PURM
Perspectives on Undergraduate Research & Mentoring

The First Year Research Experience (FYRE): Through the Eyes of Research Coaches

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Introduction

Mentoring is a key component to support undergraduate students in learning to navigate research. Undergraduate students can develop research skills through undergraduate research experiences (UREs) consisting of one-on-one mentoring with professors, faculty, or senior graduate student research assistants. Course-based undergraduate research experiences (CUREs), however, enable students to experience research right in the classroom. Such initiatives can involve peer or near-peer student mentors who guide undergraduate students through aspects of the research process thereby supporting student research skill development. This paper explores the perspectives of these peer and near-pear mentors and opens up a broader discussion around how, when and where mentoring experiences have an impact on mentors. The majority of scholarship on peer and near-peer mentoring in research focuses on the dyad or triad models of mentorship within a URE-style research group setting. Further, within the literature on CURE, the bulk of scholarship is related to student skills outcomes and there is less investigation into what peer and near-peer mentors within CUREs gain from their experiences. As such, this paper presents the outcomes (i.e., the benefits and challenges) from the perspectives of the senior undergraduate and graduate students, who worked as research coaches, mentoring students within the First Year Research Experience (FYRE) program at the University of Saskatchewan.

Literature Review

In 2015, Shanahan et al. (2015) conducted a literature review of over 100 peer-reviewed articles aimed at supporting faculty mentors who undertake undergraduate research mentorship. Their paper identified ten salient high-quality practices of undergraduate research mentorship. One of those salient practices is to promote intentional opportunities for peers or near-peers (i.e., other senior undergraduate or graduate students) to learn and practice mentoring skills (Shanahan et al., 2015). The majority of the literature on graduate student mentoring, however, focuses on the dyad (undergraduate student-graduate student) or triad (undergraduate-graduate-faculty supervisor) individualized models of mentorship usually found within a lab-based or similar research-intensive setting (Shanahan et al., 2015; Pfund et al., 2006; Edwards et al., 2011; Dolan & Johnson, 2009). Dolan and Johnson (2009) explicitly focused on the impact of UREs (Undergraduate Research Experiences) on graduate and postdoctoral mentors. Their study showcased how one-on-one

mentoring relationships promoted both socio-emotional, instrumental, interpersonal, professional, and cognitive gains, as well as challenges and costs. Gains for mentors included confidence, satisfaction, better interpersonal communication skills, and increased disciplinary knowledge. Challenges included issues related to student protégés holding widely varied and inconsistent knowledge required to conduct research, balancing time commitments, and learning to let the protégé succeed or fail on their own.

There is somewhat less understanding of professional and academic development outcomes for peer and near-peer mentors who work within course-based research (CURE) experiences. While it may be true that some of the outcomes experienced by URE mentors versus CURE mentors are similar, the contexts are different. In a dyad or triad-based URE model, the mentors develop mentorship skills related to four main areas. First, mentors develop skills through building interpersonal relationships with students. Second, within a URE, the peer or near-peer mentor supports the student protégé with increased networking within the discipline. Third, the mentoring relationship builds explicit support for a particular research project, such as providing feedback, reframing challenges as learning opportunities, and reciprocally, improving graduate student research productivity through undergraduate labour support, which aids the graduate student. Finally, there are gains for the peer/near-peer mentor by supporting the protégé to meet basic expectations of the research or lab environment to ensure that the student protégé learns technical, social, and academic skills (Dolan & Johnson, 2009). It should also be noted that within a URE setting, the protégé has often been chosen and brought into the environment in part due to an advanced skillset, high marks, or other characteristics of potential success.

In CURE, the role of the peer and near-peer mentors resembles a "facilitator of scholarly thinking" (Shanahan et al., 2015, p.11). Their role might be somewhat more similar to that of a laboratory assistant or a tutorial assistant, a paid position designed to support specific course outcomes, guiding students to learn enough research skills to complete a project or lab, and whose job includes explicit responsibility for pedagogy and teaching of research methodology not just for one student but for a whole class. In contrast to a protégé within a URE, students in a first-year class may come from a wide variety of backgrounds, experiences, and knowledge; it becomes part of the peer and near-peer mentor's duty to address students, provide support, and teach them where they are. Student protégé training within a CURE focuses on academic and classroom norms, rather than the specific expectations of a particular research group or lab. Communication skill gains for the peer/near-peer mentor move beyond one-on-one and side-by-side interpersonal communication skills towards group facilitation and classroom-wide learning. There is little focus on disciplinary networking. Likewise, few CURE courses support specific research project gains, such as direct help, on the peer/near-peer's own research project. Yet, CURE mentors retain important aspects of the dyad or triad mentorship model, including learning how to provide good feedback, framing challenges as learning opportunities, improved cognitive and socioemotional growth, improved teaching and communication skills in general, and improved qualifications and career preparation (Dolan & Johnson, 2009; Shanahan et al., 2015).

If there have been fewer studies of peer and near-peer experiences as mentors within CUREs, one counter example is the Graduate Research Consultant (GRC) program at the University of North Carolina-Chapel Hill (Pukkila et al., 2013) which reported "extremely positive experiences" for their graduate research coach/consultants. The paper suggested that these opportunities influenced the coach's professional development and expertise in inquiry-based teaching and learning and provided almost 80% of those coaches with a "valuable" or "extremely valuable" opportunity. The GRC program provided an early model for the FYRE program as it developed at the University of Saskatchewan.

