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Community College Computing Programs' Unique Contexts for Promoting Gender Equity

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Community College Computing Programs' Unique Contexts for Promoting Gender Equity

Abstract

This paper documents issues that community college programs encounter and their needs as they work to improve gender equity in computing. It also describes how the National Center for Women & Information Technology (NCWIT) Extension Services Learning Circles (LC) have supported these community colleges (CCs) in their efforts. Multiple data sources from the NCWIT Extension Services evaluation provide evidence that CCs need support that is designed for their varying contexts. Student background, administrative processes, funding resource levels, and faculty and administrator buy-in all have implications for how CCs accomplish gender equity work. CC-specific tools are needed to address the needs and general structure of these predominantly two-year schools. NCWIT materials such as the self-assessment tool and student entry survey were described as helpful to the campus change leader teams because they provided information that informed their actions. The LC community was also helpful because it provided participants with the opportunity to learn directly from their peers.

Introduction

Since 2014, women have comprised just one-fifth of those graduating with associate degrees in computing and information systems (CIS) [1]. Due to the growth in the number of CIS associate degrees conferred to men, the proportion earned by women has diminished by more than half from 1999 levels [1]. The CIS gender gap in community colleges[1] (CCs) is particularly concerning from an equity perspective, since these institutions provide crucial access to post-secondary education, including for the socioeconomically disadvantaged, first-generation, older, and Hispanic college students they disproportionately serve [2]. However, relatively little research and programming focuses on supporting gender equity[2] within computing programs specifically within the CC context. This issue has motivated the National Center for Women & Information Technology (NCWIT) Extension Services to expand its programming to CCs. NCWIT's relevant goals focus on recruitment and retention efforts to address the underrepresentation of women through its Learning Circles (LCs) initiative.

In this paper, we make a case for the importance of CCs for shaping the computing workforce and outline the state of gender equity in CCs, as well as what we know about retention in CCs, transferring to 4-year institutions, and the unique contexts of CCs. We then describe the LC initiative in more detail and share some lessons we have learned through this project that may be useful to others with similar aspirations.

Evaluation feedback suggests that the LCs broadly provide essential structure and resources for developing and implementing strategic recruitment and retention plans. To better understand how to best serve CCs in this work, this paper asks: 1) What are the needs of community colleges that are trying to advance gender equity in undergraduate computing? and 2) What NCWIT resources support their gender equity work?

Background

Importance of CCs

Community colleges are important institutions of higher education. The American Association of Community Colleges found that over 40% of all undergraduates in the United States are enrolled in community colleges (CCs) [3]. These institutions "are centers of educational opportunity. They are an American invention that put publicly funded higher education at close-to-home facilities, beginning nearly 100 years ago with Joliet Junior College (in Joliet, Illinois). Since then, they have become inclusive institutions that welcome all who desire to learn, regardless of wealth, heritage, or previous academic experience" [4]. Their inclusive nature means CCs serve diverse student populations. For this work, they have a threefold mission: supporting students to 1) transfer into baccalaureate programs, 2) enter the workforce, and 3) access lifelong learning for personal and professional enrichment. In service of these goals, CCs provide students with a variety of resources. This includes targeted career counseling, remediation of basic skills, specialized course offerings including training programs for particular employers, individualized instruction and attention, flexible scheduling, and multiple course delivery modalities (in-person/hybrid/online, weekend and evening classes, condensed courses, etc.).

Community colleges play an important role in providing computing education and workforce development. In the 2017 academic year, computer science and information technology majors were second only to health professions as the most popular CC STEM majors [5]. Computer science and information technology includes, among other concentrations, cybersecurity, a particularly fast-growing field attracting relatively few women [6]. With the increasing cost of higher education, CCs are likely to play an increasingly important role in computing education and students' ability to achieve their academic and career goals. Within this context, it is important to note that the growth of new and emerging roles in technology fields exceeds the rate that underrepresented groups enter these fields. Academic research continues to show the urgent need to increase the diversity of students pursuing technology-related academic credentials and the numerous benefits of doing so. To address this need, many community colleges not only provide associate degrees but many offer certificate programs, intended to be fulfilled in less time than a complete degree program; such programs are often designed for targeted student audiences and focused on specific content. Some certificate programs are designed to be "stackable," meaning that credits earned toward a certificate can count towards an associate degree, providing students a flexible career pathway.

Current State of Gender Equity in CCs

The unique mission of inclusion and open access makes CCs a crucial point of intervention in the effort to broaden participation in computing [7]. Students from underrepresented groups (URGs), as well as students who are first in their family to attend college, are better represented at CCs than at other institutions. For example, the majority of Hispanic students (53%) attend CCs [3]. And while women are outpacing men in college enrollment across the board (representing 55% of all undergraduates), the pattern is even more pronounced at CCs where women comprise 57% of all students [3]. Unfortunately, these trends do not transfer to CC computing programs. Hispanic students, for example, earn 21% of all associate degrees, but only about one-tenth of associate degrees in computing and information sciences (CIS) [1]. The discrepancy is even

more striking for women, with women earning 61% of all associate degrees, but only 20% of CIS associate degrees [1]. Percentages for women of color are lower still: Black women earn 7% of all associate degrees and only 3% of CIS associate degrees, while Hispanic women earn 15% of all associate degrees and only 3% of CIS associate degrees [1]. Because men have earned increasingly more computing associate degrees over the past two decades, women's percentage of degrees has decreased by more than half from 1999 levels, even as the overall number of computing associate degrees has grown [1]. The computing gender gap in CCs is particularly concerning from an equity perspective, since these institutions provide crucial access to postsecondary education for many socioeconomically disadvantaged and first-generation college students [2].

