomes. Student learning outcomes are more difficult to assess because assessing learning is challenging, takes time, and is subjective. Therefore, defining the focus of undergraduate research is necessary not only for proper resource allocation but also for effective assessment of undergraduate research. Haeger et al. (2020) would appear to agree that defining undergraduate research should be a priority. After a series of focus groups with undergraduate research leaders, the authors identified defining key constructs as they relate to undergraduate research as an important next step. It is necessary to define the focus of undergraduate research so students, faculty members, organizations, community partners, and future employers are able to determine the role that the undergraduate research experience plays in the development of the student. These programs are foundational to student success and subsequent participation in the 21st-century workforce. Therefore, consistently defining undergraduate research is necessary so the undergraduate research scholarly community can conduct reliable, valid, and trustworthy studies to determine whether learning outcomes are being met.

Recommendations for Future Research

The first recommendation for future research is to explore the role of mentoring in developing the identity of students in non-STEM disciplines as members of the research community. This line of research is needed because current research on participation in undergraduate research is focused on the STEM fields. However, participants in this study asserted that differences exist between STEM and non-STEM undergraduate research programs. One of the differences that participants reported was their perceptions of students identifying as members of the research community. In a study by Hunter et al. (2006), the authors found that students identified as scientists and faculty perceived students as scientists after participating in an undergraduate research experience. However, this study was focused on STEM-based experiences. In another STEM-focused study, Robnett et al. (2018) found that good mentors were significantly related to students identifying as a scientist ($p < .001$). However, a further review of the literature on mentoring, undergraduate research, and identity failed to yield any substantive studies. Therefore, understanding how students, specifically non-STEM students, experience undergraduate research within the context of mentoring and how they identify as researchers is necessary.

The second recommendation for future research is to conduct a survey exploring how undergraduate research programs at research universities are designed. In a study of this type, researchers should examine undergraduate research and should focus on programs for students in non-STEM disciplines. A study of undergraduate research at research universities is important because the concurrent mission of research universities is to teach undergraduates and for faculty members to conduct research. In an interview with *The Evolllution*, Gieth (2012) asserted that research universities have a three-pronged mission: teaching, research, and service. Meeting the research university mission of teaching undergraduates through their participation in research is not only an effective way to utilize scarce resources, but it is also a way to prepare students for 21st-century work (Altman et al., 2019). Studying programs for non-STEM students is equally important, as participants in this study asserted that differences exist in how students in STEM and non-STEM experience undergraduate research. However, participants could not point to differentiating characteristics of their programs for STEM and non-STEM students. Utilizing undergraduate research as a teaching tool requires an understanding of pedagogical approaches, an understanding of students' educational backgrounds, and an understanding of the knowledge that students do or do not bring to the research experience. Therefore, exploring how research universities are designing undergraduate research, especially for students in non-STEM disciplines, is necessary.

The third recommendation for future research is to evaluate the effectiveness of non-STEM undergraduate research programs as preparation for 21st-century work. The purpose of evaluation is to improve instruction and to ensure that learning goals are being met (Khalil &

Elkhider, 2015). Research in this area is needed because as more students graduate from college and enter the workforce, they must be able to meet the demands of a global workforce (Altman et al., 2019). Students must be able to engage in critical thinking; work as members of diverse teams; and possess communication skills, both oral and written. An open-source bibliography of assessment of undergraduate research found on the Council on Undergraduate Research website links to a Zotero library of 317 articles. However, after filtering the 317 articles for *social science, humanities,* and *non-STEM,* there remained just three articles. Current scholarship on the effectiveness of undergraduate research for students in non-STEM disciplines is limited. Undergraduate research is an opportunity for students to learn skills that are critical for their participation in this global environment, and therefore ensuring that the programs are effective is a critical next step for researchers.

Summary

Undergraduate research is a mechanism for improving student outcomes and engaging students. Students can engage with members of the academic and professional community through mentoring and inclusive practices. These practices are necessary for the success of students both while at school and during their post-baccalaureate experiences. However, to meet this call for action, institutions need to focus on three areas: the non-STEM student as a member of the research community, the role of the mentor in building relationships that can contribute to the development of critical thinking skills, and the further development of undergraduate research as a high-impact practice. Recommendations for future practice include defining high-quality mentoring, prioritizing the assessment of undergraduate research, and revisiting what constitutes undergraduate research. Recommendations for future research include exploring the impact of identity on students' participation in non-STEM-based undergraduate research programs; evaluating the effectiveness of non-STEM undergraduate research programs as preparation for 21st-century work; and surveying all undergraduate research programs at research universities, including those at the campus level as well as the department level.

References

Alderton E. & Manzi, M. (2017). Engaging students: An authentic undergraduate research experience. *The Professional Educator, 42*(1), 1-12.

Altman, J. D., Chiang, T., Hamann, C. S., Makhluf, H., Peterson, V., & Orel, S. E. (2019). Undergraduate research: A road map for meeting future national needs and competing in a world of change. *Council of Undergraduate Research* White Paper No.1.

Althubaiti, A. (2015). Undergraduate medical research programme: A cross-sectional study of students' satisfactions, perceived challenges, and attitudes. *Global Journal of Health Science, 7*(5), 117-123.

Anderson, N. J. (2017). Thinking globally, interviewing locally: Using an intensive interview project to teach globalization and social change. *Teaching Sociology, 45*(4), 388-398. DOI: i10.1177/009205 5X17718252

Association of American Colleges & National Leadership Council (US). (2007). *College learning for the new global century: A report from the national leadership council for liberal education & America's promise*. Association of American Colleges.

Astin, A. W. (1984). Student involvement: A developmental theory for higher education. *Journal of College Student Personnel*, *25*(4), 297-308.

Auchincloss, L. C., Laursen, S. L., Branchaw, J. L., Eagan, K., Graham, M., Hanauer, D. I., Lawrie, G., McLinn, C. M., Pelaez, N., Rowland, S., Towns, M., Trautmann, N. M., Varma-Nelson, P., Weston, T. J., & Dolan, E. L. (2014). Assessment of course-based undergraduate research experiences: A meeting report. *CBE-Life Sciences Education, 13*, 29-40.

Banks, M. L. Haynes, K., & Sprague, J. (2009). A model for motivating PharmD students to pursue a PhD degree. *Currents in Pharmacy Teaching and Learning, 1*, 93-97.

Bauer, K. W. (2001). The effect of participation in undergraduate research on critical thinking and reflective judgment. In *annual meeting of the Association for Institutional Research. (ERIC Reproduction no. ED 457 747)*.

Bauer, K. W. & Bennett, J. S. (2003). Alumni perceptions used to assess undergraduate research experience. *The Journal of Higher Education, 74*(2), 210-230. https://www.jstor.org/stable/3648256

Beckman, M. & Hensel, N. (2009). Making explicit the implicit: Defining undergraduate research. *CUR Quarterly, 29*(4), 40-44.

Block, J. and Block, J. (1980). California Child Q-set. Consulting Psychologists Press.

Bourelle, T. (2015). Writing in the professions: An internship for interdisciplinary professions. *Business and Professional Communication Quarterly, 78*(4), 407-427. DOI:10.1177/2329490615589172

Boyer, E. L. (1998). The Boyer commission on educating undergraduates in the research university, reinventing undergraduate education: A blueprint for America's research universities.