One area of interest for this paper is querying whether peer teaching experiences -- students teaching students, improve the methodological research skills of the peer teachers. Krych et al. (2015) showcased a form of peer teaching within an anatomy laboratory. When students in this study were asked to teach a concept to their peers, 100% reported improved content comprehension, and 92% reported increased communication skills. Likewise, Feldon et al. (2011) assessed research skill improvement in two groups of graduate students, one set with teaching and research responsibilities, and a control group with only research responsibilities. The students with teaching responsibilities demonstrated significantly greater improvement in research skills, including the ability to generate testable hypotheses and design valid experiments.

This paper seeks to add to the literature on peer and near-peer learning within a CURE environment as a contrast and extension of the literature drawn from URE. The overarching research question was, do peer and near-peers gain skills or experience challenges through their work as research coaches in the FYRE program at the University of Saskatchewan, and if so, what are those skills and challenges? In understanding these experiences, we hope to give research coaches a specific vocabulary that can be used when applying for professional positions, and to potentially delineate differences between mentorship in CURE vs. URE experiences. We will consider these learnings within the framework laid out by Dolan and Johnson (2009): gains (instrumental, socioemotional, interpersonal, professional, and cognitive) and challenges (interpersonal, socioemotional, instrumental, and external). However, the nature of a CURE, working with a wider variety of students at different stages of learning, means that FYRE coaches had different and additional experiences which allows us to extend Dolan and Johnson's framework.

Overview of FYRE

The University of Saskatchewan initiated FYRE in 2013 to explicitly grow the undergraduate research culture. FYRE is a CURE model incorporated early in a student's program of study (for published peer-reviewed articles on the University of Saskatchewan FYRE program, see Sangster et al., 2016; Guo, Loy, & Banow 2018; Lieffers et al., 2020). While many CUREs intend for students to experience original research, a FYRE class is not required to practice discipline-leading original research; instead, it asks students to undertake a research, scholarly, or artistic experience that is new to them. The goal is to support student skill development, increase confidence in learning how new knowledge is constructed, and better understand how the research, scholarly or artistic process works within that discipline. The project may or may not be original research.

The open structure of the FYRE program allows professors to develop unique discipline-driven projects that follow a research project structure within a single semester for approximately 13 weeks. Faculty members design a project framework that follows the research cycle: question, investigate and share (Figure 1). Students first work to build and refine a researchable question. Then, students collect evidence and engage in synthesis and analysis to determine findings. Finally, FYRE students must share their results with people beyond their professor. Options include sharing their results to the rest of the class, other classes in a larger research-sharing venue (e.g., campus poster session), or in a public format accessible outside the university (e.g., websites, social media, and wiki). Faculty members can develop a FYRE project as either a group or individual project, depending on the norms of the discipline.

Since its inception in 2013, the FYRE program at the University of Saskatchewan has enrolled over 17,000 students at the first-year level (Figure 2). A faculty member opts-in to the FYRE program and works with the Gwenna Moss Centre for Teaching and Learning on campus, to ensure that the course as outlined fits the requirements of the FYRE program, and to qualify for funding to hire research coaches for the class. FYRE classes have been taught across the university, from Kinesiology to Agriculture, Geography and Planning to English, Economics to Women's and Gender

Studies, History to Environmental Studies, Education to Astronomy. There have been no FYRE classes in subjects that might be considered prime CURE candidates, such as physics, chemistry, biology or geology, in part due to instructional resistance to changing the traditional laboratory format. At the University of Saskatchewan, FYRE has experienced the best reception from faculty in humanities and social science disciplines, with a few additional courses in sciences. There are normally more FYRE students enrolled in the fall semester (between 1000 and 1500 students), with fewer (about a thousand) in the winter term. A limited number of spring and summer classes choose to use the FYRE format.

Figure 1. *The FYRE Research Cycle*

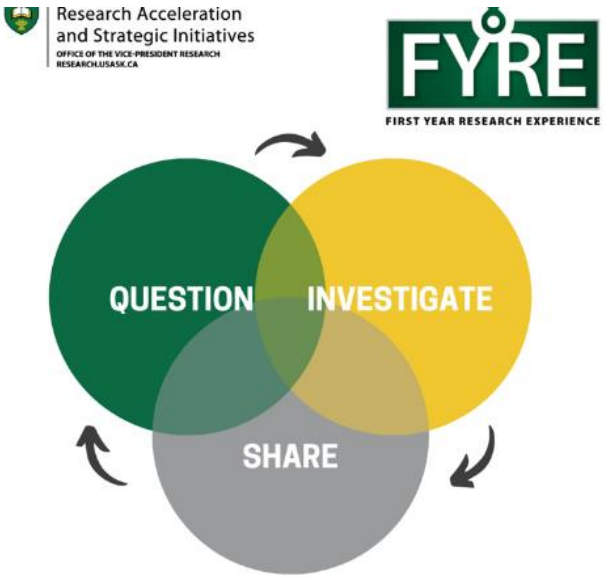
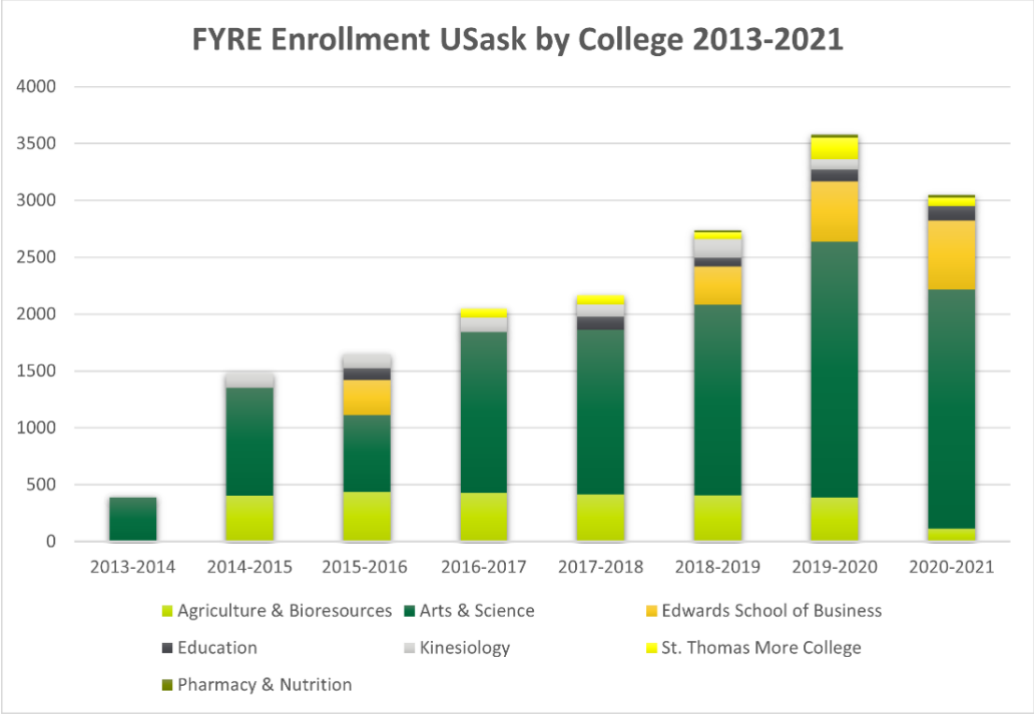


