Young scholars benefit from collaboration

Suhas Eswarappa Prameela, K. T. Ramesh and Tim Weihs highlight how students and postdocs can develop their competencies and skills during research collaboration.

To understand the complex natural world and seek solutions to society's grand challenges, science has steadily become more interdisciplinary in the last few decades. This necessitates research collaboration by bringing together researchers with different areas of expertise. Such a trend is partially reflected by the fast-increasing number of collaborative multi-PI (principal investigator) research grants. The National Science Foundation (NSF) of the United States, for instance, nearly doubled its funding for multi-PI grants compared to single-PI grants in recent years (Fig. 1a). This shift inevitably has a significant impact on graduate students and postdocs, who need to acquire and develop new skills to maximize the benefits of research collaboration.

As a representative model of collaboration, the research consortium brings together multiple institutions and has long-term funding to address complex interdisciplinary problems. These consortia may contain government or private research labs, but are generally led by academic institutions and supported by basic research funding. For example, the consortium in which the authors of this piece are involved, the Materials in Extreme Dynamic Environments (MEDE) consortium, was established by the US Army Research Laboratory to advance the design of protective materials used in extreme dynamic environments. It supports approximately 40 PIs from 21 institutions in the US and Europe over a ten-year period. Research consortia strive to break down barriers between sub-fields and promote innovation, requiring efficient organization and communication. While academics, policymakers and programme managers at funding agencies debate the pros and cons of such large collaborative efforts, the perspectives of graduate students and postdoctoral researchers should not be neglected.

Compared with students in a single-PI project, students in multi-PI projects meet regularly and work with different researchers from diverse backgrounds, such as materials science, mechanical engineering and machine learning, for a given research topic. There might be difficulties in bridging the gap between different fields. Seeking out impromptu interactions with counterparts in other groups and asking for tutorials or papers could be helpful. Furthermore, advisers should ensure that they provide tools and guidance to navigate interdisciplinary research tasks and inspire their students to work cohesively to address a common goal.

In the MEDE consortium, bi-weekly and monthly meetings help consortium researchers from different institutions meet regularly and exchange research ideas and updates. Thus, a typical student in MEDE obtains an enhanced research collaboration experience, with nearly 45% of their meetings each year occurring with consortium collaborators and the rest of the meetings with his/her PI and group members (Fig. 1b). The regular discussions help to troubleshoot and brainstorm new ideas. However, students need to strive to engage fully to benefit from these meetings. They need to plan their lab work and regularly attend the meetings to be in sync with the latest updates. Given that multiple PIs are involved in the discussions, it may take some time to reach a consensus on research priorities for sub-groups in the consortium. After taking detailed notes during these meetings, students can follow up with their adviser(s) separately to seek clarity and plan their research tasks in a manner consistent with the group's priorities.

A consortium often aims to solve a grand problem that contains a lot of sub-tasks. The advisers' attention can also be split between sub-tasks, which may cause confusion among students. Jointly working with many team members may result in authorship conflicts on papers or intellectual property (IP) arising out of their collaborations. Students should feel no hesitation to meet with their advisers, discuss any potential conflicts, review their progress and expectations towards thesis requirements, seek advice, and practice open communication. Teams participating in collaboration should set clear expectations in terms of project goals: who is doing what, and as the work progresses, who will lead the effort in drafting papers or patent applications?

Working in highly collaborative projects can also enhance a student's professional network well beyond their home university. By actively engaging in meetings and communications, students have opportunities to build strong connections with many professors, students and industry experts across the nation and the world. These relationships can lead to internships and fellowships at other institutions and various job opportunities upon graduation. In structured collaborative settings like consortia, a variety of training opportunities are available. Students can gain a wide range of soft and technical skills, for example, by attending professional development workshops to improve presentation and communication skills, and short courses to master advanced research techniques or tools.

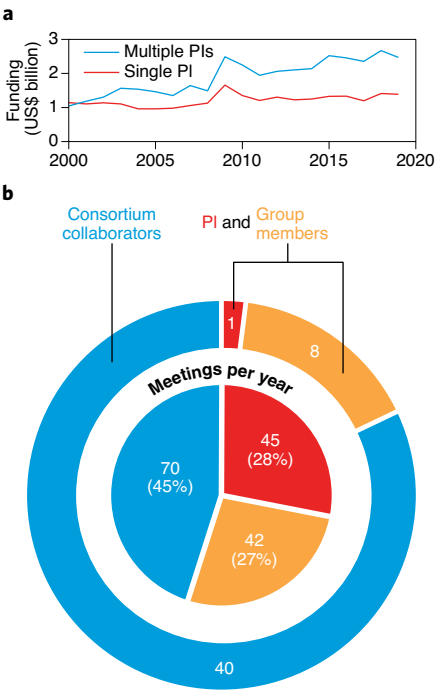

Fig. 1 | Upward trend for multi-PI funding and the meetings per year within a research consortium. **a**, NSF funding data for single-PI and multi-PI grants over the last two decades[1–3]. **b**, The inner circle shows the number of meetings per year (with percentages) between a student in the MEDE consortium and the student's thesis adviser (red), eight research group members (orange) and nearly 40 consortium collaborators (blue). The outer ring indicates the number of people with whom the student interacts in each type of meeting.

In some cases, graduate students and postdocs in the consortium can mentor undergraduates from different universities and local high-school students through established apprenticeships and local STEM programmes. This helps in honing their leadership skills and preparing them for future faculty or industry jobs. However, students should carefully balance these additional activities to ensure that they do not significantly distract them from their research.

Large collaborative efforts like consortia can develop a workforce that sees the big picture and works across disciplines. These grand views can be very beneficial to students, helping to motivate collaborative efforts. Funding agencies should highlight resources and guidelines for structuring multi-PI efforts in ways that help produce a highly collaborative and effective environment for students with broad educational opportunities. Doing so will benefit workforce development and train a future generation of researchers sustainably for the increasingly collaborative research environment. ❐

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Competing interests

The authors declare no competing interests.