Brew, A. (2013). Understanding the scope of undergraduate research: A framework for curricular and pedagogical decision-making. *Higher Education*, *66*(5), 603-618.

Brewer, G., Dewhurst, A. M. & Doran, D. (2012). Undergraduate research projects: Practice and perceptions. *Psychology Learning and Teaching, 11*(2), 208-217.

Bringle, R. G. & Hatcher, J. A. (1996). Implementing service learning in higher education. *The Journal of Higher Education, 67*(2), 221-239. https://www.jstor.org/stable/2943981

Brown, C. L. (2017). Linking public health nursing competencies and service-learning in a global setting. *Public Health Nursing, 34*(5), 485-492.

Brownell, J. E., & Swaner, L. E. (2009). High-impact practices: Applying the learning outcomes literature to the development of successful campus programs. *Peer Review*, *11*(2), 26-30. http://search.ebscohost.com/login.aspx?direct=true&db=ehh&AN=41522329

Brownell, S. E., Hekmat-Scage, D. S., Singla, V., Seawall, P. C., Iman, J. F. C., Eddy, S. L., Stearns, T., & Cyert, M. S. (2015). A high-enrollment course-based undergraduate research experience improves student conceptions of scientific thinking and ability to interpret data. *CBE-Life Sciences Education, 14*(2), 1-14.

Brownell, S. E. & Kloser, M. J. (2015). Toward a conceptual framework for measuring the effectiveness of course-based undergraduate research experiences in undergraduate biology. *Studies in Higher Education, 40*(3), 525-544. https://doi.org/10.1080/03075079.2015.1004234

Brundage, V. Jr. (2017). Profile of the labor force by educational attainment. The U.S. Bureau of Labor Statistics.

Burnette III, J. M. & Wessler, S. R., (2013). Transposing from the laboratory to the classroom to generate authentic research experiences for undergraduates. *Genetics, 193*(2), 367-375.

Campbell, C. M. and Cabrera, A. F. (2011). How sound is NSSE?: Investigating the psychometric properties of NSSE at a public, research extensive institution. *The Review of Higher Education, 35*(1), 77-103.

Caputo, J. J. K. (2013). Undergraduate research and metropolitan commuter university student involvement: Exploring the narratives of five female undergraduate students. *ProQuest LLC, dissertation.* 1-270.

Carini, R. M., Kuh, G. D., & Klein, S. P. (2006). Student engagement and student learning: Testing the linkages. *Research in Higher Education, 47,* 1–32.

Carpi, A., Ronan, D. M., Falconer, H. M., & Lents, N. H. (2017). Cultivating minority scientists: Undergraduate research increases self-efficacy and career ambitions for underrepresented students in STEM. *Journal of Research in Science Teaching*, *54*(2), 169-194.

Cartrette, D. P. & Melroe-Lehrman, B. M. (2012). Describing changes in undergraduate students' preconceptions of research activities. *Research in Science Education, 42*(6), 1073-1100.

Casey, C. M., Wormington, S.V. & Oleson, K.C. (2012). Promoting comfort and confidence while conducting research through a Pluralistic Ignorance Project. *Teaching of Psychology, 39*(4), 293-296.

Chickering, A. W. & Gamson, Z. F. (1987). Seven principles for good practice in undergraduate education. American Association for Higher Education.

Chizhik, A. W. (1998). Collaborative learning through high-level verbal interaction: From theory to practice. *The Clearing House, 72*(1), 58-61. http://www.jstor.org/stable/30189422

Choi, J. & Hannafin, M. (1995). Situated cognition and learning environments: Roles, structures, and implications for design. *ETR&D, 43*(2), 53-69.

Ciarocco, N. J., Lewandowski, G. W., & Van Volkom, M. (2013). The impact of a multifaceted approach to teaching research methods on students' attitudes. *Teaching of Psychology, 40*(1), 20-25. https://doi.org/10.1177%2F0098628312465859

Collins, A., Brown, J. S. & Newman, S. E. (1988). Cognitive apprenticeship: Teaching the craft of reading, writing, and mathematics. Technical report. BBN Laboratories Incorporated.

Colucciello, M. L. (1999). Relationships between critical thinking dispositions and learning styles. *Journal of Professional Nursing, 15*(5), 294-301.

Cooley, E. L., Garcia, A. L. & Hughes, J. L. (2008). Undergraduate research in psychology at liberal arts colleges: Reflections on mutual benefits for faculty and students. *North American Journal of Psychology, 10*(3), 463-472.

Creswell, J. W. & Poth, C. N. (1998). Qualitative inquiry and research design: Choosing among five approaches. 4th Ed. Sage Publications.

Cuthbert, D., Arunachalam, D. & Licina, D. (2012). It feels more important than other classes I have done: An 'Authentic' undergraduate research experience in sociology. *Studies in Higher Education, 37*(2), 129-142.

Davis, S. N. and Wagner, S. E. (2019). Research motivations and undergraduate researchers' disciplinary identity. *Sage Open, 9*(3).

Dewey, J. (1933). How we think: A restatement of the relation of reflective thinking to the educative process. D.C. Heath.

Dolan, E. L. & Johnson, D. (2010). The undergraduate-postgraduate-faculty triad: Unique functions and tensions associated with undergraduate research experiences at research universities. *CBE-Life Sciences Education*, *9*, 543-553. DOI: 10.1187/cbe.10–03–0052

Downey, C. A. (2013). Student research in an introductory psychology course: Outcomes of two experiential learning projects and implications for instructions of human subjects research. *The Journal of Effective Teaching, 13*(2), 21-37.

Duncan, D. W., Birdsong, V., Fuhrman, N., & Borron, A. (2017). The impacts of a national internship program on interns' perceived leadership, critical thinking, and communication skills. *Journal of Leadership Education, 16*(2), 23-39.

Eisenhardt, K. (1989). Building theories from case study research. *The Academy of Management Review, 14*(4), 532-550. http://www.jstor.org/stable/258557

Ennis, R. H. (1962). A concept of critical thinking. *Harvard Educational Review, 32*(1), 81-111.

Ennis, R. H. (1985). A logical basis for measuring critical thinking skills. *Educational Leadership, 43*(2), 44-48. http://search.ebscohost.com/login.aspx?direct=true&db=ehh&AN=8518132

Ennis, R. H. (1992). *The degree to which critical thinking is subject specific: Clarification and needed research.* Teachers College Press.

Ennis, R.H., Millman, J., & Tomko, T.N. (1971). *Manual for Cornell Critical Thinking Test: Level X and Level Z*. University of Illinois.

Facione, P. A. (1990). *Critical thinking: A statement of expert consensus for purposes of educational assessment and instruction. Research findings and recommendations.* American Philosophical Association.

Facione, P. A. & Facione, N. C. (1992). *The California critical thinking skills test.* The California Academic Press.

Facione, P. A., Facione, N. C., and Giancarlo, C. F. (1996). The motivation to think in working and learning. *New Directions for Higher Education*, *96,* 67-79.

Fair, C. D. (2007). "I just want to help people, why do I need research methods?": Community-based research with human services majors. *The International Journal of the Scholarship of Teaching and Learning.* 1-12.