Figure 2. *FYRE Enrollment by College 2013-2021*



A drop in FYRE enrollment during 2020-2021 was largely due to a switch to online instruction during the COVID pandemic. Some courses and instructors suspended FYRE projects until resumption of in-person learning.

In a typical semester, FYRE courses are supported with 66 hours of coaching per 100 students, pro-rated, depending on the class and the nature of the FYRE project. Some classes conducting original research projects may need more FYRE research coach hours while others choosing literature review projects or those with pre-set databases may require less time. The professor chooses either individual or group FYRE projects. Typically, a group project allows no more than five students per group. Most larger classes with 75 or more students have at least two FYRE research coaches while a smaller class has one coach. Research coaches typically work no more than six hours per week, though that is flexible depending on the needs of the FYRE project.

In 2019, the Undergraduate Research Initiative created a survey to establish a better understanding of student outcomes from the FYRE program. Overall data (N = 898 first year students) shows that 84% indicate that they are better equipped to identify good scholarly research, 78% say that they are better equipped to summarize findings from multiple sources, and 76% indicate that they will go into their next course with increased confidence. Other student indicators include increased project management skills (77%), further developed writing skills (74%) and 73% feel more equipped to analyze data.

From an institutional perspective, one key difference in FYRE classes when compared to traditional classes is the inclusion of research coaches as peer and near-peer mentors for the students. Research coaches are senior undergraduate or graduate students, who have more research experience via advanced course work and can serve as a coach and guide to first-year students. Often, the research coach is well-known to the instructor or to the department, giving the instructor increased confidence in the research coach's basic research skills. These positions are funded institutionally from the Office of the Vice-President Research (OVPR) and are connected directly to a particular class; as such, they report directly to the teaching professor. Coaches receive about two hours of basic training around aspects of the research coach position (e.g., how to navigate the role, how to provide substantive feedback to students, and how to navigate boundaries) from the OVPR and instructional specialists, including a librarian seconded to the FYRE program. The coaches receive a suite of additional resources and references via a shared access point, considered the "home base" for FYRE research coaches. The research coaches remain connected to one another throughout the term, and to the OVPR. All research coaches receive regular check-ins from the OVPR, additional training and support as requested and as identified, and are given help by the appropriate source (library, teaching centre, or OVPR) with problem-solving specific issues if the teaching professor is unavailable. A research coach's work centers around providing guidance, training, coaching, and feedback to students during the research process, and involves duties ranging from one-on-one or group coaching to course-wide seminars on research skills via course materials, presentations, or research activities. Therefore, research coaches are mentors to the undergraduate students developing their research skills.

Methods

Of the eight authors for this paper, seven were research coaches in the FYRE program for at least one academic term, and one is the coordinator of the program. These represent 35% of all research coaches in a given semester. The coordinator of the FYRE program issued a call to all research coaches to contribute to this article. Seven research coaches expressed interest. Caroline Aubry-Wake, Renata Leonhardt, and Irini Soubry coached for the Department of Geography and Planning, with Fern Troop, Ruby Lindsay, and Bidushy Sadika for the Department of Women and Gender Studies, and Brooke Kleiboer for the Edwards School of Business, at the University of Saskatchewan.

At the first meeting to discuss the paper call from *Perspectives on Undergraduate Research and Mentoring*, the FYRE program coordinator facilitated a discussion to generate research questions. The coaches took turns in formulating questions, which were then noted down, rephrased, and finalized through group discussion:

Outcomes, Benefits, and Challenges for Research Coaches

1. What did you learn via the FYRE program?
2. What research or teaching skills did you learn, develop, or share as a research coach?
3. What are the benefits that you experienced in the FYRE program? What are the challenges that you experienced? What lessons did you learn?
4. Did you have positive or negative experiences with students?
5. How did your overall experience as a research coach influence your life goals and sense of self as an academic?

After the facilitated meeting, each coach reflected and wrote individual pieces responding to these open-ended questions. The coaches wrote these pieces independently during a three and a half-week deadline and there were no length restrictions. Each of the research coaches provided a unique view on their experiences in the FYRE program. The coaches came together with the FYRE program coordinator in a virtual group conversation. There, the coaches discussed what stood out to them from their FYRE coaching experiences. Next, the coaches collated the reflections and group conversation minutes on a shared document. Commonly accepted practices for summarizing qualitative data were used, in the sense that all responses for all questions were collated. The research coaches then identified common and important themes. The themes in this paper are more overarching than exhaustive.