Given all of this, CC computing programs represent an important opportunity for intervention in creating more diverse, equitable, and inclusive computing education and workplace cultures. However, relatively little research and few initiatives focus on supporting computing programs and students in CCs, particularly in terms of expanding intersectional gender diversity, equity, and inclusion (DEI). NCWIT Extension Services seeks to address this unacceptable deficiency by providing services via its Learning Circles initiative to CCs.

Retention

Students enter CC settings with a variety of potential goals—from completing a single course, to embarking upon or completing a transfer pathway to a baccalaureate institution,[3] completing a certificate, or completing an associate degree to enter the workforce. These multiple goals present challenges for tracking student retention, since students who do not complete a degree or certificate may have met their initial goals. Still, retention in CCs is an issue at a national level. Fewer than 40% of students who enroll at CCs complete a certificate or associate degree within 6 years [8], [9]. Since CCs provide accessible education for disadvantaged populations that face many barriers to degree completion or meeting other educational goals, low retention rates are a point of concern [10]. While this is true for CCs in general, these retention trends are perhaps more concerning for computing fields given their potential to offer students socioeconomic mobility toward financial security.

Transferring to Baccalaureate Institutions

About 30% of CC students transfer to baccalaureate institutions and about 13% complete a bachelor's degree within 6 years of beginning at a CC [11]. While data on actual transfer rates by gender (alone or in combination with race) are limited, as are data that include nonbinary gender identities, data on gender that focuses on categories within the gender binary (women/men) suggests differences in intentions to transfer to a 4-year school, with 30% of women and 37% of men reporting that they enrolled in a CC in order to transfer to this kind of institution [12]. Given that a substantial portion of CC students are men, these numbers suggest some mismatch between students' intentions and outcomes, especially for completing a degree upon transferring but also for taking the initial step of transferring at all. Some research from 2018 also suggests there are ethno-racialized differences in transfer rates: about a half of Asian and White students transferred, while two-fifths of Hispanic students and one-third of Black students did [13]. Data

on transfer rates for women of color were not readily available for this research, suggesting this is an area for further documentation.

Cost and a confusingly complex and hurdle-laden systems are among the barriers students face transferring from 2-year CC programs to 4-year schools [14], [15]. The latter likely also contributes to relatively high rates of "inefficient" and "incomplete" transfers, where students end up with many credits that will not successfully transfer and may not complete their 4-year degrees [14]. There are some efforts that states have implemented to facilitate more successful transfers [14]. Among others, these include simplifying, clarifying, and providing advising through the transfer process, as well as developing more statewide consistency across coursework and degree requirements [14]. This second strategy can include establishing statewide associate degrees for high-demand fields [14]. Given the growing demand for computing experts and the important role that community colleges play in training marginalized populations, there is great potential for these institutions to help expand equity in computing fields across different degree pathways [16]. A key component of this will necessarily be improving equity within community college computing programs, which highlights the need for the work the CC CLTs are doing in their schools.

In addition to the institutional barriers to transferring described just above, exclusive cultural climates may be another hurdle in some cases. For example, research points to an unwelcoming environment making it challenging for women of color who transfer into STEM fields, because of discrimination based on their age, ethnicity, gender, and community college background [17]. It is perhaps unsurprising then, that retention is low for women of color who transfer to a 4-year institution to study a STEM field [17].

Serving the Community College (CC) Context

Student Needs

The CC student population tends to differ from that at a baccalaureate institution in several significant ways. Importantly, many CC students come from less advantaged socioeconomic circumstances. For example, 31% of dependent CC students come from homes with annual incomes of $30,000 or less [2]. Further, more 2-year students face food insecurity, housing insecurity, and homelessness than students at 4-year schools [18]. This implies a host of potential educational barriers, including distracting students from their studies and limiting their access to college preparation curriculum, which likely help explain the relatively high portion of CC students (60%) who need remediation [19]. Accordingly, a majority of CC students work: 62% of full-time students and 72% of part-time students [3]. They also often have responsibilities in the home: 60% of CC students are independent and do not depend on support from parents [2]. This can interfere with or interrupt these students' studies and their ability to seek academic support services. Relatedly, two-thirds pursue their studies part-time [3], extending the length of their program and making resilience and flexibility important keys to its successful completion.

Second, many low-income students, who are overrepresented at CCs, do not have the necessary computer equipment and/or a broadband Internet connection at home to complete their coursework in their own time. For example, 22% of low-income Californians (vs. over 10% of all Californians) did not have a computer or computing device in 2019 and 24% (vs. 16% of all

Californians) did not have broadband Internet [20]. This can potentially exacerbate time constraints working students face and make it more challenging to complete computing coursework, especially if it is inconvenient or impossible to access on-campus resources.