Falconer, J. & Holcomb, D. (2008). Understanding undergraduate research experiences from the student perspective: A phenomenological study of a summer student research program. *College Student Journal, 42*(3), 869-878.

Fechheimer, M. (2011). How well do undergraduate research programs Promote engagement and success of students. *CBE-Life Sciences Education, 10,* 156-163.

Felten, P., & Clayton, P. H. (2011). Service-learning. *New Directions for Teaching & Learning, 2011*(128), 75–84. https://doi.org/10.1002/tl.470

Finley, A. & McNair, T. (2013). *Assessing underserved students' engagement in high-impact practices.* American Association of Colleges and Universities.

Garcia, R. & Wyels, C. (2014). REU design: Broadening participation and promoting success. *Involve: A Journal of Mathematics, 7*(3), 315-326.

Gates, A. Q., Teller, P. J., Bernat, A., Delgado, N., & Della-Piana, C. K. (1998). Meeting the challenge of expanding participation in the undergraduate research experience. In *Frontiers in Education Conference, 1998. FIE'98. 28th Annual, 3,*1133-1138) IEEE.

Gellin, A. (2003). The effect of undergraduate student involvement on critical thinking: A meta-analysis of the literature 1991-2000. *Journal of College Student Development, 44*(6), 746-762. https://doi.org/10.1353/csd.2003.0066

George, M. (2012). Teaching focus group interviewing: Benefits and challenges. *Teaching Sociology, 41*(3), 257-270. DOI: 10.1177/0092055X12465295

Giancarlo, C. A., & Facione, P. A. (2001). A look across four years at the disposition toward critical thinking among undergraduate students. *The Journal of General Education*, *50*(1), 29-55.

Gilmore, J., Vieyra, M., Timmerman, B., Feldon, D., & Maher, M. (2015). The relationship between undergraduate research participation and subsequent research performance of early career STEM graduate students. *The Journal of Higher Education, 86*(6), 834-863.

Glaser, G. B. & Glaser, E. M. (1942). *Watson-Glaser tests of critical thinking*. World Book Company.

González, C. (2001). Undergraduate research, graduate mentoring, and the university's mission. *Science*, *293*(5535), 1624-1626.

Grzyb, K., Snyder, W., & Field, K. G. (2018). Learning to write like a scientist: A writing-intensive course for microbiology/health science students. *Journal of microbiology & biology education*, *19*(1), 19.1.10. doi:10.1128/jmbe.v19i1.1338

Guinness, P. (2012). Research-based learning: Teaching development through field schools. *Journal of Geography in Higher Education, 36*(3), 329-339. https://doi.org/10.1080/03098265.2012.696188

Hackett, C. D. (2016). Kufundisha: An innovative teaching approach for student engagement and experiential learning. *The Journal of Pan African Studies (Online), 9*(8), 84-101.

Haeger, H., Banks, J. E., Smith, C., Armstrong-Land, M. (2020). What we know and what we need to know about undergraduate research. *Scholarship and Practice of Undergraduate Research, 3*(4), 62-69.

Halpern, D. F. (1986). *Thought and knowledge: An introduction to critical thinking* (3rd ed.) Lawrence Erlbaum Associates.

Halpern, D. F. (1998). Teaching critical thinking for transfer across domains: Disposition, skills, structure training, and metacognitive monitoring. *American Psychologist*, *53*(4), 449-455. https://psycnet.apa.org/doi/10.1037/0003-066X.53.4.449

Harrison, M., Dunbar, D., Ratmansky, L., Boyd, K., & Lopatto, D. (2011). Classroom-based science research at the introductory level: Changes in career choices and attitude. *CBE-Life Sciences Education, 10*(3), 279-286.

Horowitz, J. & Christopher, K. B. (2013). The research mentoring program: Serving the needs of graduate and undergraduate researchers. *Innovative Higher Education, 38*, 105-116.

Hostetter, C., Sullenberger, S. W. & Wood, L. (2013). The key to learning: Engaging undergraduate students in authentic social work research. *The Journal of Baccalaureate Social Work.*

Hunter, A. B., Laursen, S. L., & Seymour, E. (2006). Becoming a scientist: The role of undergraduate research in students' cognitive, personal, and professional development. *Science Education*, *91*(1), 36-74.

Hunter, A., Laursen, S. L., & Seymour, E. (2008). Benefits of participating in undergraduate research in science: Comparing faculty and student perceptions. *Creating Effective Undergraduate Research Programs In Science*, 135-171.

Hurd, M. W. & Vincent, D. J. (2006). Functional magnetic resonance imaging (MRI): A brief exercise for an undergraduate laboratory course. *The Journal of Undergraduate Neuroscience Education, 5*(1), 22-27.

Hurtado, S. & Deangelo, L. (2012). Linking diversity and civic-minded practices with student outcomes. *Liberal Education, Spring*, 14-23.

Irving, J. H. (2011). Integrating research into an undergraduate accounting course. *Issues in Accounting Education, 26*(2), 287-303.

Ishiyama, J. (2006). Does early participation in undergraduate research benefit social science and humanities students? *College Student Journal, 36*(3), 380-386.

Islam, S. M. R. (2016). What are the importance and benefits of ‘critical thinking’? Retrieved from https://www.linkedin.com

Jaarsma, D., Muitjens, A., Dolmans, D., Schuurmans, E., Van Beukelen, P., & Scherpbrier, A. (2009). Undergraduate research internships: Veterinary students’ experiences and the relation with internship quality. *Medical Teacher, 31*, 178-184.

Johnson, S. R. & Stage, F. K. (2018). Academic engagement and student success: Do high-impact practices mean higher graduation rates? *The Journal of Higher Education, 89*(5), 753-781. DOI: 10.1080/00221546.2018.1441107

Johnston, R. (2006). Research quality assessment and geography in Australia: Can anything be learned from the UK experience? *Geographical Research*, *44*(1), 1-11.

Jordan, T. C., Burnett, S. H., Carson, S., Caruso, S. M., Clase, K., DeJong, R. J., Dennehy, J. J., Denver, D. R. et al. (2014). A broadly implementable research course in phage discovery and genomics for first-year undergraduate students. *mBio, 5*(1), e01051-13

Khalil, M. K. & Elkhider, I. A. (2015). Applying learning theories and instructional design models for effective instruction. *Advances in Physiology Education, 40*(2), 147-156. https://doi.org/10.1152/advan.00138.2015

Kilgo, C. A., Ezell Sheets, J. K. & Pascarella, E. T. (2015). The link between high-impact practices and student learning: Some longitudinal evidence. *Higher Education, 69*(4), 509-525. https://doi.org/10.1007/s10734-014-9788-z

King, P. M., Wood, P. K. & Mines R. A. (1990). Critical thinking among college and graduate students. *The Review of Higher Education, 13*(2), 167-186. DOI:https://doi.org/10.1353/rhe.1990.0026

Kinkel, D. H., & Henke, S. E. (2006). Impact of undergraduate research on academic performance, educational planning, and career development. *Journal of Natural Resources & Life Sciences Education*, *35*(1), 194-201.

Kobulnicky, H. A. & Dale, D. A. (2016). A community mentoring model for STEM undergraduate research experiences. *NTSA, 45*(6), 17-23.

