Original Research Paper

Discussing Barriers for Undergraduate Students to Participate in Research Experiences

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Abstract: The Office of Undergraduate Research (UgR) at West Virginia University (WVU) connects undergraduates with research opportunities. Every semester, hundreds of students express their interest in these opportunities through a widely publicized Interest Form (IF). However, only a fraction of these students proceed with the process of being matched with a faculty research mentor and participating in a structured research experience. Research experiences are known to positively impact students' persistence in college and the advancement of their careers. Therefore, we aim to identify and address potential barriers that prevent undergraduate students from following through with the process of getting involved in research. We collected data from IFs over four consecutive semesters to identify specific stages in which students stop the enrollment process in the UgR program. Additionally, we wanted to identify specific groups of students by major who were more likely to discontinue the process to develop targeted recruitment strategies for these groups.

Keywords: Undergraduate Research Experiences; Programming melt; Student Success

Introduction

While there is a growing body of evidence concerning student's success, retention, and graduation rates of those who participate in undergraduate research experiences (Fernandez, et al. 2024; Chamely-Wiik et al. 2023; Petrella and Jung 2008), there is limited work on why undergraduates initially express interest in participating in research but later choose to discontinue the process, preventing them from engaging in a high impact practice (Kuh 2008). This phenomenon shares some similarities with "summer melt", which typically refers to high school students who fail to enroll in college the fall following their graduation (Castleman et al. 2013). For the purpose of this paper, *programming melt* will refer to the phenomenon of students who cease all communications with administrators of undergraduate research programs after initially expressing interest.

For students who choose to participate in undergraduate research experiences, the outcomes are highly influential on their scholarly journey and are well documented, especially in the fields of science, technology, engineering, and mathematics (STEM). Not only do undergraduate researchers graduate at a higher rate (Ashcroft et al. 2021; Graham et al. 2013; Schultz et al. 2011) than their peers but also attend graduate school equipped with the skills needed to become impactful and independent experts in their fields of study (Eagan et al. 2013). In this regard, a longitudinal study involving 1,420 STEM students from different institutions found that undergraduates who participated in mentored research were significantly more likely to pursue graduate school in science fields, persist in their major, and have higher-grade point averages than their peers who did not engage in those experiences (Hernandez et. al. 2018).

Due to the widely advertised benefits of participating in research, a significant number of undergraduates seek these opportunities rapidly after entering college and studies have shown that programs and initiatives designed to target students as soon as

they start in college increase their chances to successfully complete their degrees (Bowman and Holmes 2018; Noble et al. 2007).

Undergraduate Research Experiences can be offered through various models and approaches, each demonstrating significant benefits for participants (Maltese et al. 2017; Linn et al. 2015; Bangera and Brownell 2014; Nagda et al. 1998). Traditional models provide one-on-one mentoring opportunities where students work as apprentices for a more experienced researcher who serves as a mentor. To connect undergraduates with research opportunities, the Office of Undergraduate Research (UgR) at West Virginia University (WVU) implemented the Research Apprenticeship Program (RAP), a multidisciplinary, academic year, one-on-one mentored research experience that was designed to introduce students to research and creative work. Students within RAP conduct research across a broad spectrum of disciplines, including but not limited to research in STEM, arts, humanities, social science, and clinical research. A recent study involving 868 RAP participants demonstrated the program's significant impact on undergraduate retention (Pacheco et al. 2023). This highlights the importance for program administrators to identify and address *programming melt*.

This article presents data from four consecutive semesters of RAP recruitment to identify the stages at which students are most likely to cease communication with the program administrators during the enrollment process. Furthermore, it examines the relationship between each stage and the students' respective fields of study. Finally, it discusses strategies to mitigate what we have referred to as *programming melt*, which may benefit not only RAP administrators but also other higher education institutions in enhancing their undergraduate research practices.

Materials and Methods

RAP is largely advertised throughout WVU and students who are interested in participating are prompted to complete an Interest Form (IF) in which they include their name, major(s), and contact information. The data from the IFs are exported to a spreadsheet, which is used by the UgR staff to contact the students and keep track of their progress in the process of being matched with a faculty research mentor.

Students' progress throughout this process was divided in 5 different stages: Stage 1 (*Interest*) includes all the students who completed and submitted an IF. In Stage 2 (*Action*) are included students who after filling out the IF scheduled and attended an informational meeting with UgR staff. To facilitate this process, after the student submits the IF, they receive an automatic email with a link to schedule the meeting with the UgR staff, which students can attend either remotely or in-person and either in a group setting or individually, depending on their preference. During these sections, students receive instructions about the next steps (send to UgR their updated resume and the names of at least three potential mentors, selected from a database maintained by UgR with the names of faculty offering research opportunities for undergraduates). Stage 3 (*Work*) includes all the students who return the information to the UgR staff (updated resume and list of potential mentors from the database). After UgR staff receives the information from the students, they start contacting potential mentors and help the student to set up a meeting and prepare for the appointment. Students who attend those meetings with potential mentors are placed in Stage 4 (*Facilitation*). Lastly, Stage 5 (*Paired*), which are the students who are paired with a faculty research mentor and register for the program.

