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Developing Systems to Support Reflective, Engaged Summer Research Opportunities

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The underrepresentation of marginalized groups in STEM fields is partly due to the limited use of teaching methods that consistently account for students' diverse cultural perspectives and experiences. Affinity Research Groups (ARG) is an innovative mentoring model that immerses students in collaborative research teams to intentionally develop students' subject-specific knowledge, research competencies, and teamwork skills. The ARG model inherently embodies many elements of Culturally Responsive Pedagogy (CRP), instruction that recognizes and uses students' cultural backgrounds and experiences to make learning more relevant and effective for students. Despite this overlap, when faculty implement ARG pragmatically, they may not be cognizant that they are implementing elements of CRP. This research investigated the effectiveness of investigating the ARG model with the lens of CRP, to understand its efficacy to institutionalize mindful implementation where faculty are more aware of the cultural components. Thematic coding and analysis of faculty and student reflections revealed three elements of CRP most organically aligned with ARG, including culturally responsive mentorship, reflective practice, and growth-oriented skill development. These findings offer valuable insights for other universities aiming to prepare faculty to implement summer research programs that purposefully cultivate academic belonging.

Keywords: Culturally responsive pedagogy, affinity research, asset-based mentoring, faculty peer mentoring, growth mindset

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Introduction

Summer research allows undergraduate students to engage in hands-on inquiry, develop disciplinary skills, and foster a sense of scholarly identity. However, without intentional mentoring structures, these programs risk becoming transactional—emphasizing output over development and mentorship as supervision rather than engaged partnership. To maximize the impact of summer research for student researchers, we integrated the Affinity Research Groups (ARG) model and Culturally Responsive Pedagogy (CRP) into the summer research program to support deeper student learning through reflection, mentorship, and community. While a body of research on structured ARG demonstrates its significant role in advocating for inclusivity, supporting professional development, and fostering collaboration among marginalized communities, this research explores the impact of combining these frameworks.

Literature Review

Underrepresentation in STEM fields may persist due in large part to the absence of culturally responsive teaching (CRT) and consistently practiced culturally relevant pedagogy (Gay, 2018; Gay, 1975), particularly at the collegiate level. CRP (Ladson-Billings, 1995) was developed in response to deficit-based models that marginalize students of color in traditional educational systems. At its core, CRP seeks to acknowledge and integrate the cultural backgrounds, experiences, and perspectives of students into teaching practices and learning environments. CRT contends that all students, regardless of background, possess the capacity to succeed and to perform well on achievement examinations, especially when they receive instruction that connects their cultural experiences to the content being taught. CRP is predicated upon three concepts: (1) faculty support students to succeed academically, (2) curriculum and materials are designed with cultural awareness to foster student learning and growth, and (3) faculty must resist deficit-orientations regarding students' lived experiences, backgrounds, and abilities (Johnson & Elliot 2020; Leonard, 2008).

The Affinity Research Group (ARG) model is a culturally-responsive method of providing research

training and opportunity to students built on a set of core values that promote mutually respectful, inclusive, collaborative, and student-centered research experiences (Teller & Gates, 2000; Villa et al., 2013)use, and integrate the knowledge and skills required for research with the knowledge and skills required for cooperative work. Although a conceptually attractive vehicle with which to involve undergraduates in research, retain them, and foster their interest in higher education, an often posed question relates to the feasibility of applying the model in a field like computer science, in which it is often the case that a solid academic foundation is required in order for a student to be involved in research.