In addition to these personal reflections, the coordinator of the FYRE program, Merle Massie, was able to draw on anonymous reflections to open-ended prompts contained within a post-class survey administered to FYRE research coaches. These anonymous surveys include responses from a larger number of research coaches (and might include responses from the seven research coaches of this study). The undergraduate research office uses these surveys to improve institutional support for the research coaches and the overall FYRE program. There are two open-ended questions, one regarding challenges ("Please describe and give examples of your top three challenges as a FYRE research coach.") and one regarding success and gains ("What were your successes/what were you most proud of during your time as a FYRE research coach?"), that elicited feedback used in the analysis below (2 surveys, one with 10 respondents, one with 15 respondents, n =25). The framing of the questions may have contributed to a more fulsome discussion of challenges, and a more limited discussion of successes and gains. The themes and observations from the anonymous survey open-ended questions add additional quotes and perspectives to the seven research coaches who engaged in this dialogue paper.

Limitations

There are several limitations to this study. The nature of a reflection piece, instead of a full-scale research project, necessitates a higher level of tolerance for personal bias. Thus, please review results accordingly. Some of the research coaches were more experienced in their position than others, having worked as a research coach in either multiple FYRE classes or across multiple terms in the same class; others provide their reflections after only one term/one class as a research coach. The reflections do not differentiate between coaches with different levels of experience. A research coach working for a more seasoned FYRE instructor may have had a different experience than a research coach working with a FYRE instructor who was new to the program. Each FYRE class has slightly different outputs and expectations, according to the needs of the discipline. The call from the FYRE coordinator led to self-selection for the purposes of writing this paper. However, that limitation

might be somewhat mitigated by the addition of qualitative data from the anonymous research coach surveys. Finally, the reflections have been organized for review purposes according to the gains/challenges as outlined by Dolan and Johnson (2009). However, those delineations were not used to set the original open-ended questions.[1]

Results: Outcomes identified by FYRE Research Coaches

Benefits/Gains

The self-reflection authors identified several benefits of being a FYRE research coach: skills development (i.e., interpersonal, pedagogical, technical and research skills), expansion and revision of content-based knowledge, and experiencing positive mental wellness. The anonymous surveys, in addition, revealed that being a research coach added significantly to these students' personal and professional skill development. For the purposes of this paper, we have developed a table that expands on the Dolan and Johnson (2009) taxonomy of gains and challenges. We have separated the self-reflection responses from those from the anonymous survey. However, quotes are drawn from both (Table 1).

Taking on the role of a research coach allowed the authors to shift from being student learners to mentor-teachers. Instrumental gains from this experience include increased qualifications towards furthering a career, increased research skill recognition and content-based knowledge. The authors found that the ability to remember their own experiences as an undergraduate aided their research coach role: "Interesting component I had not thought about - how as students ourselves, we can act as a bridge between the student and the professor, as we have a foot in both worlds." Certainly, working within the in-between space between faculty and student offered the authors opportunities for personal development, empathy, and leadership. The cognitive intellectual growth in understanding the difference between being a mentor instead of a mentee, or in being a teacher instead of a student, led to shifts in thinking and understanding. A few research coaches, via the FYRE experience, gained specific disciplinary support for their own research work. This example fits within the dyad model of near-peer one-on-one mentorship within a lab, where an undergraduate student's work can directly contribute to or support the senior student, but it was not the explicit goal of the FYRE course.

FYRE research coach experience positively affected the authors' socio-emotional wellbeing. They chose words such as "empowered" or spoke of how the experience helped them combat imposter syndrome or helped overcome shyness. They evolved as academics and became more confident. Most research coaches professed great personal satisfaction and pride, both in their own development and in the gains made by the students. The university FYRE student surveys showcase that the students gain confidence via experiencing the research process. Thus, it is important to note that the authors, as peer and near-peer mentors to the students, also gain confidence not only as teachers, but confidence that they put back into their own research projects. One coach explained using her "research coach" voice to talk herself through a difficult project – the skills learned in one area supported success in another. Positive experiences, such as students reaching out to research coaches to seek support, boosted the authors' positive psychological wellness according to the self-reflections of the authors. As research coaches, the authors were happy to see their students flourish in their FYRE projects. The coaches indicated that the experience brought enhanced self-awareness of the research process itself, which helped them to self-reflect and better understand their own work, as well as better able to construct good research questions and self-manage the

[1] Dolan and Johnson (2009) also asked about motive for becoming a mentor. Our research does not ask that question.

research process. Overall, research coaches also reported an increased understanding of issues related to student mental health and wellness, as well as their own socio-emotional growth.