Kolber, B. J., Janjic, J. M., Pollock, J. A., & Tidgewell, K. J. (2016). Summer undergraduate research: A new pipeline for pain clinical practice and research. *BMC Medical Education, 16*(135).

Kozeracki, C. A., Carey, M. F., Colicelli, J. & Levis-Fitzgerald, M. (2006). An intensive primary-literature-based teaching program directly benefits undergraduate science majors and facilitates their transition to doctoral programs. *CBE-Life Science Education, 5*, 340-347.

Kremer, J. F. & Bringle, R. G. (1990). The effects of an intensive research experience on the careers of talented undergraduates. *Journal of Research & Development in Education*, *24*(1), 1-5.

Kruse, N. B. & Taylor, D. M. (2012). Preservice music teachers' perceptions of a mentored research experience: A study within a study. *Journal of Music Teacher Education, 22*(1), 35-49. DOI: 10.1177/1057083711418510

Kuh, G. D. (1991). *Involving colleges: Successful approaches to fostering student learning and development outside the classroom*. Jossey-Bass Publishers.

Kuh, G. D. (2008). *High-impact educational practices: What are they, who has access to them, and why they matter.* Association of American Colleges and Universities.

Kuh, G. D., Cruce, T. M., Shoup, R., Kinzie, J. & Gonyea, R. M. (2008). Unmasking the effects of student engagement on first-year college grades and persistence. *The Journal of Higher Education, 79*(5), p. 540-563. https://doi.org/10.1080/00221546.2008.11772116

Kuh, G. and Kinzie, J. (2018). What really makes a 'high-impact' practice high impact. *Inside Higher Education,* (1).

Laird, (2005). *The California Critical thinking disposition inventory (CCTDI).*

Laursen, S. L., Hunter, A. Weston, T. & Thiry, H. (2009). URSSA, the Undergraduate Research Student Self-Assessment: A tool for assessing student outcomes of undergraduate research. *American Geophysical Union*. http://adsabs.harvard.edu/abs/2009AGUFMED13A0576L

Lave, J. & Wenger, E. (1991). *Situated learning: Legitimate peripheral participation*. Cambridge University Press.

Leggette, H. R., McKim, B., Homeyer, M., & Rutherford, T. (2015). Perspectives of writing related to critical thinking and knowledge creation. *NACTA Journal, 59*(4), 275-284.

Lincoln, Y. S. & Guba, E. G. (1982). Establishing dependability and confirmability in naturalistic inquiry through an audit. Paper presented at American Educational Research Association Annual Meeting.

Lincoln, Y. S. & Guba, E. G. (1985*).* Establishing trustworthiness. *Naturalistic Inquiry, 289*(331), 289-327.

Linn, M., Palmer, E., Baranger, A., Gerard, E., & Stone, E. (2015). Undergraduate research experiences: Impacts and opportunities. *Science*, *347*(6222), 627-633.

Lipman, M. (1995). Moral education higher-order thinking and philosophy for children. *Early Child Development and Care*, *107*(1), 61-70, DOI: 10.1080/0300443951070108

Lopatto. D. (2004). Survey of undergraduate research experiences (SURE): First findings. *Cell Biology Education, 3*(4), 270-277. https://doi.org/10.1187/cbe.04-07-0045

Lopatto, D. (2007). Undergraduate research experiences support science career decisions and active learning. *CBE-Life Sciences*, *6*(4), 297-306.

Mace, B. L., Woody, W. D. & Berg, L. A. (2012). Teaching environmental psychology by doing it: Explorations in the natural world. *Ecopsychology, 4*(*2*)*,* 81-86.

Marsh, L. E., Hashem, F. M., Cotton, C. P., Allen, A. L., Min, B., Clarke, M., & Eivazi, F. (2016). Research internships: A useful experience for honing soft and disciplinary skills of agricultural majors. *NACTA Journal, 60*(4), 379. http://search.ebscohost.com/login.aspx?direct=true&db=ehh&AN=120310969

Maton, K. I., Domingo, M. R. S., Stolle-McAllister, K. E., Zimmerman, J. L., & Hrabowski, F. A. (2009). Enhancing the number of African Americans who pursue STEM PhDs: Meyerhoff Scholarship program outcomes, processes, and individual predictors. *Journal of Women Minor Science Engineering, 15*(1), 15-37. doi: 10.1615/JWomenMinorScienEng.v15.i1.20

Matthews, R., Smith, B. L., MacGregor, J., & Gabelnick, F. (1996). Learning communities: A structure for educational coherence. *Liberal Education*, *82*(3), 4–10, [On-line]. Available: Ebsco http://search.epnet.com

Maxwell, J. A. (2005). *Qualitative research design: An interactive approach*. Sage Publications.

McDorman, T. (2004). Promoting undergraduate research in the humanities: Three collaborative approaches. *CUR Quarterly*.

McKinney, K. & Busher, M. (2011). The sociology research experience capstone course at three institutions. *Teaching Sociology, 39*(3), 290-302.

Merriam, S. B. (1998). *Qualitative research and case study applications in education.* Revised and expanded from “Case Study Research in Education”. Jossey-Bass.

Mullen, C., & Klimaitis, C. (2021). Defining mentoring: a literature review of issues, types, and applications. *Annals of the New York Academy of Sciences*, *1483*(1), 19–35. https://doi.org/10.1111/nyas.14176

Multhaup, K., Davoli, C., Wilson, S., Geghman, K., Giles, K., Martin, J., & Salter, S. (2010). Three models for undergraduate-faculty research: Reflections by a professor and her former students. *CUR Quarterly*, *31*(21).

National Education Association. (2012). Preparing 21st century students for a global society: An educator's guide to "the four Cs." Author Unavailable: http://www.nea.org/assets/docs/A-Guide-to-Four-Cs.pdf (n.d.). Retrieved December 1, 2019, from https://nces.ed.gov/ipeds/TrendGenerator/app/answer/7/32.

National Science Foundation. *Research Experiences for Undergraduates (REUs): Sites and supplements*. Program Solicitation 19-582. https://www.nsf.gov/pubs/2019/nsf19582/nsf19582.pdf

Pellegrino, J. W. & Hilton,, M. L. (Eds.). (2012). Education for life and work: Developing transferrable knowledge and skills in the 21st-century. National Research Council.

Nussbaum, M. (2004). Liberal education & global community. *Liberal Education, 90*(1), 42–47.

Nussbaum, E. M., Dove, I. J., Slife, N., Kardash, C. M., Turgut, R., & Vallett, D. (2018). Using critical questions to evaluate written and oral arguments in an undergraduate general education seminar: A quasi-experimental study. *Reading and Writing,* 1-22. https://doi.org/10.1007/s11145-018-9848-3

Palmer, J (Ed.). (2001). *Fifty major thinkers on education: From Confucius to Dewey*. Routledge.

Partridge, L. & Sandover, S. (2010). Beyond 'Listening' to the student voice: The undergraduate researcher's contribution to the enhancement of teaching and learning. *Journal of University Teaching and Learning, 7*(2).

Pascarella, E. T., Seifert, T. A., & Blaich, C. (2009). *Validation of the NSSE benchmarks and deep approaches to learning against liberal arts outcomes.* Center of Inquiry in the Liberal Arts at Wabash College.

Pascarella, E. T. & Terenzini, P. T. (1991). *How college affects students: Findings and insights from twenty years of research*. Jossey Bass.

