Research in Pairs

An Undergraduate Atmospheric Science Experience

Adapted from "A Pair-Researching Approach for Undergraduate Atmospheric Science Researchers," by **Neil F. Laird** (Hobart and William Smith Colleges) and **Nicholas D. Metz**. Published online in BAMS, March 2020. For the full, citable article, see [DOI:10.1175/BAMS-D-18-0190.1](https://doi.org/10.1175/BAMS-D-18-0190.1).

The commonly favored approach for mentoring undergraduate (UG) students has been to match one student with one or more research mentors who are typically faculty, postdoctoral researchers, or graduate students. An alternative pedagogic approach implementing UG student pairings (i.e., pair-researching) has been used with success since 2005 during an 8–10 week UG summer research program at Hobart and William Smith Colleges (HWS). We have found pair-researching especially beneficial to increasing the numbers of rising sophomores and rising juniors into our research program.

Pairing students to complete course-related labs or projects is not a new concept; however, the approach is not widely used with UG researchers, and discussion of the pair-researching approach is very limited in the education and STEM published literature.

Collectively, we have mentored 27 collaborative UG student pairings (54 total students) during summer research experiences between 2005 and 2017. Our application of the UG pair-researching approach incorporates both collaborative and group-supported individual research. The two UG researchers in each pairing typically spend the first several weeks working together on a paired project in collaboration with their mentor. They focus on identifying, reading, and discussing relevant scientific literature, analyzing data connected to their overarching topic, and crafting their own individual scientific question. As an example, UG paired projects from past summer programs have explored a dataset (e.g., radar, satellite, surface map analysis) to identify the

climatological occurrence of specific weather events (e.g., synoptic fronts, lake-effect snowstorms, atmospheric rivers). The remainder of the summer research experience allows each UG within the pairing to complete a unique individual project that builds upon the paired early summer collaborative effort. This individual portion of the research experience for each UG occurs while maintaining a close partnership with their mentor and the other UG researcher in their pairing.

Based on our extensive experience using pair-researching, we have found each UG substantially contributes to the paired research and then often surpasses expectations during their individual research. Each UG tends to bring their own perspective and skills to the pairing to enhance and/or complement those of their research partner. When paired students are more familiar and comfortable with working individually, they make the transition to the individual research sooner. This transition typically occurs in weeks 3–4 and varies based on UG pairing and research project. The effectiveness of pair-researching is aided by

▲ *** Fig. 1. Neil Laird discussing the overarching research topic and background scientific literature with a pair-researching group in the first week of their research experience.**

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// When I was an UG student, I preferred to work on my own. I was apprehensive to be paired with another UG student to conduct research at HWS, and was worried that I would end up doing most of the work. Luckily for me, I am happy to report that my experience working with my wonderful and motivated research partner changed my mind about collaborative research projects. I learned valuable information about communicating with a coworker, the benefits of delegating tasks, the occasional need for patience and understanding, and the importance of being able to trust your team."

—Student comment

a critical design element: the UG researchers have abundant access to their mentor, who establishes an environment with a sense of "working in collaboration with their mentor" rather than "working for their mentor."

Benefits and challenges

Our use of UG pair-researching was initially born to balance the desire to offer more UG research opportunities by a limited number of

mentors and the reluctance to take on an unmanageable number of individual research projects, thereby hindering the quality of mentoring. Our UG pair-researching approach has continually evolved since 2005, and only recently, after discussion with colleagues and some former UG researchers, did we fully recognize that sharing this pedagogical approach may be beneficial to other UG mentors. In 2018, we solicited

feedback from former UG researchers about their experiences in pair-researching during the HWS Summer Research Program. These former UG researchers are now in various stages of graduate studies and careers. In total, 24 former UG researchers responded to the open question: "What are your thoughts about your experience of being paired with another student to conduct research during the summer research program at Hobart & William Smith Colleges?" Based on UG researcher feedback and our experience, we have identified benefits and challenges from both the perspectives of the UG researchers and mentors.

While each of the 24 responses featured a unique perspective, the following four benefits of a pair-researching experience were stated over and over again by the respondents. Students (a) acclimated to a collaborative and comfortable learning environment that mimics the

"real world" (i.e., active communication and collaboration), (b) felt as though they were able to accomplish more since two students initially worked together on a project, (c) perceived an environment that was not intimidating and provided peer support, and (d) felt added accountability given an additional person to brainstorm with besides their mentor.

From a mentor perspective, the greatest benefits for UG researchers largely parallel those identified by students, with the following additional benefits: (a) building confidence and decision-making ability, (b) producing high-quality results in less time, and (c) leading to students being highly satisfied with their research experience.

The greatest benefits of the pair-researching approach for the research mentor are that it

- allows efficient mentoring of fewer research projects while concurrently providing research opportunities for more UGs,
- contributes substantially to building student cohorts, and
- more effectively provides an environment that supports students in research early in their UG studies.