Table 1. *Gains of being a FYRE research coach (drawn from self-reflections and anonymous surveys)*

Gain	Example	Self-reflection	Anonymous survey	Quotations
Instrumental	Content-based knowledge pertinent to research area or coursework	2/7	3/25	Going through student discussion posts allowed me to revise relevant concepts that benefitted my own manuscripts. I appreciated how their project was closely tied to my own year-long project so my expertise was especially useful and I felt confident in providing guidance.
	Skills-based knowledge specific to research	2/7	6/25	Being a FYRE coach really helped me break down…what I am actually doing when I am researching.
	Improved qualifications	3/7	7/25	I took on this position as an opportunity for self-development towards experience in mentoring and coaching, and it has definitely improved these skills for me.
Socio-emotional	Enhanced confidence	4/7	4/25	Self-confidence in general, and dealing with imposter syndrome.
	Personal satisfaction and pride	4/7	8/25	I am really proud of my students…some of them wanted to investigate more about their research question. I felt positively reinforced when I receive appreciation from students.
	Enhanced self-awareness	5/7	4/25	By guiding less experienced students through the process, it made me realize that I have valuable experience in this topic, and that I know how to perform scientific investigation. Overall, it was really empowering.
	Mental health and wellness	3/7	2/25	I recognize the difficulties that students in my class may have experienced…This awareness allowed me to be humane and approachable as a coach/mentor. Having students reach out to ask questions and feeling comfortable sharing their struggle in their respective projects and asking for help also made it feel like I managed to create a safe space for them to learn.
Interpersonal	Improved feedback skills	5/7	21/25	I also learned about providing useful feedback to students – balancing between useful, but not giving away the answer.
	Improved teaching/pedagogical skills	5/7	13/25	Through FYRE, I could understand that students learn in different ways and that one of the roles of a teacher is to reach all audiences. I developed all the material for these FYRE guides; this was a great teaching experience for me because I could see

				how it works in practice, to develop teaching material and apply it. I could identify gaps in the material and where it could be adjusted.
	Improved communication skills	5/7	22/25	I was able to refine my interpersonal communication abilities, as I led skills webinars and had one-on-one interactions with students, which definitely benefits my academic career.
	Group facilitation skills	3/7	11/25	I learned how to wait an uncomfortable length of time for questions and answers.
	Improved professional-ism	3/7	8/25	Gaining interpersonal skills and learning to work on a team in a professional setting rather than a student/academic setting was another useful skill.
Professional/ technical	Improved technical skills	3/7	12/25	Creating and organizing the FYRE modules, becoming familiar with our learning management system, and hosting FYRE presentations within online environments.
	Time management	4/7	11/25	I worked on my time management, having to balance my duties as a mentor and taking time to develop content to help the students and answer questions, with my own research responsibility.
	Boundaries	4/7	8/25	As a research coach, I had to decide how much energy to put into it, as research doesn't have well-defined boundaries.
	Career clarification	3/7	3/25	As a research coach, I feel a sense of respect because of my academic abilities, which boosts my conviction in fulfilling my ambition of becoming a professor.
Cognitive	Intellectual growth	3/7	5/25	I polished my own research skills and knew ways to overcome research-based challenges. I realize the difference between the 'teacher' and 'student' sides of me.
	Experience in being a mentor instead of a mentee	4/7	5/25	By having the opportunity to be a mentor, I got to see the other side of the process and I can now understand better the roles in both sides take in this relationship. I believe this will strongly help me develop and maintain good mentor-mentee relationships in my own research bubble.
External	COVID-19 pandemic and the shift to online learning	6/7	15/25	It felt good to help people and connect to students even though the classes were all online

As research coaches, the authors gained effective interpersonal skills, including improved feedback, mentorship and leadership skills, improved teaching and pedagogical skills, and communication skills including public speaking. The authors learned to distinguish the specifics of teaching research *skills* as opposed to simply relaying disciplinary *content*. An additional quote is worth adding: "A lot of the science process we do 'instinctively', without thinking too much about it. But by teaching it, I really had to step back and think about how and why every step fits in the scientific method and the overarching research process." Being able to break down the research process, to explain it step-by-step to students, led the authors to a new view of the whole process as coaches. Working as a research coach, each author gained pedagogical skills by experiencing what it is like to be a teacher.

These skills included developing and applying teaching materials, learning about and implementing different marking strategies, supporting professors, and learning from their methods. The iterative process of developing, using, then adjusting and changing teaching materials helped the authors as research coaches to understand that effective teaching, like research, is a process. Further, the authors learned various grading strategies, were able to support FYRE faculty members, and gained knowledge in pedagogical methods. One major difference from a URE is that research coaches had much higher exposure to group facilitation. Learning how to manage group dynamics and fostering and supporting group and classroom-wide learning brings forth additional skill sets in interpersonal communication. Finally, research coaches work within a professional dynamic that might include faculty instructors, other research coaches, lab instructors or tutorial assistants, requiring professionalism in a work context, as opposed to a student context.

The research coaches developed a host of improved technical and professional skills, from navigating university learning management systems (such as Blackboard or Canvas), through time management, boundary setting, to career and professional clarification. Research coaches practiced many technical skills, such as logistics and technical planning for large-scale research sharing events. The transition to virtual delivery meant research coaches acted as student support for technical glitches and requirements. As research coaches, the authors became skilled at time management to control their own course load and research project needs while balancing the sometimes pressing needs of the FYRE class. Setting boundaries helped students in their FYRE experience. Coaching students to do their own research work, especially when the authors are more experienced and know the answer, is boundary setting that not only supports research coaches, but effectively transitions students into taking control of their own learning. Some research coaches believe that the technical and professional skills inherent in being a research coach will translate well into their long-term professional development, either in academia or outside. Research coaches also learned effective ways to adapt and accomplish their roles in the COVID-19 pandemic. Some of the research coaches worked prior to and during the COVID-19 pandemic and reported differences between pre-pandemic and pandemic learning and engagement. The pivot online required the authors to effectively host and coordinate online meetings with students. While fulfilling their mentorship responsibilities in the COVID-19 pandemic, the authors learned to be more empathetic toward students and recognized students' need for extra reassurance, guidance, and reminders. An additional quote explains, "I learned that in this time of COVID-19, students need extra prodding to get things done and sometimes this is best done by someone other than the professor." The breadth of learning in communication ranged from written to oral and included multiple formats. While specific to and practiced within the online environment, hosting and coordinating meetings, as well as promoting student engagement via icebreakers and polls, and letting silence be a classroom tool, all of these technical and pedagogical gains are likely to translate into the in-person world. Finally, research coaches themselves appreciated FYRE as it provided additional ways to connect to others, relieving the isolation of the online environment. Being a research coach gave them added connections and helped to reduce loneliness.