This paper addresses this question by describing how the model has been applied to computer science research projects that involve students with different skill levels and experience. In particular, it presents example structured tasks and related activities that illustrate how students develop domain expertise, gain an understanding and appreciation of the research process and its practice, and acquire team, communication, problem-solving, and higher-level thinking skills.","container-title":"30th Annual Frontiers in Education Conference. Building on A Century of Progress in Engineering Education. Conference Proceedings (IEEE Cat. No.00CH37135. Key ARG values include: (1) Inclusivity, (2) Respect and Trust, (3) Shared Responsibility, (4) Continuous Development, (5) Structured, Intentional Mentoring, and (6) Community Building. ARG actively engages students in research groups with deliberately design activities aimed toward developing students' disciplinary knowledge, research abilities, and team skills (Gates et al., 2008). ARG leaders, for example, set aside time during community meetings to focus on teaching and practicing a skill, such as articulating research in a succinct manner.

The ARG model makes few assumptions about students' prior knowledge, experience, or preparedness to do research or graduate school. Instead, it builds a structure for intentional skill development, peer mentoring and support, and direct instruction and practice in research mindsets, skills, reasoning, and applications. ARG involves greater inclusion through its deliberate development of skills, rather than assuming students arrive at the lab with knowledge of the nature of scientific research, the lab community practices research skills together, led by more experienced mentors and students.

Method

We investigated the integration of interdisciplinary STEM research, use of culturally responsive practices, and the implementation of the ARG model in a cross-disciplinary, institution-specific grant-funded program. This work is part of an interdisciplinary institution-wide grant in which faculty and instructors collaborate to develop, modify, and implement short-term research experiences with undergraduates from minoritized groups. The university is a Minority-Serving Institution in an urban area of the mid-Atlantic United States, recently identified as an R2 institution as classified by Carnegie (https:carnegieclassifications.acenet.edu/).

Participants

Data for this paper come from faculty and student artifacts of ARG practice, including documentation of the research process and outcomes via journals and reports. Faculty participants included individuals from math, computer science, biology, computational science, and environmental science. Eighteen student researchers were undergraduates from the same university who applied for the summer experience in the spring semester. In the summer of 2023, faculty participated in face-to-face Affinity Research Group training on campus (cohort 1, n= 11), and in the summer of 2024, returning and new faculty participated in an online version of the training with interactive components via Canvas (cohorts 1 and 2, n= 22). Documents from a selection of these participants were analyzed for this study, with a sample drawn from experienced ARG departments (computer science), departments with undergraduate research traditions with limited use of ARG (e.g., biology) and departments new to undergraduate research practices (mathematics).

Program Description

As members of the funded program, faculty engage with one another in training, meet with program leadership, and discuss their work in formal and informal settings with other faculty mentors approximately three times per semester and twice during the summer experience. The accountability documentation in the form of reports and notebooks keep program personnel informed about the status of the research, and at the same time create a point of reflection on practice. The rationale for written documentation is that reflection can enhance practice, and can draw out assumptions, biases, and implicit standards that may or may not be evident in day-to-day interaction in a research team. In this way, reflection can broaden access and improve culturally responsive mentoring. Embedded questions in the journal and the report structure, specifically, include the entry prompts: "what I learned," "problems encountered," and "plans for next week" in the journals and "Describe the student's areas of strength and areas of improvement." and "What changes were made to the goals and methods, if any?" in the faculty reports. The prompts are designed to focus on reflection on practice in a public forum.

The program consisted of Affinity Research Group training that used a CRP lens. Kean's ARG is managed systemically with collaborative online training, year-long faculty discussion,

and is implemented collaboratively across many disciplines. The professional development supporting faculty throughout the year was designed around two core pillars — Focus on Mindsets and Structured Collaboration. A central goal was to help faculty use a growth mindset and adopt an asset-based approach to research planning—recognizing and building upon their existing strengths and experiences. This approach sought to shift the narrative from deficit-based assumptions to one that affirms the diverse knowledge and potential each student brings to the research environment. A second key pillar was incorporating a faculty peer mentoring component, including offering faculty regular, semi-structured opportunities to engage in collaborative dialogue with their colleagues which provided a space for sharing challenges, exchanging effective practices, and building a strong, supportive faculty learning community.