Finally, CC students may be less likely to have communities of support within the computing field. They may have fewer mentors and contacts in this industry, given that social networks are often fairly socioeconomically homogeneous and many computing careers often offer relatively high incomes [21]. Student clubs are difficult to maintain year after year as high student body turnover rates challenge continuity. Student leadership often needs to be updated every semester, as students move in and out of the CC system. CC students' work and family responsibilities may limit their ability to participate in club activities. All of these challenges can stack up against CC students and limit their access or exposure to lucrative computing careers and inhibit their success.

Structure

CCs generally have a diverse operational structure and rarely have units dedicated to computing programs like many baccalaureate institutions do. This can make it challenging to design universal equity programming and may mean CCs have limited personnel to design and implement equity-boosting initiatives. Further, CC governance structures and policies vary by state and may differ substantially from the regulations of other colleges and universities [22]. This may make it more or less challenging to develop programs that target members of historically marginalized groups. Some CC computing programs reside in a department or division dedicated to math or, even more broadly science, technology, engineering, and math (STEM). Others sit within a department of professional studies. Smaller CCs may only have discipline-specific program coordinators with each computing area under the leadership of a different faculty member. Further, sometimes computing programs are split among multiple divisions, which complicates sharing tools, classroom and laboratory equipment, operating procedures, and ensuring diversity among all computing programs as a whole.

Further, CCs' practical orientation means they are responsive to a variety of educational and local industry needs. They therefore dedicate resources to degree programs that can fill workforce gaps and provide industry certifications through their course content. Along with implementing fixed, cost-saving approaches like vendor instructional resources (e.g., Oracle Academy), the specific requirements for industry certification also restrict CCs' flexibility for introducing new equity-advancing approaches.

Internal Resources at Community Colleges

CCs' capacity for improving gender equity is also limited by a relative dearth of internal resources. To start, lower tuition, state and local funds, and research grant monies mean that CCs often have relatively little funding [23], [24], which can limit capacity for advancing equity through recruitment and retention of a diverse student population. This can limit CCs' ability to 1) educate and train faculty to incorporate inclusive teaching practices and offer programs targeted at DEI recruitment and retention and 2) alleviate the financial pressures that impede students' ability to focus on their studies.

Further, while many CC resources are dedicated to the main mission of providing quality, low-cost education, CC faculty are often under-resourced, teaching several, often different classes per semester. With no funding resources for teaching assistants and other academic pursuits, CC faculty have limited extra time available to pursue research interests, seek grant opportunities, obtain professional development, attend conferences, or support student outreach or co-curricular activities. Like faculty at baccalaureate institutions, CC computing faculty are often experts in their fields. However, they have fewer resources to pursue the most current pedagogical training. Also, even more than at baccalaureate institutions, CC computing programs are staffed by a significant percentage of adjunct professors who have even fewer opportunities to pursue professional training in pedagogy [25]. As interest in computing programs has exploded over the last few years, the large increase in introductory computing classes has forced computing departments to staff these classes as fast as possible without the opportunity to ensure that properly trained staff are being assigned to these critical gateway courses.

Limited access to accreditation/program validation is also a challenge to 2-year computing programs demonstrating their legitimacy when seeking funding for gender equity work. For years, many professional and accrediting bodies focused exclusively on bachelor's degree programs. More recently, some of these institutions have begun to consider CCs in the area of curriculum design, accreditation standards, and pathways into the workforce. In addition to facilitating fundraising for CCs, accrediting bodies can also help CCs support transfer-seeking students by providing resources on standards for transfer to baccalaureate institutions that are accredited by the same organizations.

Given the relatively few DEI funding opportunities available to CCs, as well as time constraints, funding, staff, and institutional support for DEI are not as easily or readily available to CC computing programs. As such, these programs depend largely on the dedication of strongly committed faculty and staff members to volunteer their time with varying levels of commitment and interest by the larger institution.

Project Background

Launched in 2007, Extension Services provides professional development, access to custom data analysis reports, guidance on evaluation, and expert consultation to undergraduate computing departments. Departmental participants (i.e., change leader teams or CLTs) create and implement a research-based, multi-component, and contextually informed strategic recruitment and retention plan for DEI initiatives within their respective undergraduate programs. Departments and institutions have widely varying policies, student populations, and cultures, so change efforts delineated in their strategic plans must be relevant to their specific contexts and challenges. NCWIT's extensive research-based resource collection and the NCWIT Undergraduate Systemic Change Model[4], which depicts six areas of focus for improving diversity in undergraduate computing, support the work done as part of Extension Services.

Extension Services Learning Circles (LCs) were created through a pilot project funded by National Science Foundation Improving Undergraduate STEM Education Program and Pivotal Ventures, with the goal of scaling Extension Services to more computing departments by using a

community-based learning format. While initially designed for four-year institutions, Extension Services was able to test the LC initiative with a small number of CCs (n=5 across 2 LCs: a 2019-2020 cohort and a 2020-2021 cohort).

