Agile Research Studios: Orchestrating Communities of Practice to Advance Research Training

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Abstract
Undergraduate research experiences enhance learning and professional development, but providing effective and scalable research training is often limited by practical implementation and orchestration challenges. We demonstrate *Agile Research Studios* (ARS)—a socio-technical system that expands research training opportunities by supporting research communities of practice without increasing faculty mentoring resources.

Author Keywords
Agile research; community of practice; self-directed learning; regulation skills; socially shared regulation of learning; socio-technical systems

ACM Classification Keywords
K.3.1. [Computer Uses in Education]: Collaborative learning

Introduction
Undergraduate research experiences provide numerous personal, professional, and societal benefits including enhancing student learning and broadening student participation and retention in diverse fields of study. But providing effective mentoring to undergraduate researchers is often limited by practical implementation and orchestration challenges [4]. 1-on-1 mentoring is effective but time-

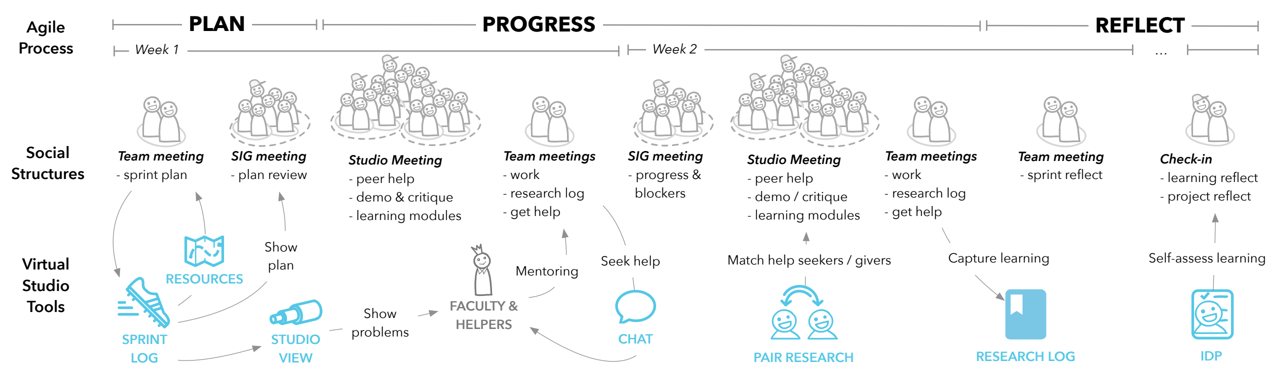

Figure 1: Agile Research Studios support regulation by adapting agile methodologies to research through 2-week sprint cycles of research planning, progress making, and reflection. Social structures help to orchestrate research activities by (a) supporting learning self-directed research planning, monitoring, reflection, and replanning; and (b) facilitating help-seeking and collaboration to promote learning and progress-making. The virtual studio tools extend social structures to more effectively orchestrate learning and support in and out of the classroom.

intensive [3]. As a research group expands in size, faculty have less time and attention to mentor each student. Without significant mentoring, undergraduate students have difficulty engaging in *authentic research* consisting of (a) core activities including designing a research plan, collecting and analyzing data, and preparing manuscripts, and (b) planning, monitoring and replanning research work.

The following question drives our research: **How might socio-technical systems train large numbers of students to conduct authentic research and produce research outcomes without increasing the orchestration burden on research mentors?** We propose *Agile Research Studios* (ARS), a new socio-technical model for research training consisting of processes, social structures, and tools for orchestrating research training within research communities of practice in which students collaborate to learn and conduct research and develop their abilities to be more self-directed [1, 11], see Figure 1. ARS (1) adapts agile processes [10] to research training so students learn to more effectively plan authentic research inquiry and (2) makes effective use of the expertise and resources across the research learning community to support research progress. We argue that by more fully leveraging the support of the research community, this approach will allow more students to engage in authentic research activities and produce research.