Data Analysis Plan

Key research questions that guided this work were:

1. Which specific components of Culturally Responsive Pedagogy (CRP) do faculty inherently and perhaps unknowingly integrate into their Summer Research ARG communities, and which of these components were most frequently referenced in participant reflections?
2. How did faculty enact CRP in the ARG framework to support student apprenticeship in STEM research?

The study presented in this paper draws on a document analysis of artifacts produced by both faculty and students. This analysis is situated within a broader research approach framed by Social Design Experimentation (SDE) (Gutiérrez et al., 2020), a methodological paradigm that engages stakeholders—educators, and learners—as co-designers. Student documentation included journal entries weekly using specified prompts and faculty documentation included midterm and final reports. Structured interviews were transcribed. The lead analyst is a social science researcher who has studied ARG applications for 18 years in varied contexts. Using thematic coding (Miles et al., 2014) based on the ARG model, student journals and faculty midterm and final reports were analyzed to understand whether and how the elements of ARG are evident in the reflective responses of students and faculty. In addition, faculty interview data is used to triangulate (Patton, 1999) findings at each thematic level. In the discussion, we reflect on the implications of ARG efforts within this institutional-level change effort, and the role of carefully crafted accountability documentation to improve planning, help seeking, and interaction across research teams. The codebook was developed inductively and deductively. For example, code "growth mindset/asset focused" and "reflection/reflective practice" were developed before reviewing the data, and code "faculty ownership/engagement" developed as notebooks were reviewed alongside faculty reports.

Results

Student weekly journals and faculty midterm and final reports were analyzed to understand whether and how the participants utilized ARG in a way that was supportive of student lived experiences and backgrounds. Coded evidence across 12 faculty mid and final reports and 9 student journals by STEM discipline appear in table below. This method of triangulating data across participant type assures greater reliability, and additional faculty interview data reported below provides additional backing of the findings.

Table 1:
ARG Documentation- Culturally Responsive Mentoring in Practice

Theme	Percent of faculty with at least one instance of coded element in reports	A "yes" in the box indicates at least one student in the program exhibited the theme in their journals			
		Math	Computer Science	Biology	Total % across disciplines
Faculty ownership	100%	YES	YES	YES	100%
Reflective practice	71%	YES	YES	YES	100%
Growth mindset approach to research	100%	YES	YES	YES	100%
Collaboration across students in research	100%	YES	YES	YES	100%

The following excerpts from the documentation provide additional context and qualitative insight that help to further illuminate and interpret the patterns presented in the table.

Faculty Ownership/Engagement

Faculty reports and student journals indicate high fidelity with the ARG model in evidence of faculty engagement through weekly meetings and the emphasis on student feedback as methods of engagement. The quotes from faculty reports show the work that faculty do to engage their students, including email exchanges, weekly meetings, and immediate feedback via online documentation. Student journals, in turn, describe meeting and interactions directly with faculty that verifies faculty are available and supportive.

Faculty Report Entry

(Student) keeps a lab notebook in which she records data and visual observations on a daily basis or while doing experiments before entering them into the spreadsheet. In addition to receiving feedback through the journal entry, students receive immediate feedback on errors made during measurements or data entry.

Faculty interviews indicate ways in which faculty are cognizant of the background knowledge and perspectives that students bring to their collaborative research efforts. A biology professor working with interdisciplinary student teams remarked on this positive element of her experience mentoring the team: "they have a perspective that I don't have," she said.

Faculty being ready to take leadership on modalities used in their labs was essential. Each faculty established their own structure. In-person conversations and journal reflections revealed both a need and a strong desire among participants for more flexible, blended research environments—spaces that support a mix of in-person and remote collaboration. During a faculty peer mentoring session, participants engaged in a discussion about the need to move beyond traditional, lab-based models of research. They emphasized the importance of creating more flexible and inclusive research environments and shared a variety of digital tools and platforms they use to support blended research settings—combining virtual collaboration, field-based inquiry, and interdisciplinary approaches that better reflect students' diverse interests and lived experiences. The most commonly mentioned technologies were Google tools and Slack that allowed research teams stay aligned, prioritize tasks, share ideas, and facilitate ongoing communication and collaboration. Faculty reported using the tools to mentor learning, collaboratively write, collect data, and brainstorm across locations.