Each LC ideally consists of three change leader teams (CLTs). CLTs are matched based on similarity in institutional and program context to facilitate learning from each other's experiences. An Extension Services facilitator leads teams through a series of approximately 12 monthly online meetings aligned with an academic calendar. During the online meetings, CLTs build community with peers, share knowledge, explore ideas, and support each other's planning and implementation. Meeting topics, which are aligned with the Undergraduate Systemic Change Model, provide CLTs with knowledge to conduct self-assessment, develop strategic recruitment and retention plans, and utilize evaluation data. Outside of the online meetings, an Extension Services Consultant (ESC) meets regularly with CLTs one-on-one to assist the CLTs as they plan their contextually specific DEI recruitment and retention strategies. ESCs typically hold doctoral degrees in education, sociology, evaluation and other relevant social sciences and are deeply knowledgeable about social theory and change. They are experienced as evaluators and consultants to a variety of educational programs, generally working in STEM disciplines.

Key NCWIT resources that CLTs utilize during the LCs include a self-assessment tool for compiling and assessing information about student demographics and departmental policies, practices, etc.; student entry survey to gather information about students enrolled in introductory courses and investigate the effectiveness of current recruiting efforts; student retention-focused resources with strategies to retain women in undergraduate computing and engage underrepresented students; resources to guide strategic planning for recruiting women; and a Tracking Tool for gathering and charting enrollment and outcomes data (currently the Tracking Tool only analyzes data from four year institutions although revisions are underway to accommodate community colleges). Through its website, https://ncwit.org/, NCWIT also offers institutions hundreds of resources with theory- and research-informed suggestions for policies and practices to expand gender equity.

The LC year culminates with each CLT submitting a strategic recruitment and retention plan that includes research-based recruitment and retention strategies—complete with evaluation mechanisms—feasible for their own departmental and institutional contexts. These plans also incorporate strategies across multiple areas of the Undergraduate Systemic Change Model. Small gift funds are provided to each CLT to support some of their strategic change efforts.

Data and Methods

This paper draws on a variety of data sources to assess the participating change leader teams' (CLTs) reported needs and challenges in doing work to advance gender equity, as well as which the NCWIT and Extension Services resources can best be leveraged to address those needs. In the Findings section, we describe findings from five community colleges spanning two separate years of Learning Circles. In the first year (2019-2020), Extension Services began with two colleges that award both two- and four-year degrees and were part of the same state system. In the second year (2020-2021), three CCs that exclusively grant associate degrees joined the initiative. We integrate data from evaluation surveys and interviews, and—for the most recent

LC cohort—structured personal reflections from three points-of-contact leading their CLTs. For this last piece, two points-of-contact reviewed and contributed to this paper as co-authors, and another point-of-contact contributed to the early development of the paper.

We descriptively analyzed a total of 13 responses from an end-of-initiative survey, which was administered by external evaluators at the University of Washington Center for Evaluation & Research for STEM Equity (CERSE). The survey was designed as an evaluation tool with the evaluation team designing multiple-choice and open-ended questions to address evaluation questions[5] and the project team providing feedback on those questions. The survey focused on individuals' experiences in the LCs, including perceived benefits, challenges, and anticipated outcomes. Individuals from all five colleges and points-of-contact from four institutions responded to the survey. For the analysis, we created descriptive statistics summarizing quantitative data and reviewed the responses to each open-ended question to identify themes and sub-themes survey participants raised [26]. These themes were assessed both deductively – based on NCWIT's systemic change model and program activities – and inductively – allowing for unexpected themes to emerge [27].

CERSE also coded transcripts of semi-structured, 30-minute interviews with six people from four schools (including the point-of-contact from each). Like with the survey, the evaluation team designed the protocol, with input from the project team, as part of the evaluation. Interviews aimed to gather more detailed information about LC experiences, including institutional needs for expanding gender equity, and helpful NCWIT resources.

In this project, the evaluation focused on variation in the institutional structures and challenges change teams highlighted on surveys and during interviews. Because this work did not home in on individual identity, we did not systematically collect demographic data about the change teams or the institutions they represented while they participated in the LCs.

Positionality Statement

The perspectives in this paper are shaped by the author team's various privileged and marginalized identities and relevant expertise. The individual authors include two of the community college faculty who spearheaded their change leader teams during the 2020-2021 academic year, program staff at the organization administering the Learning Circles, the ESC, and the evaluation team for the project. In addition to those currently teaching at CCs, another has done so in the past and was also a faculty educator at a CC. Two authors attended community colleges while pursuing their post-secondary education. All members of the author team have one or more advanced degrees and are currently middle class. Several grew up working class and/or were the first in their families to attend college or graduate with a bachelor's degree. The authors identify as cisgender women. Most are racialized as White, one as Native American, and another as Asian. One White author is part of a multi-ethnic, multi-racial family and another author is a first-generation migrant to the U.S. The team members have varying ability statuses and family structures.

Findings

In this section, we outline how our data helps answer the two questions, 1) What are the needs of community colleges that are trying to advance gender equity in undergraduate computing? and 2) What NCWIT resources support their gender equity work? Findings show that CC change leader teams (CLTs) emphasize their unique needs and challenges, which require resources and support that are tailored to their context. The teams found several NCWIT resources useful, particularly the one-on-one guidance of expert Extension Services consultants and staff, as well as a self-assessment and student entry survey, which allowed them to better understand—and convincingly communicate to their colleagues—the state of gender equity in their departments. Some teams also identified several student recruitment and retention workbooks and tip sheets as helpful in formulating their recruitment and retention plans. Finally, the CLTs unanimously reported that the gift funds NCWIT provided were helpful for implementing some of their goals. On the other hand, resources like the Tracking Tool—which schools can use to longitudinally collect and assess enrollment, attrition, retention, and completion data—were designed with 4-year schools in mind and are not yet useful for 2-year institutions.