Challenges

Although the authors benefited greatly from their research coach experiences, they faced distinct challenges. In the FYRE courses, students faced difficulties in teamwork, supporting students to understand the complexity and messiness of research, and staying productive in the overall academic and research processes due to the COVID-19 global pandemic (and beyond). These challenges are outlined in Table 2 and reflect a revised and expanded taxonomy including interpersonal challenges, socio-emotional challenges, instrumental, professional/technical, and external challenges, particularly due to the online environment.

Table 2. *Challenges of being a FYRE research coach (drawn from self-reflections and anonymous surveys)*

Challenges	Examples	Self-reflection	Anonymous Survey	Quote
Interpersonal	EDI (equity, diversity, and inclusion issues)	2/7	4/25	I felt inner conflicts about my abilities to mentor white students as a woman of color. I also have had a white student being disrespectful to me. Talking to my supervisor helped me overcome my self-consciousness due to cultural differences, as he was angry about a student being disrespectful to a member of his teaching team. My communication with international students was hard and it would be better to receive some training on communication and problem-solving with non-native students.
	Assessment – gauging student needs	4/7	15/25	I had to learn what research is from the perspective of a student who just left high school, to communicate better with students. A challenge I faced was assessing the background knowledge and skills the students had. Adjusting the material presented to the students' knowledge. It was hard to gauge what knowledge/experience they already had, and what was completely new or completely boring to them.
	Group dynamics and challenging conversations	3/7	12/25	Three of my students encountered issues that had to be dealt with on a personal level and away from a group setting, and I was able to participate in training regarding challenging conversations.
	Fostering engagement/ motivating students	5/7	15/25	One of the biggest challenges was keeping the students engaged in the FYRE project throughout the term. It is challenging to explain that research demands time and dedication and that it is important to commit. Among my main challenges was motivating students on a level that would enable them to complete their work; namely, convincing them why the work matters and what skills they are learning to take further into their education.
	Teaching professional/ communication skills	2/7	9/25	Students didn't seem to know about professional conduct. Poor email etiquette, poor time management for coming to meetings; difficulty pre-planning and scheduling meetings more than a day in advance.
Socio-emotional	Establishing trust	3/7	7/25	I have learned to be more proactive in reaching out to students who are not contributing or who need a bit of help. Many people feel a sense of shame in asking for help but I've learned ways to help them feel

				more comfortable in discussing strategies to get caught up.
	Fear/emotional costs	2/7	5/25	Mentoring these students was stressful – what if I made a mistake in my explanation of a topic, or provided misguiding or confusing guidelines, and caused the students to fail?
	Student mental health	2/7	4/25	Some did not submit their assignments, interact with me or the professor, and/or respond to emails. They were unresponsive during group project. Ultimately, the professor had to reach out to individual students, asking them to participate, and accommodate those who replied to the professor's email. But sometimes [student success] came down to students mental health, and a lot of the time they just needed encouragement.
Instrumental	Teaching outside discipline	2/7	5/25	I was an RA within a field that is not really in my expertise, so at the start I felt I might not be able to adequately guide the students within their research topic. However, I found out that the general research steps are the same, irrelevant of the topic. For me, it was an interdisciplinary experience, from which I learned and discovered a lot.
Professional/technical	Boundaries	3/7	6/25	Setting boundaries for myself – in the way that I had to help students find their way rather than just showing them.
	Time management	3/7	12/25	Time management – some weeks I would hear nothing from any students and typically as a due date approached, I would be flooded with messages which was hard at times to balance with my own coursework.
	Technical – navigating technical needs of course	2/7	9/25	Technology and administration of the project. Canvas was feature-poor with groups.
External	COVID-19 online environment	6/7	15/25	I learned how important peer contact and learning is to students, and how they are less able to connect and learn from each other in an online environment. It was challenging to engage with the students and really develop a mentorship/coaching relationship given that all of our correspondence happened over email.

There were several interpersonal challenges reported by the research coaches, including issues of equity, diversity and inclusion, and teaching students the basics of professional communication. Another challenge included addressing group dynamics, in particular helping student groups whose internal communications had broken down or were non-existent. The two toughest interpersonal challenges for research coaches were in assessment (i.e., gauging student needs) and in fostering student engagement. Student motivation to engage with the FYRE project, bringing students' research skills up to basic competency, and navigating the sweet spot between offering introductory and advanced research mentorship based on student needs, was a challenge reported by the majority of both the authors of this study and by research coaches in the anonymous survey. A FYRE class pushes students to understand and take ownership of their research learning process. An

additional quote is useful here: “Because it is a first-year class, maybe some students didn't realize how independent and self-led university learning can be.” It is indeed challenging for the authors as research coaches to mentor students through the process of transitioning from passive memorization to actively seeking out information and learning to put it together coherently in new ways.

The research coaches identified several socio-emotional challenges in their work with students in the FYRE classes. Some reported challenges to establishing trust, and conversely, relief when students would come to them, or seek them out for help. Others indicated some concern with emotional costs, worrying about making mistakes or training students in the wrong methodologies or giving bad advice. A few research coaches indicated the challenges of navigating student mental health issues. Again, this was often reported as a challenge that in some cases required faculty intervention, or registered as relief at being a “safe space” for students. Overall, research coach challenges weighed more heavily toward interpersonal than socio-emotional challenges, indicating that there is less personal risk from being a research coach, though there can be a high measure of frustration at things like lack of student engagement.