Agile Research Studios

ARS consist of: (a) *agile methodologies*, (b) *social structures* including team meetings, special interest group meetings and studio meetings; and (c) *virtual studio tools* including sprint logs, resources, studio views, chat, pair research,

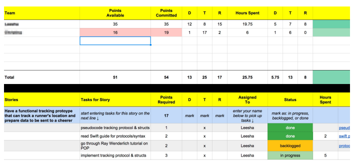

Figure 2: Screenshot of a spreadsheet prototype of a project team's *sprint log*. The top half of the sprint log provides an overview of commitments, hours spent, and progress on the current sprint. Students plan their sprints in the bottom half by recording high-level deliverables, or *stories*, and the *tasks* for accomplishing those stories. Students use a *point system* to estimate required effort to avoid committing more time than they have available for the sprint. As students make progress they mark tasks as *done*, *backlogged*, or *in progress* and record hours spent. Students also link to useful resources next to stories and tasks.

research logs, and individual development plans. Together, the components of the ARS model address practical socio-technical challenges in orchestrating the development of *regulation skills*, i.e., cognitive, motivational, emotional, metacognitive, and strategic behaviors for reaching desired goals and outcomes [5, 6]. We describe below how the ARS model helps students develop regulation skills needed for conducting authentic research that demands (1) self-directed research planning, monitoring, reflection, and replanning [1]; and (2) adopting effective help-seeking and collaboration to overcome challenges [8, 6].

Research Planning

ARS address the orchestration challenges of learning to plan research in the following ways:

- **Doing all research steps.** To engage more students in authentic research, ARS adapts agile methodologies to *slice* research work vertically to fit student competencies [2] and promote progress across all phases of research. Students grow their project in complexity and generalizability over time, as their skills and the research work matures.
- **Doing planning.** In an ARS, students take on the responsibility for planning their work at frequent intervals following agile methodologies. Students record tasks and progress in *sprint logs* that support students' and mentors' awareness of progress and potential needs for replanning (see Figure 2).
- **Learning planning.** To help students learn to plan research work on their own, mentors in an ARS provide plan feedback weekly through *special interest group* (SIG) meetings. This meeting facilitates peer review and feedback by mentors and students to help student teams develop their planning skills, devise strategies to overcome challenges, and connect to *resources* [5, 6]. To promote reflection, student teams use *research logs* to record and reflect on research progress throughout a sprint and complete self-assessments in the form of *independent development plans* at quarterly intervals.

Getting Help

ARS address the orchestration challenges of learning to get help in the following ways:

- **Distributed help.** To better support students while respecting the limits on mentor time, in an ARS the responsibility for providing help is shared across the entire community. Instead of relying on a single mentor to resolve problems, an ARS seeks to make effective use of the diverse sets of expertise that individual community members have by connecting students to those who can best help on a particular problem. This should enable the community to fulfill numerous help requests without using mentor time, and lead to students feeling more supported.
- **Scaffolding help-getting.** To help students connect to peers who can help them, ARS scaffolds the process of getting help by using *pair research* [7] to match students to help one another (see Figure 3), *SIG & studio meetings* to facilitate students connecting to helpful peers and mentors in and out of their SIG, and *chat* programs such as Slack to enable students to seek and receive help on-demand.
- **Learning help-seeking.** ARS normalizes help-seeking and trains students to seek help effectively. Further,

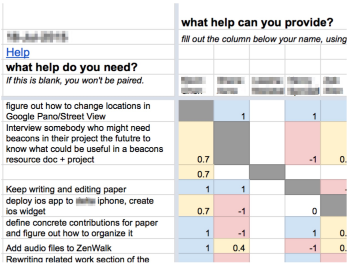

Figure 3: Screenshot of a Google Spreadsheet prototype of the *Pair Research* tool. Students enter their needs for help and how well they can help others. Based on collected preferences, the system automatically pairs students to help each other on diverse research needs.

as students are connected to help and help themselves with the support of the above mentioned scaffolds, we expect the common practice of getting and giving help to over time lead to broad shifts in students' help-seeking dispositions [9].

Summary

In summary, the practices, structures, and technologies in an Agile Research Studio empower undergraduate students to plan research work at weekly intervals and overcome challenges quickly with the support of peers and mentors. This allowed them to conduct independent research along a faculty member's core research directions, as would be possible through dedicated 1-on-1 apprenticeship with faculty members but at just a fraction of the time required to support a much larger research learning community than would be traditionally feasible.

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