Improving Access to Advanced Cyberinfrastructure Using Regional Computing Collaborations and People Networks: Recommendations from a National Workshop on Expanding Computing Using Collaborative Models

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ABSTRACT

Cyberinfrastructure (CI) and CI-enabled research continue to play an ever-increasing role in academia and day-to-day life. Two-year institutions and under-resourced four-year institutions face significant challenges in offering advanced cyberinfrastructure resources and support to their campuses and faculty. The National Science Foundation-funded Building Research Innovation in Community Colleges (BRICCs) community was established to bring together administrators, researchers, and educational professionals involved in CI across institutions of different sizes to address gaps in CI accessibility, training, and awareness. This community has continued to meet online and at workshops to identify ways to improve access to and utilization of CI resources at these smaller institutions and community colleges. This report contains the major recommendations resulting from our workshops in 2022 that explored the efficacy of developing collaborative regional models for making advanced CI more accessible at these institutions.

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CCS CONCEPTS

• **Regional Consortia**; • **Advancing Cyberinfrastructure**; • **Cyberinfrastructure Networking**;

KEYWORDS

Under-resourced institutions, Community College Resources, Cyberinfrastructure

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1 INTRODUCTION

Cyberinfrastructure can play a substantial role in student education and workforce development by providing networks to build opportunities for students to have "hands-on" experiences in research. This can provide them the opportunity to build a skill set internalizing this knowledge to carry forward into their careers. Not surprisingly, there is a growing need for collaborative CI research-support networks that can spur computational and data-enabled research and curricular programs [1]. Such collaborations must start at the grass-roots level. These networks can potentially support instructors, students, and researchers at under-resourced 4-year institutions and 2-year colleges that are new to CI practices. Academic transfer of credit hours is a complex matrix with large universities but not all the collaborations providing access and inclusion in supercomputing have academic goals. Workforce development requires a much more sophisticated awareness of cyberinfrastructure. Students who are well prepared for using modern CI approaches will be more successful.

In order to identify and address issues related to inequities in access to advanced cyberinfrastructure, the community-building group "Building Research Innovations at Community Colleges" (BRICCs) was established through the National Science Foundation CC* CIRA program (NSF award number 2019136) [2-3]. Research has different contexts at four-year and two-year schools. With a focus on skills-based education, community colleges do not focus on research as a primary objective. Several of these institutions are commonly grouped under "small" and "medium" programs under the Carnegie Classification of Institutions of Higher Education [4] A common characteristic of 2–4-year institutions, however, is the demanding teaching workload faced by faculty at these schools. This workload leaves little time for engaging in practices like seeking external funding, establishing in-house CI resources and support, or pursuing research using approaches common at R1 schools. Research can, however, be introduced strategically and is an opportunity for special-tailored NSF solicitations that could jump-start research projects derived from teaching at these colleges. Furthermore, increasing exposure to CI early in students' academic careers as well as increasing accessibility to CI is very important for professional success [5]. Another way in which research institutions can increase their productivity and success is by focusing on areas of expertise. At community colleges, expertise can manifest from a variety of sources, including regional opportunities for collaboration, community specific needs, or research interests shared between faculty. Focusing resources into these areas of expertise rather than trying to expand the breadth of research can help foster more successful research programs, especially at smaller or medium-sized institutions. A shared understanding of these issues provide value to smaller 4-year institutions and community colleges seeking to find models to support their growing needs for computing resources, teaching expertise and research projects. Here, BRICCs aims to identify pathways to bring innovations in research cyberinfrastructure to smaller institutions and community colleges.

2 METHODOLOGY

BRICCs endeavors to increase awareness of available cyberinfrastructure resources and build a platform where institutions can pool and share knowledge and endeavors. In the progression of achieving these aims, BRICCs organized a second workshop toward identifying means to build "Collaborative Computing Models" that can facilitate regional collaborations to expand computing at schools new to CI. This report summarizes the recommendations from our workshop held on August 11-12, 2022, at Corpus Christi, Texas. The body of this report outlines the recommendations of the workshop to develop collaborative models and people networks and complements our paper that reports findings from the workshop [6]. The following subsections summarize the results of each of the panel discussions.

3 LANDSCAPE CONSIDERATIONS TO KEEP IN MIND

The workshops were based on the premise that there are opportunities to offer advanced research computing into the academic mission of under-resourced 4-year institutions and community colleges. Building capacity for research at smaller and medium-sized four-year schools and community colleges should take advantage of less restrictive architectures that are prevalent at large research-intensive universities. Careful enunciation of what constitutes research and how research is defined at a Community College is an important consideration. While the topics were selected to elicit detailed observations and experiences relating to the different dimensions and perspectives of creating models for collaborative computing, the following overarching outcomes were noted across many, if not all, of the panel discussions. Here, we discussed this from the various perspectives of the workshop participants.