Research coaches reported some instrumental and technical challenges in their work. For those crossing disciplinary boundaries to teach at cognate classes, lack of specific disciplinary knowledge showed up as a concern. Likewise, research coaches reported technical challenges around boundaries and time management, being “flooded” by requests and having to manage those requests around their own work. Technology challenges, whether it was navigating the learning management system used by the university (such as Blackboard or Canvas) or in matching technology knowledge with the project requirements came up in some research coach reflections. Overall, with the exception of time management, these challenges appeared manageable within the broader experience.

One of the overarching challenges the authors faced was the external pressure from the pandemic, causing diminished interactions with students within the pandemic’s remote learning environment. Most of the authors struggled to keep students engaged via online or email conversations, or keeping their interest through online presentations. The challenge of finding ways to connect with students could, in some cases, result in last-minute meetings, poor scheduling, poor email etiquette, difficulty with pre-planning or difficulty maintaining momentum and time management. Other students simply disappeared from group projects or from the class itself, causing a cascading problem across projects and for the professors and research coaches. As research coaches, they struggled to find creative ways to address the online environment and implement new strategies, submission formats, laddered FYRE project steps, and sacrificing personal time to reach out to individual students, all while managing their own competing time-sensitive demands for their own classes and research expectations.

Discussion

What do we know about how CURE mentor experiences compare with the experience of mentoring UREs? Although the data are from different populations, institutions, and studies, it may be informative to consider FYRE research coach experiences in the context of experiences reported by graduate student mentors of UREs (Dolan & Johnson, 2009).

FYRE coaches mentor CUREs in addition to their graduate research work, and do not expect instrumental gains from coaching, such as improved personal research productivity or increased supervisor interaction. However, they did report instrumental gains in content-based knowledge, and clear gains in research skills from their experience breaking down and explaining the research process. FYRE coaches did expect their experiences to give them improved qualifications. Both FYRE

research coaches and the URE mentors examined by Dolan and Johnson (2009) reported socio-emotional gains including increased confidence, personal satisfaction, and enhanced self-awareness. The FYRE coaches also noted positive effects on mental health and wellness. FYRE research coaches noted greater gains related to interpersonal skills than did Dolan and Johnson's (2009) URE mentors, particularly in the areas of improved feedback skills, increased group facilitation, and improved professionalism in terms of being part of an instructional leadership group. Both sets of mentors (URE and FYRE) reported improvements in their teaching and communication skills.

The Dolan and Johnson (2009) taxonomy included gains in professional skills, and the FYRE research coach group revised and expanded this part of the taxonomy to include professional and technical skills, such as technical assistance, time management, and establishment of boundaries. Both URE mentors and FYRE research coaches reported career clarification. The FYRE research coaches were able to articulate their roles as mentors and explain how mentoring differed from being a mentee, as a way to build trust and connection with students. The FYRE research coaches were also able to identify external gains such as online communication skills due to the non-in person limitations imposed by the pandemic. Finally, both groups reported cognitive gains including intellectual growth.

Similarly, while Dolan and Johnson's (2009) taxonomy for challenges for URE mentors captured many of the reported challenges of the FYRE research coaches, there were also key differences. The FYRE research coaches expanded the category of interpersonal challenges to include issues of equity, diversity, and inclusion, navigating group dynamics, fostering student engagement, and directly mentoring students to address deficiencies in their professional and communication skills such as email etiquette. The FYRE research coaches did not report as many issues as did the URE coaches in balancing protégé needs with their own, except as an aspect of professionalism and boundaries. Both the URE and FYRE coaches reported that it is a challenge to assess and gauge student knowledge and abilities. The socio-emotional challenges of establishing trust and emotional costs were reported in both studies, though the FYRE research coaches added an explicitly noted understanding of student mental health challenges. While URE students reported reduced research productivity as an instrumental challenge, that was an expectation for FYRE research coaches, as their coaching was in addition to their research expectations. Instead, FYRE-related instrumental challenges included cross-disciplinary teaching. FYRE research coaches had distinct professional and technical challenges, including establishing boundaries, time management, and technical challenges, so these were added to the taxonomy. The main external challenges were different for the FYRE research coaches compared to the URE students, unrelated to issues of recognition or power, instead responding almost entirely to the pandemic.

It is clear that the experiences of FYRE research coaches, as mentors within course-based research experiences, may be similar to those of URE mentors as measured by Dolan and Johnson (2009) on a socio-emotional level, but their reporting is expanded at the instrumental, interpersonal, and professional/technical level. As well, the experiences of the FYRE research coaches are consistent with the findings of both Krych et al. (2005) on students teaching students, and Feldon et al. (2011) on how teaching improves methodological research skills. FYRE research coaches explicitly break down and teach the research process, not specific disciplinary content; therefore, they learn the research process better by teaching it to others. Similarly, while this study did not empirically measure improvements in research abilities, FYRE research coach reflections clearly indicated substantial improvement in essential research skills.