Paul, R. W., Elder, L., Bartell, T. (1997). *California teacher preparation for instruction in critical thinking: Research findings and policy recommendations*. Commission on Teacher Credentialing.

Pomerantz, N. (2006). Student engagement: A new paradigm for student affairs. *The College Students Affairs Journal, 25*(2), 176-185.

Porter, S. R. (2011). Do college student surveys have any validity? *Review of Higher Education, 35*, 45–76.

Potter, S. J., Abrams, E. Townson, L., Williams, J. E., & Wake, C. (2010). Intellectual growth for undergraduate students: Evaluation results from an undergraduate research conference. *Journal of College Teaching & Learning, 7(*2), 25-34.

Provost, J. (2016). Research for all: A CURE for undergraduates. *ASBMB TODAY.* https://www.asbmb.org/asbmbtoday/201604/Education/CUREs/

Pyne, K. B., Scott, M. A., O'Brien, M., Stevenson, A., & Musah, M. (2014). The critical pedagogy of mentoring: Undergraduate researchers as mentors in youth participatory action research. *Collaborative Anthropologies, 7*(*1),* 50-83.

Reinvention Center. (2001). *Reinventing undergraduate education: Three years after the Boyer Report.* SUNY Stony Brook.

Resnick, L. B. (1987). The 1987 Presidential Address learning in school and out. *Educational Researcher*, *16*(9), 13-54. DOI: 10.2307/1175725.

Robnett, R. A., Nelson, P. A., Zurbriggen, E. L., Crosby, F. J., & Chemers, M.M. (2018). Research mentoring and scientist identity: insights from undergraduates and their mentors. *International Journal of STEM Education*, *5*(1), 1–14. https://doi.org/10.1186/s40594-018-0139-y

Rogers, M. & McDowell, W. G. (2015). Assessing the impact of undergraduate research on graduation rates at the University of Georgia. *CUR Quarterly, 36*(2), 33-40.

Roksa, J., & Levey, T. (2010). What can you do with that degree?: College major and occupational status of college graduates over time. *Social Forces 89*(2), 389-415. doi:10.1353/sof.2010.0085.

Rowlett, R. S., Blockus, L., & Larson, S. (2012). Characteristics of excellence in undergraduate research (COEUR). CUR Quarterly.

Russell, S. H., Hancock, M. P., & McCullough, J. (2007). Benefits of undergraduate research experiences. *Science (Washington)*, *316*(5824), 548-549.

Saldaña, J. (2016). *The coding manual for qualitative researchers* (3rd ed.). Sage Publications.

Seymour, E., Hunter, A., Laursen, S. L., & Deantoni, T. (2004). Establishing the benefits of research experiences for undergraduates in the sciences: First findings from a three-year study. *Wiley InterScience*, *DOI 10.1002/sce.10131*

Shanahan, J. O., Ackley-Holbrook, E., Hall, E. Stewart, K. & Walkington, H. (2015). Ten salient practices of undergraduate research mentors: A review of the literature. *Mentoring & Tutoring: Partnership in Learning*. DOI: 10.1080/13611267.2015.1126162

Siegel, H. (1980). Critical thinking as an educational ideal. *Educational Forum, 45*(1), 7-23.

Singer, J. & Zimmernan, B. (2012). Evaluating a summer undergraduate research program: Measuring student outcomes and program impact. *CUR Quarterly, 32(*3), 40-47.

Sireci, S. G. & Zenisky, A. L. (2006). Innovative item formats in computer-based testing: In pursuit of improved construct representation. In S. M. Downing & T. M. Haladyna (Eds.), *Handbook of test development* (p. 329-347). Lawrence Erlbaum Associates Publishers.

Smith, J. S. & Wertlieb, E. C. (2005). Do first-year college students' expectations align with their first-year experiences? *NASPA Journal, 42*(2), 153-174. https://doi.org/10.2202/1949-6605.1470

Snyder, D. W., Nielson, R. P., & Kurzer, K. (2016). Foreign language writing fellows programs: A model for improving advanced writing skills. *Foreign Language Annals, 49*(4), 750-771.

Social Science. (n.d.). Retrieved December 1, 2019, from https://www.merriam-webster.com/dictionary/social science.

Spiro, R. J., Feltovich, P. J., Jacobson, M. J., & Coulson, R. L. (1991). Knowledge representation, content specification, and the development of skill in situation-specific knowledge assembly: Some Constructivist issues as they relate to cognitive flexibility theory and hypertext. *Educational Technology*, 22-25.

Stake, R. E. (1995). *The art of case study research*. Sage Publications.

Stanford, J. S., Rocheleau, S. E., Smith, K. P. W. & Mohan, J. (2017). Early undergraduate research experiences lead to similar learning gains for STEM and Non-STEM undergraduates. *Studies in Higher Education, 42*(1), 115-129.

Stedman, J. B., Apling, R. N., & Riddle, W. C. (1993). Goals 2000: Educate America Act overview and analysis. U.S. Department of Education.

Sternberg, R. J. (1986). Critical thinking: Its nature, measurement, and improvement. National Institute of Education.

Stoeckman, A. K., Cai, Y., & Chapman, K. D. (2019). iCURE (Iterative course-based undergraduate research experience): A case study. *Biochemistry and Molecular Biology Education, 47*(5), 565-572.

Stuart, L. (1999). *21st Century Skills for 21st Century Jobs*. A Report of the U.S. Department of Commerce, U.S. Department of Education, U.S. Department of Labor, National Institute for Literacy and Small Business Administration.

Taraban, R. & Logue, E. (2012). Academic factors that affect undergraduate research experiences. *Journal of Educational Psychology, 104*(2), 499-514.

Terenzini, P. T., & Pascarella, E. T. (1991). Twenty years of research on college students: Lessons for future research. *Research in Higher Education*, *32*(1), 83-92.

The Evolllution. (2012). Discussing the mission and values of research universities. Author Unavailable. https://evolllution.com/opinions/audio-discussing-the-mission-and-values-of-research-universities/

Thiry, H., Weston, T. J., Laursen, S. L., & Hunter, A. (2012). The benefits of multi-year research experiences: Differences in novice and experienced students' reported gains from undergraduate research. *CBE- Life Sciences Education, 11(*3), 260-272.

Tinto, V. (2003). Learning better together: The impact of learning communities on student success. Higher Education Monograph Series, 1.

Trojan, S., Meyers, C., & Hudson, N. (2016). Incorporating writing-intensive assignments in an animal science production course. *NACTA Journal, 60*(4), 417-422.

Tsui, L. (1999). Courses and instruction affecting critical thinking. *Research in Higher Education, 40*(2), 185-200. https://doi.org/10.1023/A:1018734630124

Walters, K. S. (1986). Critical thinking in liberal education: A case of overkill? *Liberal Education, 72*(3), 233-244.

Watson, G. & Glaser, E. M. (1980). Watson-Glaser Critical Thinking Appraisal: Forms A and B. Psychological Corporation.

Webber, K. L., Krylow, R. B., & Zhang, Q. (2013). Does Involvement Really Matter? Indicators of College Student Success and Satisfaction. *Journal of College Student Development, 54*(6), 591-611. doi:10.1353/csd.2013.0090.