Community College Needs for Expanding Gender Equity

Context-Specific Support

In interviews, CLTs from CCs consistently emphasized a need for support that is informed by a comprehensive understanding of the school's context. During most of the interviews, the teams explained that CCs can have important administrative and programmatic differences from other colleges and universities, which require new or adapted approaches. In the following quote, one CC point-of-contact described their perspective on how CCs differ from other schools.

> "There were just some things [proposed] from the bigger colleges and universities that were different for us—just policies and things like that. Like how we handle our grants and gift awards and how we're able to use those funds. And […] our department, it was a little bit different. We tend to be smaller. So, some of the strategies I think that may have worked for the bigger colleges and universities wouldn't have worked well for us just because it'd be in a different type of environment."

Certainly, a focus on two-year degrees is among the chief differences between CCs and baccalaureate schools. At the same time, it is also important to acknowledge the great heterogeneity that exists *among* CCs. To start, CLTs pointed to differences among CCs in student demographics that can have implications for recruitment and retention strategies. For example, one team suggested that recruitment activities that focus on high school students who will enter their program as a cohort and live on campus may not be appropriate. As they put it, "a lot of [the research informing NCWIT resources] looked at high schools. That's not necessarily where we go to recruit." Further, this individual remarked that much of the research applies to "recruiting for students who are residential really, including for students who are coming in as a cohort and retention of students who are coming in as a cohort, and a community college is not built that way." This CLT member may be referring to many newly admitted CC students often being older and no longer enrolled in high school when they decide to attend CCs, more CC students commonly completing their programs part-time rather than as a cohort of full-time

students beginning and finishing the program simultaneously, and CCs not typically having on-campus housing.

The need to understand an institution's population is likely not unique to CCs, as baccalaureate institutions participating in LCs routinely raise this during interviews as well. For example, racial and ethnic heterogeneity in student population across 4-year institutions meant that issues of intersectionality comprised a larger share of some change team's gender equity needs. Further, one co-author's anecdotal observations suggest that understanding current and prospective students is essential at any type of school to appropriately target messaging around recruiting and other interventions. These kinds of idiosyncrasies, however, may be particularly challenging for CCs to identify and navigate given their limited resources and the complication of varying definitions of "success" within these institutions.

When comparing this last point with input from another CLT it becomes clear that not all CCs have compatible structures and needs. While the CLT above suggests that high schools may not be its primary recruitment target, another CLT suggested that many of their students come from high schools and emphasized the importance of equitable recruitment from that source.

CLT members who participated in interviews outlined several additional ways CCs can differ from each other. Beyond the variation across years regarding whether CLT members' institutions exclusively grant two-year degrees, a distinction arose in terms of whether the CCs are operating independently or are part of a large system of schools with a centralized administrative structure. One CLT member put it as follows: there are many states that operate CCs as a "system" instead of independent institutions. For example, [our state has] a group of [dozens of] community colleges. Each of these CCs within the [system] must use the same [course plan] and thus is limited in flexibility to adapt content."

Further, some of the colleges are located in more densely populated areas than others, which may mean they have more resources and serve a different body of students. As one CLT member put it, "it was sometimes hard to relate when [somebody from another school in a different context was] talking because we just don't have [the same] resources or that setup."

Buy-in from Faculty and Administrators

Institutional commitment and capacity are necessary for making change at CCs as well as at baccalaureate institutions. Multiple CLTs also expressed the importance of buy-in and active participation on the part of their colleagues and raised challenges associated with keeping their colleagues and/or administrators engaged. Some of this stemmed from the replacement of one or more administrators who had made the initial commitment to support the gender equity work. One CLT member remarked, "We have had a little bit of difficulty more so because of our own college's administration. The [administrator] who initially agreed and encouraged us to participate left the college […] So, we had [new leadership] […] that was not supportive of the program. And so, we've had to battle that a little bit, so that's the biggest thing that is slowing us down."

It is challenging for one or a small number of individuals to make productive institutional change without broader support. Not only do change leaders need to build and sustain the help of colleagues and administrators, but they also have to garner the support of additional individuals who may not support the initiative and/or may have particularly limited capacity while transitioning into a new role. While the need for institutional buy-in was not unique to CCs, challenges associated with building lasting relationships with administrators motivated for change may be particularly salient at these schools since CC administrators often face particularly high turnover [29], [30]. For example, one co-author's anecdotal observations suggest that long-term change may require hiring individuals dedicated to the success of gender equity initiatives, for whom these activities are part of their job and not an overload. However, the lower tuition and limited external funding opportunities CCs have access to may make hiring such dedicated staff impractical.

Community College Perspectives on the Efficacy of NCWIT Learning Circle Support, Resources, and Tools

Survey data from four of five CLT points-of-contact suggest that the CCs generally found many of the resources and support either somewhat or very helpful. Through qualitative data, CC CLTs highlighted the usefulness of targeted support from the Extension Services consultant and staff, particularly when it was aligned with the institution's context. CLTs also felt especially supported by learning from each other's relatable experiences, tools for departmental self-assessments, student entry surveys, student recruitment and retention workbooks and tip sheets, and the gift funds for implementing the strategic plan activities. Further, there were some resources that CLTs thought could be improved.