We gathered data from spreadsheets of four RAP recruitment cohorts, two in the fall and 2 in the spring semester to identify at which stages students are most likely to discontinue their search for a research experience.

Additionally, as we aimed to correlate students in each one of the 5 stages with their field of study, we categorized them into seven major groups: *Physical Sciences* (Chemistry, Physics, Mathematics, and Geology), *Engineering and Technology* (Mechanical, Civil, Aerospace, Petroleum, Electrical, Chemical, Biomedical, Computer Engineering, and Computer Science majors), *Behavioral and Social Sciences* (Psychology, Sociology, Anthropology, Political Sciences majors), *Biological and Health sciences* (Biology, Pre-Medical, Nursing, Animal Sciences, and Biochemistry majors), *Arts and Humanities* (Philosophy, Music, English, History, Foreign Language, and Gender Studies), *Undecided* (included any students who have not yet declared their major). Finally, a group of students who declared more than one major or a major and a minor. We named this group as Multiple Majors (MM) and separated them into three different sub-groups: MM STEM (all majors and

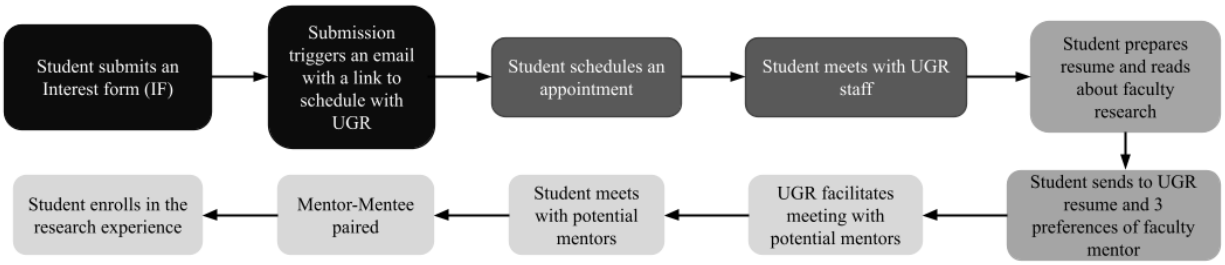

Figure 1. Workflow of RAP recruitment. Diagram summarizing the stages of RAP recruitment.

minors within STEM fields), MM STEM/non-STEM (one of the majors or minors in STEM and the other(s) in non-STEM fields), MM non-STEM (none of the majors within STEM fields).

Results

The total number of students in all disciplines who expressed interest in entering the RAP program in the fall (2023 and 2024) and spring (2023 and 2024) semesters was 1,385. Table 1 shows the distribution of the students who showed interest in RAP by their academic year.

Table 1. Percentage of students who expressed interest, categorized by their year in school

Cohort	Year in School			
	Freshman	Sophomores	Juniors	Seniors
Fall	68%	21%	7%	2%
Spring	63%	27%	7%	1%

Out of the 1,385 students who showed interest in the program, only 360 were able to successfully complete the stages needed to enroll in the program. The fall cohorts combined had the highest number of students expressing interest (n=835) whereas the spring cohorts had a total of 550 students showing interest (Table 2).

Table 2. Interest compared with participation in fall and spring cohorts of RAP.

Cohort	Number of students who showed interest	Number of students paired
Fall	835	227
Spring	550	133
Total	1385	360

Regardless of the number of students who expressed interest in the fall and spring, Stage 2 (*Action*) experienced the highest *programming melt* across both cohorts. In the fall cohort, there was a 65% decline, and in the spring cohort, there was a 62% decline among students who initially expressed interest. This means that from all students who expressed interest, only 35% of students in the fall and 38% in the spring advanced to stage 2. In contrast, the decline in stage 3 (*Work*) was much lower, with a reduction of 18% in the fall and 29% in the spring. This indicates that, of all students who expressed interest, 29% progressed to this stage in the fall, while 26% did so in the spring. Once students achieved stage 4 (*Facilitation*) practically all of them (less than 1% decline in both fall and spring) advanced to the final stage (*Paired*) (Figure 2).