Welsh, A. J., Shaw, A., & Fox, J. A. (2017). The pairing of a science communications and a language course to enrich first-year English language learners' writing and argumentation skills. *Journal of College Science Teaching, 46*(5), 64.

Wenger, E. (1998). *Communities of practice: Learning, meaning, and identity*. Cambridge University Press.

Weston, T. J. & Laursen, S. L. (2017). The undergraduate research student self-assessment (URSSA): Validation for use in program evaluation. *CBE- Life Sciences Education, 14*(3). https://doi.org/10.1187/cbe.14-11-0206

Whipple, E. E., Hughes, A. & Bowden, S. (2015). Evaluation of a BSW research experience: Improving student research competency. *Journal of Teaching in Social Work*, *35*(4), 397-409. DOI: 10.1080/08841233.2015.1063568

Willison, J., & O'Regan, K. (2007). Commonly known, commonly not known, totally unknown: A framework for students becoming researchers. *Higher Education Research & Development*, *26*(4), 393-409.

Winter, D., McClelland, D., & Stewart, A. (1981). *A New Case for the Liberal Arts: Assessing Institutional Goals and Student Development*. Jossey-Bass.

Wollschleger, J. (2019). Making it count: Using real-world projects for course assignments. *Teaching Sociology, 47*(4), 314-324.

Woods, M., Paulus, T., Atkins, D. P., & Macklin, R. (2015). Advancing qualitative research using qualitative data analysis software (QDAS)? Reviewing potential versus practice in published studies using ATLAS.ti and NVivo, 1994-2013. *Social Science Computer Review, 34*(5), 597-617.

Yin, R. K. (1998). *The abridged version of case study research: Design and method.* In L. Bickman & D.J. Rog (Eds.), Handbook of applied social research methods (pp. 229-259). Sage Publications.

Yin, R. K. (2018). *Case study research and applications: Design and methods*. 6th Ed. *Sage Publications*.

Young, S. & Maley, M. (2018). Using practitioner-engaged evidence synthesis to teach research and information literacy skills: A model and case study. *The Journal of Academic Librarianship, 44*(2), 231-237. https://doi.org/10.1016/j.acalib.2018.02.002

Zhao, C. & Kuh, G. D. (2004). Adding value: Learning communities and student engagement. *Research in Higher Education, 45*(2), 115-138. https://doi.org/10.1023/B:RIHE.0000015692.88534.de

Zhao, P., Li, P., Ross, K. & Dennis, B. (2016). Methodological tool or methodology? Beyond instrumentality and efficiency with qualitative data analysis software. *Qualitative Social Research Forum, 17*(2).

Zilvinskis, J., Masseria, A. A., & Pike, G. R. (2017). Student engagement and student learning: Examining the convergent and discriminant validity of the revised National Survey of Student Engagement. *Research in Higher Education, 58*, 880-903. DOI 10.1007/s11162-017-9450-6

APPENDICES

APPENDIX A

Semi-Structured Interview Protocol

A. Hello, my name is Tracy Sikorski and I am a PhD candidate in educational psychology at the University of Illinois at Chicago. In this study, I am seeking to understand how key stakeholders define undergraduate research for non-STEM students and what challenges are experienced in designing and implementing programs of research for non-STEM students. To answer these research questions, would you be willing to participate in an interview? The focus of the questions will be demographic information related to the institutional commitment to undergraduate research, the goals of such programs, the different types of programs available, as well as assessment efforts. Finally, there will be an opportunity to share any additional information you may want to share as it relates to the program of undergraduate research for non-STEM students. If you consent to participate, we'll begin.

B. Introduction

C. What is the name of your institution?

D. What is the name of the institutional undergraduate research office?

E. What is your primary role at your institution?

F. How long have you been in this position?

G. What is the reporting structure of the office?

H. Does the office host annual dissemination efforts for students that participate in UR programs? What is the format? Is there judging?

APPENDIX A (continued)

I. Do you have an advisory board? What are their roles and responsibilities?

J. How many FTE’s are assigned to the office? What is the distribution (staff, faculty, mentors, students) of the appointments?

K. What is the source of the office’s funding, both for programmatic and salary?

L. How many students do you serve on average annually?

M. Which academic programs do you primarily engage with? Are there any academic programs that you do not engage with?

Definition of UR

1. *How does your office/ your campus define undergraduate research?*

Goals of URP

2. *Could you expand on what you see as the primary goals of participating in undergraduate research activities?*

Types of URP

3. *What are some of the types of undergraduate research activities at your institution?*

Assessments of URP

4. *How do you assess the effectiveness of the institution’s undergraduate research activities as they relate to these goals and the types of programs you have?*

STEM/non-STEM

5. *How are the goals, program types, and methods of assessment tailored for specific academic disciplines? Is there differentiation by disciplines?*

APPENDIX A (continued)

Specific to non-STEM Programs

6. *What challenges do administrators face in delivering, implementing, and assessing undergraduate research programs to non-STEM students?*

Additional Questions or Comments

APPENDIX B

Table 7

Research Study Alignment Table

Research Questions	Findings
RQ1: What are the goals, types, and methods of assessing undergraduate research programs at select research universities?	Goals. The goals of undergraduate research programs are (1) improving educational outcomes; (2) engaging students; and (3) preparing for post-graduation. Types. The types of undergraduate research programs are (1) all-campus programs and (2) peer programs. Methods of Assessment. There are limited formal methods of assessing undergraduate research programs.
RQ2a: How are undergraduate research programs similar and different at select research universities?	Similarities in undergraduate research programs across the institutions include (1) mentoring and (2) inclusivity. Differences in undergraduate research programs across institutions include (1) the way in which undergraduate research is defined and (2) institutional resources available for undergraduate research programs.
RQ2b. How are undergraduate research programs similar and different among programs in STEM disciplines and non-STEM disciplines at select research universities?	A similarity in undergraduate research programs among STEM and non-STEM disciplines is the importance of diversity. Differences in undergraduate research programs among programs in STEM and non-STEM disciplines include (1) the types of resources available and (2) perceived membership in the undergraduate research community.
RQ3: What challenges do stakeholders at these institutions face in developing, implementing, and assessing undergraduate research programs for students in non-STEM disciplines?	The two challenges stakeholders face in developing, implementing, and assessing undergraduate research programs for students in non-STEM disciplines are (1) assessment and (2) recruitment of non-STEM students.

Validity			
Triangulation. Multiple data sources were used to validate the findings for this question. Web data was collected, coded, and used to inform discussions during the semi-structured interviews. The web data and interview data were compared prior to coding to ensure validity among the responses.	Note taking. During each interview, the researcher took copious amounts of notes. The notes were referenced and used to clarify any questions that arose throughout data coding and analysis.	Demographic Data. The researcher collected demographic data on each participant institution. The data was entered into a database and cross referenced throughout data coding and analysis (see Appendix D). These attributes were also entered into NVIVO to establish similarities and differences among the institutions.	Inquiry Audit Trail. The researcher maintained an audit trail which included dated web documents, interview transcripts, marked up versions of the transcripts, notes from the interviews, and coding decisions.