Community colleges focus on serving the community, including workforce development and preparing students for 4-year colleges. Models and solutions to fulfill the needs of smaller institutions, and 2-year colleges cannot be built on the business processes, mission, and motivations of larger 4-year universities as there are vast differences between them. For example, research is not part of the business process in 2-year and under-resourced 4-year schools, so centralized resources, mechanisms, and facilities for research do not exist there. Regional projects may be more successful than large national efforts for infrastructure development because regional and community colleges serve students with a wider skill and experience base and thus a larger and more flexible goal outcome. These relationships may grow more with national efforts if there is a structure to work within to build technology infrastructure. This may not be the traditional hardware in every location. There must be more collaborative and accessible engagement opportunities for success.

In addition to meeting the people and expertise needs, a distributed organization and a collaborative structure are required to create a solution for the smaller schools. We note that there are differences in approaches to incorporating CI between larger and smaller community colleges as well. The collaboration must extend between the 2- and 4-year schools and include collaboration on equipment and facilities as well as academic and curricular collaborations to write curricula, develop the materials and offer them across multiple institutions. There is a need for social networking that will engage community colleges, specifically, to allow the building of broader regional collaborations. Any collaboration will require well-defined roles for services provided as well as a definition of the expertise that can be provided. CI providers at larger R1 institutions often have staff or significant time dedicated to developing and emanating research-oriented training. Smaller and medium institutions often lack the necessary personnel or time to develop such materials and would benefit from collaborations with larger institutions to gain access to these educational resources. RENs (regional Research and Education Networks) could act as the foundations for regional collaboration.

4 SITUATING CI TO ACCELERATE RESEARCH AT SMALLER SCHOOLS

Engaging external community advisory boards: Community college programs are developed based on the recommendations of community advisory boards. These boards typically include significant representation from local industry and educational entities. Student success depends on our ability to blend industry needs (workforce), industry standards (advancement), and innovative research to provide a well-balanced set of advisory resources. One way to meet the challenge in advancing CI at community colleges is to help establish CI as an industry that is represented on these boards. Local industry engagement is critical but should represent both those who hire and those developing new technologies. For CI, we can serve on the board as a peer industry identifying skills and training needed in the workforce. As a community college partner, we can provide access to leading edge CI resources to assure that the learning experience is state of the art and relevant. Community colleges can really expand their market in today's remote work era as both didactic and experiential CI curricula can be done online. With several companies and agencies offering remote work locations, students from a community college may be working in industries that are in other parts of the state, or country! State agencies and advisory boards should recognize these opportunities, particularly in the context of CI technologies. Creation of diverse advisory boards, internship opportunities, and faculty professional development are all components needed to build an inclusive cyberinfrastructure for all post-secondary education.

Mechanisms to support faculty in curricular development: Faculty at these schools are over-committed, have a large course load, and have little time to spare. Engaging with them to invite possibly unknown methodologies into a curriculum can be a challenge. There are, however, opportunities here, but first we need to recognize that it is important for an institution's senior leaders to understand and agree that this is a priority. Thus, it is important to identify local needs and priorities when we advocate. Faculty can play an important role as CI ambassadors who can help students familiarize themselves with current CI and data science approaches. Here, we need to offer sufficient scaffolding to ensure that students can contextualize the value of CI in their day-to-day lives. Life events such as hurricanes, wildfires, and drought, as an example, impact the entirety of the state, but utilizing local data with students in that locality can bring a resonance that gives students that extra motivation for problem-solving to make a difference. This is an opportunity for the large research-focused institutions to provide community college access to existing research infrastructure. Using regionally obtainable data, whether it be from within the classroom or obtained through publicly accessible information, can broaden the definition of research within the community colleges allowing students through portals to utilize high performance computing as one facet of solving a problem or addressing a need that exists in their own community. This could be in many formats: the Open OnDemand portal, providing access to coding training, graduate students to provide instruction, or even shared use of laboratories. The NSF-funded Future of Technicians program website presents scenarios, written by industry and college collaborators, that provide opportunities for students to work on research/problem solving as an independent learning experience or as a class project [7]. They leverage grant funding to support the work and offer a model to improve CI access and student success.

Advancing CI as Part of the Research Enterprise: Faculty members at smaller institutions may not be aware that they are already conducting some level of crucial research as part of their educational and training processes that could be valuable to the research community at scale. Promoting this type of educational and instructional research, coupled tightly with the educational process, can incentivize research at smaller institutions. Another way to incentivize research could be to build relationships with RENs and larger institutions that could lead to collaborations with researchers at larger universities. These relationships and collaborations could relieve some of the administrative burden from faculty at 2–4-year institutions. Lastly, many smaller colleges lack developed technology or CI plans. These colleges can work with RENs to identify planning resources and receive assistance in developing these plans.