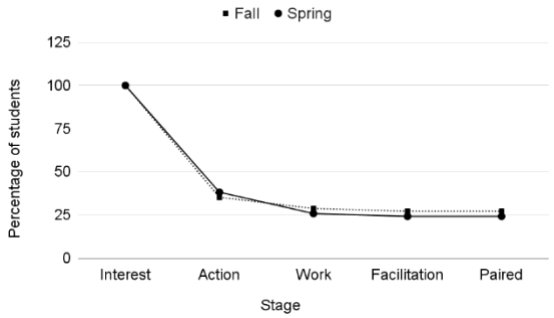

Figure 2. Programming melt in fall and spring cohorts. Interest (stage1), Action (stage 2), Work (stage3), facilitation (stage 4), and Paired (stage 5). Data are presented as percentages, with 100% representing the total number of students who expressed interest (n=1385).

When we analyzed students by their field of study, we found that the vast majority of students across all stages were in STEM and in STEM-adjacent fields (i.e. Health Sciences). Regardless, the pattern of *programming melt* was consistent across all fields of study, with stage 2 (*Action*) exhibiting the highest decline in both the fall and spring cohorts (Figures 3A and 3B). For students who declared more than one major, a major and a minor, or were undecided, only a small percentage were in non-STEM fields and the profile of *programming melt* followed the same pattern. The decline in stage 2 was especially pronounced

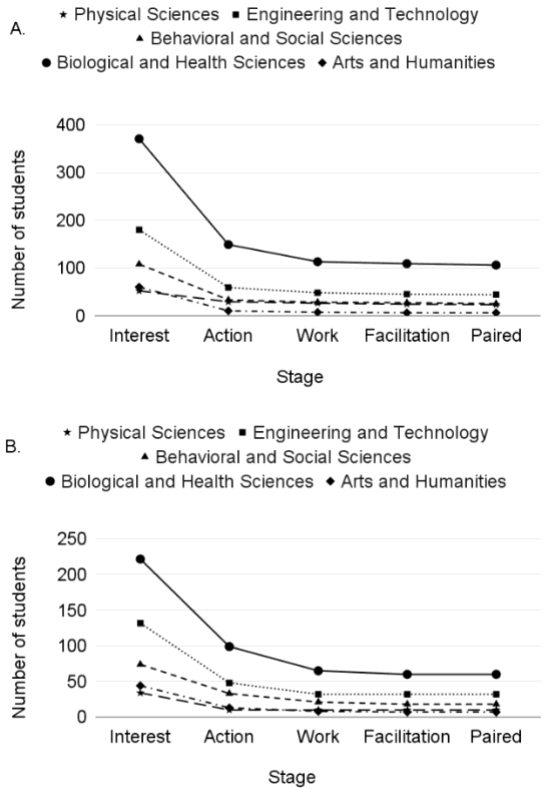

Figure 3. Programming melt in fall and spring cohorts by field of study. The graphic represents students who declared just one major by the time they showed interest in RAP. A. fall cohorts and B. spring cohorts.

among the undecided group (Figures 4A and 4B).

Discussion

High impact practices (HIPs), such as undergraduate research experiences, are widely recognized for their substantial benefits to all participating students. As a result, higher education institutions have consistently implemented these practices to improve student retention and success (Kuh *et al*. 2017). However, participation in HIPs may be restricted by factors such as limited awareness and accessibility barriers (Grabsch et al. 2021).

Our results showed that while a significant number of students expressed interest in participating in undergraduate research through RAP, less than half ultimately followed through and took part in the program.

The factors influencing undergraduate students' decisions to participate in research experiences are complex and highly variable. We know that specific barriers such as financial constraints play an important role in a student's decision-making. For instance,

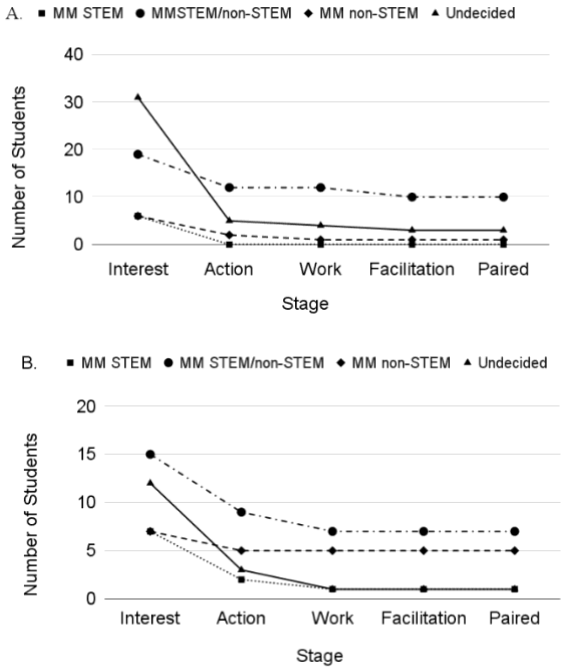

Figure 4. Programming melt in fall and spring cohorts by field of study. The graphic represents students who declared either more than one major or major and a minor (MM), and those who were undecided. A. fall cohorts and B. spring cohorts.

studies have shown that stipends are among the top factors influencing students' decisions to engage in research programs, alongside the focus of the research project itself (Kelly 2023; Economy *et al*. 2014). By alleviating financial concerns, stipends make research opportunities more accessible, particularly for students who might otherwise face barriers to participation.