Reflective Practice/Opportunities for Reflection

Evidence from journals and from faculty reports indicated that students were urged to reflect upon their actions weekly, and that faculty were asked to reflect upon the status of their work at the midpoint and at the end of the 8-week session. This practice was urged through embedded questions in the journal and the report structure as described in the methods section. Quotes coded with this theme highlight student problem solving and metacognition related to their practice of doing research.

Student Journal Entry

I learned to not over think or over correct my ArcGIS skills. If I had just trusted my instincts prior to doing anything I would have accomplished my goal hours ago.

Growth Mindset/Asset Focus

The growth mindset/asset focus theme was assessed based on tone, language use, and framing of research experiences by faculty and students as opportunities to improve and learn (see coded results in the table above). Student entries share a shift in understanding over the week of research and indicate growth over time in the project. The 'growth' mindset and focus on student assets are key features of the ARG model, and documents show overall strong fidelity with ARG values and mindsets about students. For example, in the passage below language about students indicates the role of faculty in guiding inexperienced research students, whereas research indicates faculty may alternatively deem students as ineffective or unsuited for research when they don't immediately fit to (unstated) expectations.

Faculty Report Entry

As most our students work in summer, we try to work on a reasonable time schedule ahead of time and discuss with students is very important. And students may need guidance on overall project background at the beginning as they may have little experience on the research before.

A faculty member described work with an undergraduate with limited coursework experience in the field. At first, the student was not meeting the faculty member's implicit expectations of background knowledge needed to provide quality assistance in research. As the faculty member got to know the student, she found the student's familial connection to food and her culinary expertise was relevant to their nutrition-focused research, and the project evolved to take advantage of those student interests and abilities. As a mentor, the faculty member reframed the way the engagement with research could begin for the student to ensure assets were the key to initial participation.

Collaboration across Students

A key component of the ARG model is the development of an affinity for a topic of research across team members, and as such meeting with peers and the faculty lead is vital to fidelity of the model. Reports and journals analyzed show regular interaction in the summer research experience.

Faculty Report Entry

I noticed that teamwork between two students in research is a very important aspect. When we are meeting each week to discuss some research topics and ARG professional development topics, students can ask each other questions and discuss together, which makes the learning environment more enjoyable as they can feel I am not the only one talking. Also, one student can sometimes show the other student how to do some lab work if one of them has some experience on certain analysis before.

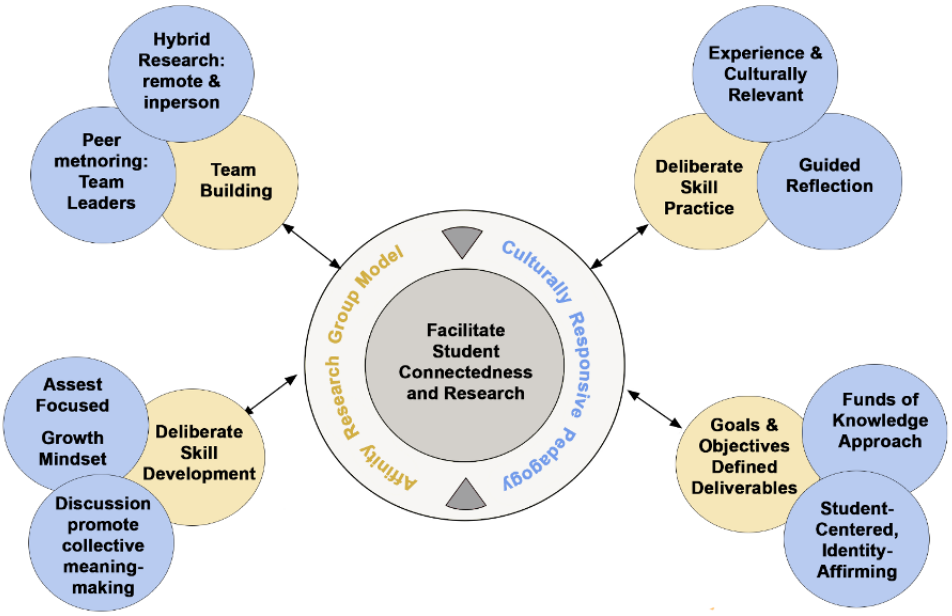
Faculty detailed the benefit of collaborative work among peer undergraduates, and student entries show that communication with peers is common and can led to troubleshooting of research problems, such as understanding software issues across machines and building a high-quality research poster.