Recommendations

One of the research coaches in the anonymous surveys wrote, "There are some things that just have to be learned by experience, and navigating the role as a research coach is, in my opinion, one of them. While I found the initial training that we did to be helpful, there was a lot that I just had to learn as I did it." There is no real substitute for the "challenge by FYRE" (pardon the pun) of learning on-the-job by being a research coach. However, the above reflections indicate that there is some room for improvement in terms of research coach training, as well as increased pedagogical interventions at the classroom level to support student research skill development. At the moment, research coach training focuses primarily on how to give good feedback and supports significant communication skill development. It would be good to expand that training to include additional focus on fostering engagement, motivating students, and assessing student needs. These are areas where research coaches clearly spend a lot of time. The training already incorporates senior research coaches talking about their experiences, and deliberately works throughout the term to keep junior research coaches connected to senior coaches. Specific check-ins and additional training throughout the term, instead of front-loaded training, may provide better support. The FYRE program could do a better job of asking the teaching professors to be more critical and reflective regarding pedagogical practices, particularly in terms of breaking down projects into manageable pieces for students to learn in a step-wise process. As research coaches noted, a first-year class could be populated by students from all backgrounds and experiences. It's thus a challenge to bring everyone up to par.

Research coaches can also use this paper to self-identify their own or additional skillsets that they can use to build professional vocabulary. Sometimes, being able to articulate skillsets, such as socio-emotional or interpersonal skills, helps coaches and peer mentors better define what they have learned from their experiences, and to apply for graduate school or professional jobs where those skills might be valued and in demand.

Finally, it is clear that there are additional skillsets needed by mentors within CUREs than those within UREs, particularly in areas specific to pedagogical training, group and classroom-wide communication, group work facilitation, and supporting student engagement. If a university is creating supporting materials for CURE mentorship, there needs to be additional focus placed on these issues. The specific skillset research coaches report, of being able to break down and teach the research process, as opposed to teaching the norms of a specific lab or simply conferring content knowledge, is significant and could present an area of fruitful further exploration, particularly in understanding how engaging directly in the teaching process helps the research coach learn more deeply.

Conclusion

The FYRE program focuses on developing student research skills and learning at the first-year level which students can apply and continue to strengthen throughout upper year courses. Peer and near-peer mentors who work within the FYRE program as research coaches gain many of the same benefits and experience similar challenges as mentors in the dyad or triad based URE models, but this paper has shown distinct differences to working within a CURE setting, particularly in the areas of interpersonal, professional/technical, and instrumental areas of gain and challenge, as well as addressing the external demands of the pandemic. Research coaches in the FYRE program made the shift from being students to being mentor-teachers and in doing so developed significant professional and research skills, while working to overcome challenges. Through working with a larger number of students and student groups (rather than mentoring one or a small number of individuals) FYRE research coaches gained group facilitation and interpersonal communication and teaching skills on a broader scope. They also developed direct pedagogical skills, and some found enhanced mental wellness, satisfaction, pride, and confidence. While most expanded or updated

their disciplinary content knowledge, the key gain was specifically teaching and mentoring students through the research process. In breaking down and teaching research, the FYRE research coaches were able to learn it more deeply and in turn, apply that enhanced knowledge and skillset to their own work. FYRE research coach work was not without its challenges and these included working within COVID-19 restrictions, equity, diversity and inclusion issues, helping groups navigate teamwork, assessing student skillsets and developing personalized feedback for improvement, finding ways to overcome apathy and disengagement, and overall supporting students to understand the complexity and messiness of research and the need to devote the time required to conduct it well. Overall, this experience demonstrated that the CURE near-peer mentorship model, as experienced by FYRE research coaches, has benefits for mentors over and above those found from mentoring URE experiences. Supporting CURE mentorship may require enhanced training practices that account for the needs of larger groups, classroom-wide teaching and learning, facilitation, communication, assessment, and fostering student engagement. Overall, CURE mentorship experiences can provide vehicles for developing diverse mentoring and teaching practices, even in challenging times.

References

Dolan, E., & Johnson, D. (2009). Toward a holistic view of undergraduate research experiences: An explanatory study of impact on graduate/postdoctoral mentors. *Journal of Science Education and Technology, 18*(6), 457-500.

Edwards, T. M, Smith, B. K., Watts, D. L., Germain-Aubrey, C. C., Roark, A. M., Bybee, S. M., Cox, C. E., Hamlin, H. J., & Guilette Jr., L. J. (2011). Group-advantaged training of research (GATOR): A metamorphosis of mentorship. *BioScience, 61*(4), 301-311.

Feldon, D. F., Peugh, J., Timmerman, B. E., Maher, M. A., Hurst, M., Strickland, D., Gilmore, J. A., & Stiegelmeyer, C. (2011). Graduate students' teaching experience improve their methodological research skills. *Science*, *333*(6045), 1037-1039.

Guo, X., Loy, K., & Banow, R. (2018). Can first-year undergraduate geography students do individual research? *Journal of Geography in Higher Education, 42*(3), 412-426.

Krych, A. J., March, C. N., Bryan, R. E., Peake, B. J., Pawlina, W., & Carmichael, S.W. (2005). Reciprocal peer teaching: Students teaching students in the gross anatomy laboratory. *Clinical Anatomy*, *18*(4), 296-301.

Lieffers, J. R. L., Finch, S. L., Banow, R., & Loy, K. (2020). A course-based first-year research experience for undergraduate nutrition students. *Journal of Nutrition Education and Behaviour*, *52*(4), 451-455.

Pfund, C., Pribbenow, C. M., Branchaw, J., Lauffer, S. M., & Handelsman, J. (2006). The merits of training mentors. *Science*, *311*(5760), 473-474.

Pukkila, P. J., Arnold, M. S., Li, A. A., & Bickford, D. M. (2013). The graduate research consultant program: Embedding undergraduate research across the curriculum. *CUR Quarterly*, *33*(4), 28-33.

Sangster, S. L., Loy, K. L., Mills, S. D., & Lawson, K. L. (2016). Engaging first-year university students in research: Promise, potentials and pitfalls. *The Canadian Journal for the Scholarship of Teaching and Learning*, *7*(1), 1-33.

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*, *23*(5), 359-376.