



Lightweight, Scalable, and Relational Learning Experiences as an Approach to Overcoming System-Level Challenges in Education

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Abstract

In this paper, we report on a series of research projects that together motivate a larger idea: the design of lightweight, scalable, and relational learning experiences for overcoming system-level challenges in education. We start by discussing *Exploratory Reading Groups*, a program designed to expose students to the creative aspects of computer science and to enhance intrinsic motivation and purpose for learning through exploratory reading of research papers. Unlike traditional graduate student reading groups which focus on depth, our reading groups are designed for a broad exploration of ideas. More importantly for this paper, they are designed to be lightweight in time commitment, to be scalable and student-driven, and to foster supportive peer relationships.

As we ran this program, we found that these design parameters not only led to our original goal of supporting creative exploration, but also resulted in the unexpected emergent benefit of facilitating student entry into undergraduate research experiences. There were three reasons for this. First, the lightweight nature of the program (~1-2 hours a week for 4 weeks) lowered entry barriers for busy students. Second, the scalable and student-driven nature of the program circumvented the obstacles of limited faculty time or staff resources common to many programs. Third, the relational nature of the program facilitated knowledge sharing and relational networks that helped to overcome the many systemic misalignments at the root of faculty-perceived barriers to undergraduate research, findings that came out of a series of interviews we conducted with STEM faculty on barriers to undergraduate research.

We conclude by proposing that the design of lightweight, scalable, and relational learning experiences may be an effective approach to overcoming system-level challenges in education and discuss a few examples of what that might look like and future directions.

Exploratory reading groups for scaling creativity and motivation in CS education

Our work started from an interest in exposing students to the creative aspects of computer science important for applying skills to societal problems and for attracting diverse populations of students. We saw that undergraduate research experiences (UREs) were a proven and effective way to do this [1]–[5], but that these experiences remain difficult to scale due to the challenge of finding mentors with the necessary time [6]–[13]. So we asked: *How we might foster creativity and motivation in CS education, but in ways that are also scalable to broad populations?*

Through a two-year design-based research process, we developed *exploratory reading groups* (ERGs), a program in which students read and discuss papers on topics such as *Technology and Democracy*, *Socially Expressive Robots*, *Fairness in AI*, *Future of Education and Work*, and *Safety of Autonomous Vehicles*. Each theme is proposed by faculty actively working in the research area and framed to be societally relevant and motivating to students. And unlike graduate journal clubs that dig deep into one paper at a time, students participating in our exploratory reading groups discuss 2-3 papers in each session to explore a broad set of ideas.

Analyses of participant interviews found that this broad exploration of ideas was valuable to students in different ways. For some, it helped with stimulating creativity and project ideas. For others, they found personal connections and purpose through their readings. Still others benefitted from the joy of sharing knowledge with others and increased confidence and clarity in their career goals.

One important part of this project was the many design iterations we went through to make the reading groups lightweight, scalable, and relational. Our SIGCSE paper describes this in more detail [14], but we briefly describe examples of each of these aspects:

- *Lightweight.* To keep our program accessible to all interested students, the weekly time commitment was extremely minimal. Each reading group phase was 4 weeks long (which included a launch session) and students were only required to 1) attend the one-hour weekly meeting, and 2) read and present a *single paper* during that phase. This structure encouraged student participation since a relatively small amount of time on their part enabled them to get exposed to many interesting ideas.
- *Scalable.* The time commitment from faculty was also minimal. Faculty only needed to define their sponsored theme. Once launched, the reading groups were student-run, which made them extremely scalable and sustainable.
- *Relational.* To foster community, the reading groups emphasized relationships through “get-to-know-you” questions, in which each presenter would pick a question for everyone to answer, which could range from the typical check-in (“How was your day?”) to long-term goals (“Where do you see yourself in 5 years?”) or even pretty vulnerable questions (“When was the last time you cried?”). In interview analyses, we were surprised that this relatively simple intervention had a large impact on students, creating comfort, a sense of belonging, and peer support.