Targeted Extension Services Consultant and Staff Support

Between the Extension Services consultant and staff, each change leader team received targeted support that was situated within the unique context of their CC and helped facilitate their progress through the program. As one person suggested, "Our consultant was excellent, and we benefited so much from meeting with her outside our Learning Circle meetings." Another pointed to specific guidance they found particularly helpful: "I really think [the most useful part of the LC was] the work that we did with [the consultant], when she was helping us with our website and our program flyers because I think that's going to have the biggest impact. We just learned a lot from that exercise, and I think it just changes the way that we're going to message our program to all the different groups and allies. I think it's going to have the biggest impact."

Another put it as follows: "[…The Extension Services staff person] worked very hard and diligently to help aid us in getting that [recruitment and retention] plan created and coming up with something that was truly acceptable to not only NCWIT but, in my opinion, more importantly, acceptable by our president. So, she definitely went above and beyond in that area."

Interviews revealed that it is critical for the Extension Services consultant and staff to be attuned with the specific contexts of the schools, as well as "the differences between […] four-years […] versus the community college." In one case, a CLT found one of the Extension Services

representatives did not demonstrate knowledge of the necessary context and described the dynamic as detrimental to their enthusiasm to participate in the program.

Community Building within Learning Circles

Those CC change leader teams that found the experiences of other teams relatable and which developed good connections to the other schools found the opportunity to learn from other schools particularly helpful. As one CLT member suggested, "I loved having the other schools there to hear about what they're doing, to get feedback from them because we're all the same. We're all community colleges, people with similar kinds of issues that we had so that's always helpful to hear. I'm really big about learning from others. I don't need to start from scratch […], so that was very helpful." Not all schools, however, had this experience, with some suggesting the sense of community developed within the LCs was "neither valuable nor not valuable" or "somewhat not valuable." These schools attributed these ratings to either not finding other teams' contexts to be relevant or that they did not have enough of a chance to connect and brainstorm with the other teams. Recruiting more CCs to participate in NCWIT Extension Services and other programs may improve the opportunity to pair teams with similar contexts.

NCWIT Learning Circle Resources and Tools

The self-assessments, student entry survey, and the gift funds emerged within the survey and interview results as consistently helpful for the CC change leader teams. All four survey respondents rated the self-assessments and gift funds as "very valuable" and all four rated the student entry survey, online meetings, and recruitment and retention plan as "very valuable" (75%) or "somewhat valuable (25%). The self-assessments and student survey enabled the CCs to better understand their own context and the gaps they need to fill. This also allowed the schools to better demonstrate to others in their institutions that there is a need to expand gender equity and to identify ways to move forward. The following quotes from three separate change leader teams describe some of the benefits of these resources and tools.

> "[The self-assessment] was very good, because that forced us to look inward and even though we thought we were doing a very good job, we saw that there were a couple of holes that needed to be filled, and […] The other good thing about participating in the learning circle was […] we got [additional] faculty members on board […] I think it built a sense of community within the department. Having those two faculty members on board, I think was a big win."

> "The [student entry] survey they had us do was informative. We had the impression that a lot of our students were older students and we actually found out the reverse so that was very informative—changed our whole marketing strategy."

> "We examined our recruiting strategies with a new lens after the Learning Circle. Our student entry survey told us what was working and what was not working. After the Learning Circle and survey, we realized we needed to scale up our community outreach effort to recruit more women and other underrepresented populations. The process also validated our recruitment storytelling approach, which was helpful."

The majority of CCs raised that the gift funds, which are distributed after the finalization of the departmental strategic recruitment and retention plans, played an important role in facilitating their work. These funds are designed to support the participating departments in implementing prioritized activities emerging from their strategic plans. One CLT member who had been delayed in their work due in part to a lack of administrative support suggested that having the "money in hand" has moved administrators toward green lighting the CLT's efforts. Multiple people also reported delays in the funds becoming available due to CC-internal uncertainty about how to administratively process the check. This may be particularly salient in CC contexts due to the relative infrequency of receiving external gift funds and needing additional time to identify appropriate CC personnel to assist with navigating the intake and distribution of the gift fund check.

Though many NCWIT resources have been helpful for the CC CLTs, it became clear that CCs can be better served if all materials work for the CC context. For example, multiple teams at 2-year schools discussed the NCWIT Tracking Tool, which several CLTs from four-year schools found useful for assessing and tracking student enrollment and retention changes within their program. This resource is currently only available for 4-year contexts and one team pointed to the need to adapt related resources, in part because it will send the message that the program is "geared towards" and "welcoming community colleges." By doing so, it can send a message of inclusion, which can enhance broader participation from CCs and influence the likelihood of embedding the change strategies within their culture.

The discussion just above, along with the comment from another change leader team about the need for Extension Services representatives to demonstrate greater knowledge of CC contexts, suggests that providing CC-specific resources can meet the context-specific needs of these schools. Importantly, these quotes suggest that being more inclusive toward CCs can also help with the salient need to attain and maintain the buy-in of CC faculty and administrators.