None of the 24 UG researchers noted challenges in their pair-researching experiences; however, a few did speculate on ways difficulties might arise in the design of the experience, such as (a) one student in a pairing taking a substantially greater leadership role in some areas of the paired project given background skill sets, or (b) disagreement about ideas that could lead to a lack of research progress. The authors have not observed these problems, but note that if one of these (or any unforeseen difficulties) were to arise, the research mentor would need to mediate and resolve any issues. If difficulties remained, the best option would likely be to transition each paired UG researcher into their individual project earlier.

The greatest challenges of the pair-researching approach for the research mentor are

- deciding on an overarching research topic for pairing that is (a) interesting and approachable for UG researchers, (b) reasonable in scope to “complete” during an intensive summer program, and (c) multifaceted whereby researchers could choose from numerous avenues of investigation that are unique and important contributions to the scientific community. We have found that a substantial portion of the experience should be the UG researchers determining

Fig. 2. Nicholas Metz working with two paired undergraduate researchers to collect field measurements with a mobile rawinsonde
* system during their research experience.

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“I really appreciated the unique partner approach that was implemented. This was my first internship and the largest research project I had yet to undertake during my education, so it’s reasonable to say that my confidence in myself as a ‘scientist’ was underdeveloped. Being able to discuss ideas with my partner not only boosted my confidence but encouraged me to pursue different ideas during our research. As our project progressed, we each naturally developed different interests in our topic. Then, during the second half of the summer, it was valuable to pursue our own ideas and rewarding when we could see how we contributed to a collaborative project.”

—Student comment

their own research questions with guidance from the mentor. This allows UG researchers to cultivate ownership of their project and participate in the entire research process.

- achieving a “correct” balance of paired and independent research for each student. Each pairing may transition to independent avenues of investigation on different schedules based on the overarching research topic they are investigating, decisions on method of research analyses, quality of interactions between students in pairing, and skill sets of each student.

Summary and discussion

Our experiences have demonstrated the pair-researching approach to be a successful alternative to the one-to-one student-mentor approach typical in the atmospheric and related sciences. While pairing or partnering UGs is not a new concept, especially for academic coursework, it appears the approach is not widely used for mentoring UG researchers. An approach similar to pair-researching is most widely used in computer science and is called “collaborative programming” or “pair programming.” Pair programming offers numerous benefits including (a) higher-quality code/results in less time; (b) greater student satisfaction with the experience; (c) enhanced teamwork, knowledge transfer, and learning; and (d) improved student retention, confidence, and program quality.

The authors have used both the pair-researching approach and one-on-one approach for UG research mentoring. While both

approaches have been productive and lead to positive research outcomes, we have found more benefits to UG researchers and mentors using the pair-researching approach. It replicates the collaborative nature of scientific investigation, develops a strong peer-to-peer supportive partnership, and allows UGs to make great advancements on their research.

Research experiences help introduce UGs to the concept and process of research, and can provide a more informed, experienced workforce for the broad atmospheric science community; however, from the mentoring perspective

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//This was my first formal research experience. Psychologically, I feel that it was better to have someone that was experiencing the same thing with me every step of the way for the first few weeks of the program. We could celebrate our successes and commiserate over the more tedious parts of the project. I feel like having someone with whom I could fully discuss all aspects of the project on my level (rather than solely a mentor–student relationship) helped me to not feel overwhelmed in this new experience.”

—Student comment

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considerable preparation is necessary when proposing, planning, and conducting research interactions with UGs—especially given that these experiences are potentially transformative for continued UG studies, graduate school, and a career in the atmospheric and related sciences. The pair-researching approach can greatly benefit research programs with a limited number of mentors, and especially benefit mentors at primarily UG institutions. However, it also has potential for established Research Experiences for Undergraduates (REU) programs to provide more UG research opportunities without an increase in their number of mentors and a relatively small, but worthwhile, increased workload for each mentor toward maintaining quality experiences for UGs. ••

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BAMS: Why did you initiate this pair-researching approach for students?

Neil Laird (Hobart and William Smith Colleges):
I had the opportunity to conduct atmospheric science research as an undergraduate student and I still remember that experience being very rewarding, but also challenging at the same time because of a feeling of “going it alone.” As my passion for research grew, I developed a desire to introduce as many undergraduate students to research as possible.

I have continually explored ways to make these research experiences conducted by undergraduate students working within our research lab truly collaborative—Both collaborative between mentor and student, as well as collaborative among students that are undertaking the research experience concurrently.

BAMS: What surprises you the most about this work?

NL: *It often surprises me that the pair-researching approach has not been more widely used or reported on in the atmospheric science community, and that it has been so successful given the large number of students that have participated in pairings over the years. Given the varied personalities, skill sets, and background experience of students that have conducted research in our lab, we have been able to make the experience beneficial for both students and mentors. Sometimes when reflecting back on the years of conducting research with undergraduate students, it overwhelms me where these former students are and the amazing careers they have created for themselves.*

BAMS: What was the biggest challenge you encountered in developing this research approach?

NL: *The biggest challenge has been finding funds over the many years of this work that have allowed undergraduate students to participate in atmospheric science research while in a summer research program at a primarily undergraduate institution. The funding has come from several sources, including the National Science Foundation, the National Oceanic and Atmospheric Administration/National Weather Service, and Hobart & William Smith Colleges.*