Vila et al. (2013) identified four foundational elements of the ARG model, represented by the gold circles in the diagram below. Building upon this framework, the current illustration introduces an additional layer by incorporating blue circles, which reflect the ways in which faculty members in this study integrated components of Culturally Responsive Pedagogy (CRP) into their ARG practices. This expanded model highlights the organic alignment between ARG and CRP, suggesting that faculty may be enacting CRP principles, intentionally or not, within their research communities.

Faculty ownership and growth/asset-based mindsets greatly impacted the bottom two elements, which involve research project planning. Faculty take a more mindful approach to understanding their students' strengths and flexibly designing student contributions based on this analysis a more inclusive experience. By actively assessing each student's unique assets—such as prior knowledge, lived experiences, cultural perspectives, and skill sets—faculty are better equipped to design research roles and contributions that are both meaningful and developmentally appropriate. This flexible, student-centered approach not only maximizes individual growth and engagement but also promotes a more inclusive and equitable research experience. Identifying goals and objectives for the research activities that are explicit, visible to all members, and responsive to the group members strengths is essential. Rather than letting the faculty researcher's strengths completely guide the research, the students' academic and cultural funds of knowledge play a critical role. Rather than applying a one-size-fits-all model, faculty tailor opportunities that recognize and build upon student potential, fostering a sense of belonging and ownership in the research process.

Reflective practice and collaboration across students greatly impacted the top two elements, which involve engaging and motivating student action. Undergraduate research opportunities work best when faculty have direct interaction with undergraduates rather than communicating with the novice researchers through graduate student intermediaries (Villa, et al, 2013). Students and faculty expressed that hybrid models offer greater accessibility, accommodate diverse schedules and responsibilities, and can enhance participation from individuals who may face barriers to traditional, fully in-person research settings. This feedback highlights the importance of designing research experiences that are adaptable, inclusive, and responsive to the varied needs of team members, while including a structure embedded to scaffold reflective experiences.

Figure 1:
RP ARG Model for Mentoring New Researchers



Conclusion

If faculty are to cooperatively disrupt the organizational status quo used in selecting students, expanding perceptions of students suited for research to those students beyond implicit expectations of academic skills that mirror privileged student backgrounds. Faculty need to broaden their understanding of which students are suitable for research, as well as expand notions of the purpose of undergraduate research mentoring. The practice of implementing the Affinity Research Groups (ARG) model alongside Culturally Responsive Pedagogy (CRP), allowed faculty to cultivate a growth mindset and enabled them to adjust their expectations based on the strengths and unique assets of each student. In a collaborative multidisciplinary STEM environment, structured collaboration and reflective practices helped faculty recognize and refine the culturally responsive strategies they employed in their research labs. Additionally, faculty became more aware of the steps they took to create their research lab communities, especially those that aligned with CRP. Like any other teaching method, the blended ARG-cRT philosophy involves a particular way of structuring interaction and can be taken up by any faculty member interested in learning this approach.

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