Continual Support Systems to Orchestrate Support in Research Communities

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Project Overview: As research groups expand in size, it becomes increasingly difficult for community members to identify the expertise within the community and the resources available to help with research challenges. Mentors spend additional time providing ad-hoc support, but this strategy quickly becomes intractable without orchestration supports. I plan to design, implement, and evaluate *orchestration technologies* capable of detecting diverse student needs, identifying available actions and help resources to meet those needs, and connecting resources and needs in ways that are cognizant of the collective needs and resources across a community.

Research Challenge: Self-directing independent research requires students to develop *regulation skills* - cognitive, metacognitive, motivational, and emotional skills for reaching a goal - that are needed to plan research work, monitor progress, seek help, and reflect on what's learned [3, 4]. My previous work with my advisor Haoqi Zhang led to the design of Agile Research Studios (ARS), a socio-technical model that orchestrates the development of regulation skills for up to 20 students by distributing the support for training across a community [5]. While effective, scaling training to more students quickly becomes infeasible without additional orchestration technologies that can help community members identify needs in their own research and connect them to tasks and help resources (mentors and peers) in a decentralized manner. Computational supports for orchestration are necessary as we scale to larger communities because ad-hoc mentoring strategies such as manually routing students to helpers and providing support wherever it is needed quickly become intractable and ineffective at scale.

Proposed Research: I propose a hybrid human-machine *continual support system* that will (1) automatically detect measurable symptoms of deeper research challenges; (2) present these symptoms to students, their peers, and their mentors to promote awareness and action as appropriate; and (3) use mixed-initiative supports to diagnose and route challenges to those who have the expertise and availability to help. For example, as a student logs their research progress during the week, the system may detect that they spend disproportionately high hours on debugging while neglecting their understanding of the research challenge. Seeing this, the student can reflect on what they can do to repair, such as pair programming to debug. If the student does not demonstrate a measurable improvement, the system can suggest peers who have the time and technical expertise to help the student. The system might also suggest that the student reach out to their research mentor to prioritize system features based on the research direction. These systems thus decentralize the monitoring and support routing burdens that mentors experience in large scale research communities, and offload that work to technical systems that can monitor and route effectively. Unlike prior approaches that develop automated systems for diagnosing problems and locating expertise [2], I take a mixed initiative approach that better leverages both technical systems and the entire community to provide support through detecting needs, identifying helpers, and making connections. Over the next three years, I will take a design-based research [1] approach to explore the following:

Part 1: Human and Machine Barriers to Distributing Support within Research Communities
RQ: What are critical challenges that community members and machines face when identifying the expertise within the community and the resources available to help with research challenges?
I will use qualitative methods to conduct field observations and interviews within the Design, Technology, Research (DTR) program at Northwestern University to uncover the difficulties

around optimally leveraging existing resources within research communities, and will implement low-fidelity systems to uncover the technical challenges of monitoring and coordinating support. The outcome of this phase will be low-fidelity prototypes of continual support systems that begin to overcome these barriers to distributing support.

Part 2: Implementing a Continual Support Architecture and Platform

RQ: How might we design a system for student researchers that surfaces challenges to learners, peers, and mentors and optimally connects learners to resources within a research community?

I will extend the low-fidelity continual support system prototypes by implementing an architecture and platform that will leverage existing ARS tools to (1) monitor student research progress and the availability of support, (2) route students to support opportunities as challenges arise, (3) contextualize the task for the person providing support, (4) verify that learners received support, and (5) update the status of the learner in the community. The outcome of this phase will be a novel continual support architecture and testable platform deployed in the DTR program.

Part 3: Evaluating Effects of Continual Support on Student Performance

RQ: What is the measurable impact of a continual support platform on student researchers' self-directed learning performance and the core research and regulation skill performance?

I will evaluate the impact of a continual support platform on the self-direction of students by designing an assessment process for their research and regulation skill performance over time. The criteria for this assessment will be grounded in expert practices described in learning science literature and best practices observed in the DTR research community. In addition, we will conduct qualitative interviews to assess perceived impact. The outcome will be evidence-based analysis of the mechanisms by which a continual support system improves student performance.

Intellectual Merit: My work presents continual support systems as a novel way to distribute monitoring and coordinate support resources in research communities using humans and machines. By devising mixed-initiative systems to orchestrate continual support across a community, we can leverage the capabilities of humans and machines to change the ways in which organizations work, significantly increase the quality and scale of research training.

Broader Impacts: Improving the quality and scale of research training will mean more students are able to develop the regulation skills in planning, help-seeking, and reflection required to conduct cutting-edge scientific research. Further, by scaling research training opportunities to more learners, we can better prepare the future workforce with the lifelong self-directed learning skills needed to work through today's complex challenges.

Citations

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