Community College Perceptions of the Efficacy of Additional NCWIT Resources Leveraged within Learning Circles

Additional NCWIT resources from its large repertoire of research-based resources were also utilized within the Learning Circle meetings and were found to be helpful. These specific resources are freely available on https://ncwit.org/ and are easily accessed by individuals and departments independent of LC participation.

CCs in the LCs found "Top 10 Ways to Recruit Underrepresented Students to Your Undergraduate Computing Program" to be particularly useful. This resource provides recruiting tips that all higher education and even K-12 Career & Technical Education (CTE) programs can adopt. In addition, CCs in the LCs used the "Recruit Strategically: A "High Yield in the Short Term" Workbook for Attracting Women to Undergraduate Computing and Engineering" and the "Strategic Planning for Retaining Women in Undergraduate Computing Workbook" to formulate their recruitment and retention plans. NCWIT also offers a variety of posters that feature women and highlight computing careers and ideas for combining passions or hobbies with computing, which one CC CLT member credited with prompting students to consider adding a computing certificate to their education plans.

Student retention-focused resources were particularly helpful to one CC CLT for which retention was their biggest pain point. The point-of-contact noted these retention resources as being helpful as they discussed their retention strategies: "Top Ten Ways to Retain Students, Strategic Planning for Retaining Women in Undergraduate Computing Workbook," "Top Ten Ways to Engage Underrepresented Students in Computing" and the "NCWIT Engagement Practices," organized around the three research-based principles "Make it Matter," "Grow Inclusive Student Community," "Build Student Confidence and Professional Identity," which outlines actions faculty can take to engage and retain all students. According to the point-of-contact, "we learned strategies for retention including equitable curriculum and support services. One of the key reflections about support services was the lack of female tutors and we are going to make it a priority to hire some more female tutors."

Two CC CLTs found NCWIT's "Counselors for Computing" (C4C) materials helpful. C4C provides information and resources to assist school counselors with advising K-12 girls and students from underrepresented groups on computing careers. These CC CLTs provided C4C packets to counselors at local K-12 schools and reported positive effects on subsequent communication and outreach efforts with the schools. One community college worked with NCWIT Communications Team to co-brand the "C4C Community College Pathway to IT and Computing Careers" flyer and is disseminating it through their Admissions and Education Opportunity Fund offices.

Discussion

Multiple data sources from the NCWIT Extension Services evaluation provide evidence regarding specific CC needs as well as the variation in CC needs. Broadly, CCs need support that is designed to their contexts. In some cases, this means that the student demographics and the level of resources drive what their institutions do. CCs need faculty and administrators who are committed to gender equity and are willing to support the work so that the workload is not shouldered by one or two people. Relatedly, faculty and administrator buy-in was described as a core need by the CLT interviewees.

Some of NCWIT's research-based resources designed for self-assessments were described as very helpful to the CLTs. Teams especially found the self-assessment tool and the student entry survey as appropriate to their context and resulted in new information that changed the way they acted. Most also described the strong impact of the learning community for enabling them to learn from their peers as well as the targeted Extension Services staff and consultant support. Some reported that specific recruitment and retention focused resources, including workbooks and tip sheets, were useful as they discussed current strategies and pain points and identified new strategies to adapt for inclusion in their strategic plans. Two community colleges reported that materials provided by NCWIT's C4C program enhanced their relationships with local school counselors. The gift funds, which provide a small amount of financial support for an intervention, were also described as very helpful. The helpfulness of these supports is likely related to how little funding they have historically had for this work. Importantly, the resources that were more positively reviewed were those which were context-adapted or generic enough to work in many contexts.

Finally, the interviewees from the CLTs reported that when resources weren't adapted to their context, the information was both 1) not helpful and 2) de-motivating and felt exclusionary. Relevant examples include recruitment materials that were not targeting the right population for one of the CLTs and the NCWIT Tracking Tool, which has not yet been adapted to incorporate the varying ways to track student success within a 2-year context (i.e., single course completion, transfer to baccalaureate institutions, certificate completion, associate degree attainment to enter the workforce).

This work highlights multiple things about CCs. Many of these schools operate with wide-ranging resource levels, different governance structures and policies, and different student populations than baccalaureate schools, which results in unique needs. However, we note that not all CCs have the same contexts and there is great heterogeneity among CCs. Finding this variation within such a small group of CCs suggests that while our largely qualitative methods limit our ability to generalize the specific needs of the CCs engaged with this project, it seems clear we must attend to the variation across CCs based on their unique populations and leadership contexts. As with any gender equity work, it is essential to understand the specific contexts before recommending interventions. This is a general tenet that works across all schools. However, there does seem to be an unmet need for CC-specific tools that consider the general structure of 2-year schools. Because CCs fill an important gap in terms of computing training and re-skilling, they must be included as a key partner in gender equity work.

A discussion of context would be incomplete without mentioning that the Covid-19 pandemic significantly impacted the 2020-21 LC cohort, which began in early 2020. While LCs have historically relied on virtual meetings, it is the norm that most other activities (e.g., recruiting, teaching, campus CLT meetings) take place in person. The Covid-19 pandemic upended this normal practice. On the one hand, CCs are often leaders in providing their coursework through distance education and have significant institutional capacity to do so. On the other hand, lockdowns and other local policies required all coursework and activities to suddenly become remotely delivered.