Incorporating CI in Enterprise Computing: New CI technology must be easy to adopt and easy to practice. Often Enterprise Technology Services become a "firefighting" outfit rather than a developmental, visionary team. Cross-disciplinary opportunity is more critical at the community and regional levels than ever before. Establishing communication between administrators, IT support staff, and faculty researchers is an integral part of ensuring success for all parties. Active information sharing provides an opportunity to communicate the needs as well as educate the campus leadership of the value of enhancing CI capability in support of research and education, such as serving to attract and retain faculty and prepare the next generation workforce. We do need to acknowledge there are fundamental priority differences. Enterprise IT is driven by uptime (the 9s), whereas research CI prioritizes leading edge technology. Regular opportunities to bring research IT and enterprise IT members together can help foster a better relationship between these two groups. At the institutional level, a challenge is striking the balance between the requirements for supporting the enterprise with those of the research community, and staffing these efforts is a formidable challenge at institutions of all sizes and academic achievement. Developing the relationships could garner leadership support, facilitate revival of research agendas, pursuit of external funding, increase opportunities for faculty engagement, and compliance with regulatory requirements.

Workforce Development and Improving Student Participation in CI: Students at all 2- and 4-year schools can greatly benefit from access to the larger CI ecosystem of resources, training materials, and data-science practices. Lack of student awareness concerning CI and HPC is a major impediment to these resources playing a larger role in students' professional success. Increasing faculty that utilize CI resources and the number of courses that either use these resources or provide training on how to use them will help increase their impact on students' academic life. The earlier that students are introduced to these resources, as well as the opportunities that exist in this field for employment, the more comfortable and willing they will be using them and the more they can help the students succeed. If students are made aware of potential academic opportunities and pathways in CI early, it can increase their future career competitiveness. Partnering with industry professionals can help guide the students' education and gear it towards gaining competency in areas that are sought after in industry can increase students' chances of professional success following graduation. Increasing the number of formal courses that incorporate CI and HPC can help overcome this lack of awareness. Including student positions in CI and HPC centers is also an effective way to train and develop the future workforce. Lastly, raising community awareness regarding the importance and impact of research and work conducted using CI resources will help expose students to potential career paths and opportunities in this field.

Learning from regional Research and Education Networks (RENs): RENs have a strong presence in most US states. Plans for increasing engagement and support of research at smaller institutions, however, vary between RENs, but the overarching goals remain the same. Some RENs, like LEARN in Texas and Edge in New Jersey, have built strong relationships with community colleges and smaller 4-year institutions. These relationships are represented by members on their advisory boards. Across the country, RENs offer a scalable framework to engage with institutions in a state or region. They have partnered with institutions on applications for Federal and State funding programs to develop campus CI plans that aim to improve the state of academics or research. They have also actively expanded CI access to remote and/or historically underserved communities by offering faster connectivity and made remote learning a possibility. These efforts have led to new collaborations between researchers at smaller and large R1 universities. RENs have also established funding models in which they have pursued external funding opportunities with R1 partners that include and benefit smaller institutions.

5 SUMMARY

We see opportunities to leverage regional collaborations to address some of the long-standing issues encountered in advancing access to CI resources, particularly at under-resourced MSIs and two-year colleges. This CI-centric service must be grounded in agile practices and needs to be flexible in how computationally inclined researchers learn, adopt, use, and produce science on campus, regional, and national CI. The overarching goal should be to promote regional CI resources and CI-expertise by facilitating one-on-one interactions with instructors, researchers, and offering workshops and training programs. There are a lot of efforts being made regarding building community support. The NSF CC* CyberTeams have done remarkable work in supporting CI-enabled research at these institutions. For example, the SWEETER CyberTeam has worked to address the technology and training needs at several schools in Texas, New Mexico and Arizona [1]. The Northeast Cyberteam was a regional initiative enabling effective use of cyberinfrastructure by researchers and educators at small and mid-sized institutions in Northern New England (Maine, Massachusetts, New Hampshire, Vermont) too. Entities, programs, and communities like the Campus Research Computing Consortium (CaRCC), Campus Champions, the Ecosystem for Research Networking (ERN), and Advanced Cyberinfrastructure - Research and Education Facilitators (ACI-Ref) are incredibly helpful [8-11]. These allow those with the resources and expertise needed to tackle CI challenges to help institutions that might not have the same support or infrastructure. Access to communities for sharing expertise and information is as important as access to physical technology. The Campus Cyberinfrastructure (CC*) program has also been very helpful, providing access to CI resources and expertise, as well as the opportunity to engage with researchers and promote collaboration. While doing so, it is important that the administrative and technological environment must be as frictionless as possible. Achieving this would include reducing bureaucratic barriers to beginning research or incorporating advanced technologies. The technology itself must also be easily deployed; making it easy to discover, access, receive support for, and incorporate into existing educational workflows and practices will help incentivize research [1-3, 12-18]. Taking a sharp departure from current do-it-yourself models at R1 schools, the collaborative approach doesn't require a single institution to do all the heavy lifting and can be scaled up or distributed to meet rapidly growing needs at these institutions. Simultaneously, a business model is needed to ensure the continued sustainability of these efforts. There is a dire need to develop models for regional collaboration that leverage the richness of the educational, organizational, and CI aspects of our environments. These efforts could include applying for funding/co-funding on projects with the supported institutions and partnering with industry to broaden the impacts of CI in student preparation. We need to incentivize more "research-curious" 2–4-year schools and identify technologies that can assist them. We also need to define partnerships that help larger institutions engage and collaborate on programs to incorporate research at 2–4-year schools.

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