APPENDIX C

Table 8

Detailed Data Analysis Steps

Step #	Detailed Steps taken during Data Analysis
1	The researcher recorded land grant status, PSI rate, 2018 UG enrollment, 1st year retention, 6-year graduation rates, selectivity rates, degree of urbanization, mission statement, and governance for all institutions from the IPEDS/NCES database.
2	The researcher looked up on the CUR website and recorded CUR membership status of all 131 R1 institutions.
3	The researcher visited home webpage of selected institutions (CUR institutional members) and searched for "undergraduate research".
4	The researcher visited the resulting undergraduate research office main page (found via the search) and recorded main web address, contact information, and undergraduate research office name.
5	The researcher reviewed the content on the main webpage of the undergraduate research office thoroughly for stated goals, types of programs, and methods of assessment of undergraduate research programs.
6	The researcher copied relevant data into a master database for further review. An example of P24's website data is found in Table 9.

Table 9

Example of Website Data

Goals	Types	Methods of Assessment
Building understanding across differences	Independent research experience	Survey research and retention studies
Examining information in the world around them	Undergraduate research assistants	Focus groups
Appreciating life-long discovery	Research experience supervised by a research sponsor	Longitudinal assessments of the impact of the program

APPENDIX C (continued)

Table 8 (continued)

Detailed Data Analysis Steps

Step #	Detailed Steps taken during Data Analysis
7	The researcher reviewed hyperlinks and other content that was available on the webpage.
8	The researcher entered webpage data into NVIVO. This data was later used to confirm the data collected during the semi-structured interviews.
9	Upon IRB approval, the researcher sent interview requests to each institution meeting study inclusion criteria.
10	The researcher scheduled interviews throughout summer 2020 for the participant's preferred time and date. Three requests were sent to each institution. Upon confirmation of interview date and time, participants were sent a Zoom link and the semi-structured interview protocol for pre-review.
11	The researcher recorded interviews via Zoom and uploaded the audio recording to NVIVO immediately following the interview for transcribing.
12,	The researcher downloaded transcribed interviews to the local drive and reviewed for accuracy. During this review, the researcher listened to the audio while reviewing the transcripts and made corrections to the transcript. The notes that the researcher took during the interview were used to supplement and confirm any discrepancies in the transcript.
13	Once all of the interviews were completed, the researcher uploaded all 29 files to NVivo for coding. Thirty interviews were conducted. One audio file was damaged and could not be transcribed.
14	The researcher entered the demographic data in NVivo for the 30 interviewed participants that was previously collected.
15	The researcher initially coded each file to the interview question that it responded to (i.e., what are the goals- coded at goals; what is the FTE - coded at FTE; what are the challenges - coded at challenges). This led to the first set of codes.

APPENDIX C (continued)

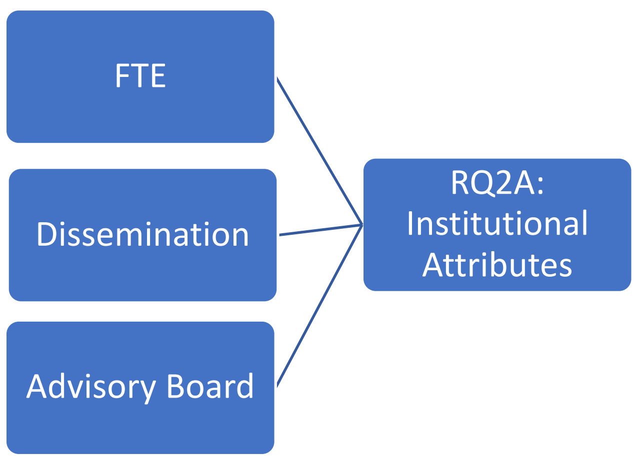
Table 8 (continued)

Detailed Data Analysis Steps

Step #	Detailed Steps taken during Data Analysis
16	Once all 29 files were coded in this way, the researcher categorized the codes according to the RQs (i.e., goals, types, and assessments; institutional and STEM and non-STEM attributes; challenges). Figure 11 is an example of this categorizing the initial codes to specific interview questions. The entirety of this group of questions was intended to capture undergraduate research program attributes.

Figure 13

Example of Initial Coding Related to Interview Questions



17	Once this process was complete, the researcher began second cycle coding (pattern coding). This process entailed identifying themes and patterns that existed within the categories.

APPENDIX C (continued)

Table 8 (continued)

Detailed Data Analysis Steps

Step #	Detailed Steps taken during Data Analysis
18	During second cycle coding, the researcher reviewed all of the text excerpts within the primary codes. For RQ1, the excerpts were then sub-coded for themes. As themes were identified, the researcher created new subcodes. For example, any goal excerpts that referred to problem solving, identifying questions, or learner were coded at the subcode critical thinking. This process continued for all of RQ1 - goals, types, and methods of assessment. The RQ1 primary codes, number of excerpts, and number of subcodes for each primary code is found can be found in Table 10.

Table 10

Research Question 1 Primary Codes, Number of Excerpts, and Number of Subcodes

RQ1 Primary Code	Number of Excerpts	Number of Subcodes
Goals	n = 151	n = 8
Types of Programs	n = 159	n = 6
Methods of Assessment	n = 105	n = 3

19	The researcher analyzed the excerpts within the subcodes for overarching themes (i.e., critical thinking and communication skills - improving educational outcomes; workshops and symposiums - all campus programs) and applied a new top-level code based on the derived themes. The result of the analysis is as follows: subcodes: critical thinking, communication skills, research skills, and retention → top-level code: educational outcomes → primary code: goals → category: RQ1.

APPENDIX C (continued)

Table 8 (continued)

Detailed Data Analysis Steps

Step #	Detailed Steps taken during Data Analysis
20	During second cycle coding for RQ2 and RQ3,-the researcher reviewed all of the text excerpts that were coded and categorized during first cycle coding to identify similarities and differences among the participants. For example, interview responses related to "defining undergraduate research" were initially coded in response to the interview question and categorized under RQ2. However, once differences in responses as they related to how participants defined undergraduate research emerged, new top-level codes were created to represent the different ways it was defined (i.e., outcome, process, co-curricular). As the researcher discovered similarities and differences among the excerpts, the researcher created a new primary code (i.e., similarities, differences) within the specified RQ category to represent the finding. During this step, some text excerpts were assigned a second code. For instance, inclusion was initially coded as a response to the goals of undergraduate research. However, once it became apparent that inclusivity was a similarity among all of the participants as well as a goal, excerpts related to inclusion were given a second top-level code located under the primary code of similarities, and categorized to RQ2.
21	The researcher conducted a text search of all files for the themes identified in response to RQ2 and RQ3. The researcher individually reviewed the resulting excerpts and if not previously coded, the researcher added a code at the appropriate level. Some items were more easily identified with a simple stem word base search (i.e., mentor, inclusive) than others (i.e., diversity, identity). A sampling of the text queries are below.