CLT members themselves often had to pivot to new responsibilities and new ways of teaching with little notice, which necessarily took time away from any DEI activities that they might otherwise have engaged in. The pandemic also made aspects of strategic planning difficult. The teams constantly needed to wrestle with what changes brought on by the pandemic might turn out to be permanent versus those that would be more temporary. For example, the CLTs needed to determine whether to plan around pandemic limitations on high school visitations or whether to plan for the possibility of in-person interactions. It is also important to note that the 2020-21 LC cohort did not experience the NCWIT in-person Summit where community building within the LCs is enhanced and participants can engage one-on-one with their Extension Services facilitator and consultant after participating in workshops tailored to the needs of their cohort.

One CLT reported that the pandemic has substantially delayed the implementation of their strategic recruiting and retention plans. For example, virtual recruiting events were severely under-attended, compared to recruiting events in prior times, presumably due to screen-time fatigue of students who had to shift all educational and social interactions to be solely online.

Communication with area guidance counselors was significantly reduced by the lockdowns thus impacting the roll-out of DEI strategic recruiting plans ultimately delaying its future potential impact. Because this CC had been primarily virtual at least for the first 1.5 years of the pandemic, there were students who will be completing their associate degrees soon who have not yet visited campus. Retention plans have thus had to be rewritten or delayed. Faculty and administrative CLT members have been subsumed in pandemic planning and adjustments with limited time and resources for DEI activities.

A second CLT also reported a decreased focus on finding technology for their rural students to continue their coursework and setting up mobile classroom vans to support those currently enrolled. While this school attempted a few live information sessions via Zoom and Facebook, they were sparsely attended. This may be due to prospective students' focus on covering their basic needs rather than adding the additional expense of tuition. CLT's traditional recruitment methods have shifted to focus on providing support and expanding community outreach. This CLT also struggled to find time and resources to focus on DEI, though was able to use some of their time during the pandemic to improve their printed communications and degree modifications to be more supportive to underrepresented students.

In other ways, the pandemic had much less effect. For instance, website redesigns could be undertaken with an eye toward how the programs present themselves through words and images, perhaps aligned with other changes happening with programs or course offerings as a result of, or in spite of, the pandemic.

Conclusion

Overall, our findings support NCWIT Extension Services' plans to further enhance its work with community colleges and implement the following activities:

- Seek funding to facilitate larger Learning Circle cohorts solely focused on CCs to broaden Extension Services' work with different types of CCs and best match participating departments according to similarities in institutional and program context;
- Expand the Tracking Tool to provide a mechanism for CCs to collect and analyze year-to-year data trends for course pathway enrollments, associate degree completions, 4-year transfer rates, and job placement rates;
- Adapt and create evidence-based informational resources that are inclusive of CCs using input from work teams of CC computing faculty, staff, and experts drawn from NCWIT's Academic Alliance;
- Partner with Learning Circle CCs to engage local and regional networks including high schools, 4-year transfer institutions, industry, NCWIT's Aspirations in Computing, and NCWIT's Counselors for Computing to create stronger academic and career pathways for students from groups that have been historically underrepresented in computing;
- Facilitate professional development sessions for consultants to have a strong knowledge base for working with CCs with different structures, student needs, and internal resources to ensure context-specific support is provided to CC Learning Circle participants;

- Implement Extension Services' new department chair engagement series to support Learning Circle CC chairs as they work to institutionalize diversity, equity, and inclusion research-based strategies within their departments and programs.

True systemic change requires attention to all parts of a system, and community colleges are an integral part of the educational system. This paper only touched on some of the unique needs of CCs and does not address how work to support gender equity in CCs intentionally includes nonbinary or genderqueer individuals, as well as women and nonbinary or genderqueer people of color. More study is needed to understand how the constraints that CC computing programs experience affect their ability to advance gender equity in technology, including with this more inclusive consideration of gender and intersectionality. It is important to do this research work in community with CC representatives so that their perspectives are heard and addressed. This is one of the reasons that this paper includes so many co-authors, to ensure that members of the population being studied had the ability to write and rewrite their own story and to member-check that the analysis was representative of their experience. More needs to be done to make sure that CCs' unique needs are met as they work toward greater gender equity. Hopefully, this paper can help change-makers better understand how to get there.

End Notes

[1]For the purposes of this paper, community colleges are defined as those schools of higher education that predominantly award associate degrees, including those that the Carnegie Classification of Institutions categorizes as "associate colleges," "special focus two-year institutions," and "baccalaureate/associate colleges" [31].
[2]In the context of this paper, "gender equity" refers to the conditions in which sufficient policies and practices are in place to support equal outcomes for students regardless of gender. The outcomes of interest are representation in the recruitment and retention of students.
[3]According to the Carnegie Classification of Institutions, baccalaureate colleges are characterized by predominantly awarding bachelor's degrees [31].
[4]See more information on the Systemic Change Model here: https://ncwit.org/program/undergraduate-systemic-change-model/ .
[5]The evaluation questions guiding the development of the survey and interview protocol include:

1. How effective is this model for changing the "systems" experienced by computing students? (summative)
2. To what extent does this collaborative and mentoring model work as a scalable solution for providing dedicated support to computing departments? (summative, formative)
3. What roles do the expert consultants play, and what benefits do the Change Leader Teams derive from their interaction with the consultants? (summative, formative)

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