In the RAP program, eligible students can use their Federal Work Study (FWS) funds to conduct research. NSF initiatives, such as the First2 Network, which supports first-generation and underrepresented STEM students from West Virginia, and the Louis Stokes Alliance for Minority Participation (LSAMP), have also provided support to students in the program. These funding sources serve as a pathway to engage low-income and historically excluded populations in research experiences. However, for students who need to fund their education through external work (such as jobs in the service or labor industries), undergraduate research stipends, whether through FWS or other sources, may not be sufficient to cover tuition, fees, and other miscellaneous expenses.

It was important to find that the highest *programming melt* happened in the *Action* stage, when students were directed to schedule and attend a meeting with UgR staff to obtain more information about the

program and its requirements. Once the students attended the meeting/information session, the *programming melt* decreased drastically and almost all students who reached the *Work* stage ended up participating in RAP. This prompted us to reconsider our advertising strategies. When students are asked to fill out the IF, they should be better informed that they can use their FWS funds to participate in the program and that there are additional funding options available. A more comprehensive explanation of funding options is currently provided during meetings with UgR staff.

Another important consideration in reducing the *programming melt* in the *Action* stage is the language used in advertisements. Undergraduate research programs can sometimes be perceived as too exclusive (Grabsch et al. 2021); therefore, our recruitment strategies need to be framed in a way that does not sound overly selective. In this regard, a focus group with former RAP participants can help us reframe our advertising strategies.

In addition, it is important to recognize that some students, particularly those in STEM fields, may hesitate to pursue research experiences due to concerns about academic workload. The perception that research is too demanding or incompatible with their major requirements can be a discouraging factor. Developing strategies to connect students who showed interest in RAP with peers who have successfully balanced research and coursework can help demystify the experience and foster a sense of possibility.

It is important to mention that most studies identifying factors associated with student decision-making for participation in research experiences focus on narratives from those who ultimately chose to participate (Kelly 2023; Economy *et al*. 2014). Future work from our group will aim to understand the decision-making processes of students who ceased communication after initially showing interest, using a qualitative approach.

When we separated the students by their field of study, it was not surprising to see that the majority of those who showed interest were from STEM fields. As is evident in many higher education institutions across the country, STEM fields tend to dominate research, with dedicated physical spaces such as labs, classrooms, and academic buildings. Additionally, the need to increase the persistence of college students in STEM majors has led to substantial investment in undergraduate research experiences (Bauer and Bennett 2003), as these are proven to boost student persistence in STEM disciplines (Sithole et al. 2017; Graham et al. 2013; Russel et al. 2007). Regardless of the number of students in each field, the pattern of *programming melt* remained consistent, with most students ceasing their participation at the *Action* stage. Thus, it seems like the field of study has no relation with students not advancing in the stages to engage in a research experience. It is worth noting, however, that *programming melt* was even more pronounced among undecided students compared to other groups. This specific group of students could benefit from a targeted recruitment strategy that demonstrates how undergraduate research can help them decide on their majors (Mastronardi *et al*. 2021).

Although some strategies can be employed to address the *programming melt* observed in the present study, implementing Course-Based Undergraduate Research Experiences (CUREs) may offer a promising alternative. This approach could enable a larger number of students to benefit from this impactful educational practice. In CUREs the research experience occurs within the context of a course in which students collaborate to engage in research as a team, often during class time (Auchincloss et al. 2014). CUREs have gained significant popularity as a means to broaden student participation in research. Unlike traditional one-on-one research apprenticeships like RAP, CUREs integrate research experiences into regular coursework, making them accessible to a wider and more diverse range of students. This approach not only increases access to research opportunities but also actively engages students from underrepresented backgrounds who might otherwise lack the chance to participate in research. By integrating research into the curriculum, CUREs aim to promote inclusivity and foster a more diverse population of future researchers (Bangera and Brownell 2014).

Future Research

In future studies, we intend to explore the relationship between our findings and students' demographic characteristics to better understand how background factors may influence the decision to participate in research experiences. Additionally, we plan to survey students who initially expressed interest but did not follow through with participation. Using this survey as an invitation, will invite them to participate in a focus group, allowing us to take a more qualitative approach and gain deeper insight into the barriers and perceptions that may have influenced their decision.

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