Table 11

Text Query Example and Number of Excerpts

Theme	Number of Excerpts
Mentor (mentoring, mentorship)	n = 290
Inclusive (inclusion, inclusivity, broaden)	n = 116
Diversity (race, ethnicity, socioeconomic, underrepresented)	n = 23
Resources (time, funding, infrastructure)	n = 310
Identity as Researcher	n = 55
Defining Undergraduate Research	n = 129

APPENDIX C (continued)

Table 8 (continued)

Detailed Data Analysis Steps

Step #	Detailed Steps taken during Data Analysis
22	Once this process was complete, the researcher reviewed each code for appropriate placement and final corrections were made if applicable.
23	The researcher generated the findings from the final list of codes.
24	Once the findings were confirmed, a complete review of the transcripts was conducted to confirm any unexpected findings. During the review, the researcher reviewed the coded text excerpts and transcripts, ran a word count query, conducted multiple text search queries that included stemmed words of the code as well as any synonyms of the code, and ran a coded query to match coded text excerpts across codes, to ensure the appropriateness of the codes.
25	The researcher drafted tables and figures based on the coded excerpts.

APPENDIX D

Table 12

Data Table

Code	Land Grant Y=1; N	PSI	Control	Selectivity	Selectivity Category	UG Enrollment Category	Retention Rate	6 yr Grad	Degree of Urbanization
P1	2	5583	Public	52.08%	More	M	81	66	City: Small
P10	1	4085	Public	83.52%	Selective	M	79	58	City: Large
P11	2	6022	Public	76.90%	More	L	91	76	City: Small
P12	2	9350	Public	82.04%	Selective	L	76	41	City: Midsize
P13	1	5312	Public	94.48%	More	L	85	64	City: Large
P14	2	7738	Public	74.02%	Selective	L	73	40	City: Large
P15	1	5043	Public	77.84%	More	L	87	68	City: Midsize
P16	1	5122	Public	46.85%	More	L	94	78	City: Large
P17	2	1319	Private	8.46%	More	M	97	94	City: Small
P18	1	5278	Public	57.97%	More	L	92	77	City: Small
P19	2	5302	Public	63.06%	More	L	88	73	City: Midsize
P2	2	779	Private	17.12%	More	M	97	90	City: Large
P20	2	4582	Public	81.54%	More	L	88	70	City: Midsize
P21	2	24131	Public	42.53%	Selective	L	90	69	Suburb: Large
P22	1	7300	Public	62.16%	More	L	93	88	City: Small
P23	2	4460	Public	91.70%	More	M	84	63	City: Small
P24	2	4724	Public	22.82%	More	L	97	91	City: Midsize
P25	2	4011	Public	22.71%	More	M	97	91	City: Small
P26	2	6708	Public	55.85%	More	L	87	74	Suburb: Large
P27	2	12544	Public	79.52%	Inclusive	L	74	48	City: Large
R28	2	11003	Public	48.68%	More	L	94	84	City: Large
P29	1	4158	Public	64.84%	More	L	93	84	City: Small
P3	1	3232	Public	47.19%	More	M	93	81	Suburb: Large
P30	1	8086	Public	77.19%	Selective	L	79	67	Town: Distant
P4	1	2666	Public	66.38%	More	M	90	83	Suburb: Large
P5	2	3548	Private	76.93%	More	M	89	70	City: Large
P6	2	21920	Public	58.55%	Selective	L	90	56	Suburb: Large
P7	2	9973	Public	36.77%	More	L	93	80	City: Midsize
P8	2	16334	Private	41.87%	More	M	93	84	City: Large
P9	2	7282	Public	81.05%	More	L	87	70	Suburb: Large

VITA

TRACY SIKORSKI, PHD

EDUCATION

2021	Ph.D., Educational Psychology, College of Education, University of Illinois at Chicago Dissertation: Undergraduate Research: An Exploratory Study of Undergraduate Research at Research-Intensive Universities Advisor: Kimberly Lawless
2010	M.Ed., Instructional Leadership, University of Illinois at Chicago Area of Concentration: Policy Studies
2007	M.Ed., Multicultural Education, National University
2002	B.A., Sociology, University of Colorado, Colorado Springs

PROFESSIONAL EXPERIENCE

2020 - Present	Associate Director, Budget and Financial Analysis, University of Illinois at Chicago
2015 - 2020	Director, Office of Social Science Research, University of Illinois at Chicago
2009 - 2015	Associate Director, Office of Social Science Research, University of Illinois at Chicago
2016 - 2020	Institutional Research Board, Social Science, University of Illinois at Chicago

SERVICE

2015 - 2020	Academic Advisory Professional Committee (APAC)
2017 - 2020	Chair, APAC
2016 - 2020	University Professional Personnel Advisory Committee (UPPAC)

2017 - 2018 Chair (rotating), UPPAC

TEACHING

2007 - 2008 SD170, Chicago Heights, Illinois

2006 - 2007 FSUSD, Fairfield, California

2003 - 2005 MJUSD, Marysville, California

HONORS

Chancellor's Student Service Award

Strategic Diversity Thinking and Planning Student Committee

PROFESSIONAL MEMBERSHIPS

2015 - Present Council of Undergraduate Research (CUR)

2017 - Present CUR Councilor, Social Science Division

2019 - Present Diversity and Inclusion Subcommittee

PRESENTATIONS

Bhattacharyya, P., Sikorski, T., & McRae, V. (2019). *Models for augmenting diversity and inclusion in undergraduate research.* Presented at the Biennial Undergraduate Research Programs Conference, Columbus, OH.

Sikorski, T. (2019). *Undergraduate research experiences for the social sciences: A literature review*. Poster session presented at the annual UIC College of Education Research Day, Chicago, IL.

Sikorski, Tracy (2012). *Developing a model of best practices for first-year programming*. Presented at the 31st Annual Conference on the First Year Experience, San Antonio, TX.

Exemption Granted

July 2, 2020

Tracy Sikorski
Educational Psychology
Phone: (312) 996-4408

RE: **Protocol # 2020-0837**
"Undergraduate Research: An Exploratory Study of How Undergraduate Research is Defined at Select Research-Intensive Institutions "

Dear Mx. Sikorski:

Your application was reviewed on **July 2, 2020** and it was determined that your research meets the criteria for exemption as defined in the U.S. Department of Health and Human Services Regulations for the Protection of Human Subjects [45 CFR 46.104(d)]. You may now begin your research.

Exemption Granted Date:	July 2, 2020
Sponsor:	None

The specific exemption category under 45 CFR 46.104(d) is: (2)

Please note that the consent document/information sheet has been administratively revised to reflect the data retention plan as stated in the application. If changes to the approved consent document are desired, kindly submit a revised document via an amendment.

You are reminded that investigators whose research involving human subjects is determined to be exempt from the federal regulations for the protection of human subjects still have responsibilities for the ethical conduct of the research under state law and UIC policy.

Please remember to:

- → Use your research protocol number (2020-0837) on any documents or correspondence with the IRB concerning your research protocol.
- → Review and comply with the policies of the UIC Human Subjects Protection Program (HSPP) and the guidance ***Investigator Responsibilities***.

We wish you the best as you conduct your research. If you have any questions or need further help, please contact me at (312) 996-2014 or the OPRS office at (312) 996-1711. Please send any correspondence about this protocol to OPRS via OPRS Live.

UNIVERSITY OF ILLINOIS AT CHICAGO
Office for the Protection of Research Subjects
201 AOB (MC 672)
1737 West Polk Street
Chicago, Illinois 60612
Phone (312) 996-1711

Sincerely,

Sandra Costello
Assistant Director, IRB #7
Office for the Protection of Research Subjects

cc: Stacey S. Horn, Educational Psychology, M/C 147
Michael Thomas (faculty advisor), Educational Psychology, M/C 147

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