An unexpected observation: the design of ERGs supported student entry in UREs

These design goals ended up leading us down a path we did not expect. As you may recall, our motivation in designing the *Exploratory Reading Groups* was as a more scalable alternative to undergraduate research experiences that could enable all students to get exposed to the creative aspects of computer science at an earlier point in time. However, as we continued to run the groups, we began to see that they were not just providing an *alternative* pathway, they were also helping to support student entry *into* undergraduate research experiences.

There were a few reasons for this. First, the *lightweight nature* of the reading groups made it an easy entry point for busy students. Once they joined, they were able to learn about research being actively worked on by faculty members and begin to understand the nature of research. Second, the *relational nature* of the groups also meant that they often built connections with other students who were in research labs which (we believe) helped them to understand what it would look like and which encouraged them to apply. Third, the *scalable and sustainable nature* of the reading groups made it feasible from the faculty and staff perspective, one of the biggest bottlenecks to UREs [7], [13], [15]–[18]. In fact, the main way we were able to convince faculty

to even spend the one-time cost of defining reading group themes was by pitching the groups as a pipeline for undergraduate students into their lab.

This quarter we decided to go all-in on this purpose and have rebranded the reading groups as pathways into research labs. With the support of the Dean and Associate Dean of Undergraduate Education in Engineering, we are working towards scaling it across the entire division as a pipeline into faculty research labs. A few aspects of the program design were changed for this purpose, but the core aspects of being lightweight, scalable, and relational still remain.

In an ongoing project, we have been reviewing the literature on barriers to undergraduate research [7], [12], [13], [15]–[20] as well as interviewing faculty to develop a rich understanding of barriers. What is commonly established is that faculty time is the single biggest barrier, and most solutions tend to center on creating more time for faculty (through providing teaching/time credit or summer stipends) or tackling challenging systemic incentives (the low value of URE mentorship in tenure review). Both of these, however, are extremely challenging in resource-constrained contexts.

A core concept emerging in our analysis is that many barriers relate to misalignments. Increasing access to undergraduate research is challenging due to misalignments at the system level between education and research, misalignments at the individual level in goals and expectations, and the constant articulation work [21] required for getting to and maintaining steady-state when seeking alignment. We believe that simple interventions like Exploratory Reading Groups could potentially be an effective tool for circumventing at least some of these challenging system-level barriers. Their lightweight and scalable nature make them effective at motivating participation and their relational nature enable them to foster connections that spark change.

A blue-sky vision: small groups as systems of action in education

We conclude with a blue-sky direction for future work. In Design Unbound [22], Ann Pendleton-Julian and John Seely Brown discuss the challenges of designing ecosystems and introduce the concept of a system of action, a “*coherent collection of interrelated action-intended components that affect the way people do things. SoA’s work systemically within a context... By systemically, we mean that the components work in concert with each other to affect the context of the problem as a dynamic system of moving parts, influences and exchanges. SoA’s are transformative in intent, affecting both explicit behaviors and embedded habits. They scale, enabling small actions to affect a larger social ecosystem through work they do inside the system.*” In other words, to design ecosystems at a system-level, one may want to consider small but scalable interventions that can make a big impact through working within the larger system to seed, influence, and facilitate change in other components. Based on our initial observations, it seems like Exploratory Reading Groups may be doing this.

Could the design of lightweight, scalable, and relational programs help with other system-level challenges in education? We are intrigued by the potential of small groups more generally as an approach to facilitating change. Small groups can be lightweight and scalable, and their relational nature makes them suited for targeted influence within a larger social system. For example, to foster cross-divisional relationships and collaborations [23], perhaps one might

create interdisciplinary skill-building groups where students from different divisions bring their strengths together to work on small tasks. To foster community-engaged partnerships between universities and the local community, perhaps one might create service learning groups that involve both students and community members.

While we started with exploratory reading groups, we have now begun to explore more general small group formation processes to understand what makes it hard for people to find others to learn or do activities together with in small groups [24]. As we develop a better understanding of this, we see interesting opportunities for the design of new platforms and processes that can facilitate small group formation, and that can support lightweight, scalable, and relational learning experiences of many types. In some sense, what we are after is a relational form of microlearning, where learners can engage in short personalized learning experiences, but in *relational interactions* embedded in and influencing a larger social system.

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