

**Results & Successes of eAlliances: A Distributed Peer Mentoring Network Model
for Women in Physics & Astronomy**

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“In vertical mentoring, it is often assumed to be a one-way advice path. But we can learn from each other in so many ways. The horizontal mentoring leveraged each of our strengths, expertise, and experience. There was no single ‘expert.’ This style of mentoring promotes each of us to provide insight and support where needed. This is the most effective mentoring model I have ever seen.” ~eAlliance participant

Introduction

An NSF PLAN D project was launched to provide effective mentoring for women physicists and astronomers in postsecondary institutions of higher education with the goals of supporting their career advancement and ameliorating their feelings of isolation. This paper is based on the experiences of the five women physicists and astronomers leading this initiative and qualitative analysis of 138 text documents collected for the evaluation of this initiative, including in-depth baseline and summative interviews with project participants (N=12 and N=35, respectively), and multiple electronic journal entries (eJournals) collected across the five years of the project from 41 of 49 participants (see Table 1).

Mentoring is important to faculty career development (Boyle & Boyce, 1998; Karukstis et al., 2006, Karukstis et al., 2010), independent of career stage (Blaha et al., 2010). In fields where women are underrepresented, women are more likely to be mentored by men, and while this can be quite successful, mentoring of women by women in such circumstances is often more beneficial (Nolan et al., 2008; Ginther et al., 2020). In physics, where women make up less than 20% of the professoriate (AIP, 2020), isolation is prevalent for women, who are often the only one in their department. To have mentoring of women by women in the field, mentors often must be located at other institutions. Using a horizontal mentoring model where peers act as both mentors and mentees provides benefits for all involved and diminishes the demands on senior

women within the field. To address these issues, we implemented a distributed (Cox et al., 2021) peer-mentoring (Daniell, 2008) network model, which we define as the following:

- Distributed = different institutions and often geographical separation
- Peer = similar career stage and/or type of institution
- Mentoring = seeking and providing advice and support
- Network = committed and (inter-) connected group

With “Mutual Mentoring to Combat Isolation in Physics,” 11 distributed peer mentoring networks called eAlliances were created in three cohorts. (See Table 1 for a summary of the data collected for the project).

Table 1.

Totals of All Qualitative Data Collected for the Plan D Initiative, by Cohort and Type, and Key Results.

<i>eAlliance Cohorts</i>	<i>Baseline interviews</i>	<i>eJournal Questionnaires</i>					<i>Summative interviews</i>	<i>Row Totals</i>
		1	2	3	4	5		
Cohort 1 (5 eAlliances; N=24)	7	20	16	12	10	16	20	101
Cohort 2 (2 eAlliances; N=8)	1	6	0	1	0	6	6	20
Cohort 3 (4 eAlliances; N=17)	3	3	0	0	0	2	9	17
11 eAlliances; 49 eAlliance members	11	29	16	13	10	24	35	138

In summative interviews, 70% of participants reported that they were highly satisfied with the initiative. When asked if they would continue to meet with their eAlliance beyond the end of the initiative, 77% responded, “Yes.”

Often, participants referred to the model as “mutual mentoring”: one eAlliance member described her experience of this type of mentoring:

The mutual mentoring model became so much more than my initial ideas of “mentoring.” Being able to provide support made asking for it easier. Also, knowing from the start that our roles were to provide advice and support, and having an implied sense of non-critical backing, made the whole experience unique. Other mentoring relationships tend to have a power hierarchy (traditional mentoring), or are more goal-oriented, both of which have elements of critique and vulnerability. With eAlliances, the mutual mentoring aspect took out any sense of competition; we have been there to bring the best out of each other. And because we are at different institutions, there isn’t any sense of divided loyalty. I feel as though my eAlliance group always has my back. At the same time, I also feel as though any advice they provide isn’t based on criticism, but on improvement. It feels like wisdom, rather than critique.

Each eAlliance consisted of four to five women faculty in physics and astronomy who were largely matched by project leadership based on participants’ stated interests and other shared characteristics. eAlliances initially met in person at a professional meeting, then once or twice per month virtually, synchronously, or asynchronously. During meetings, eAlliance members discussed “just about everything”: work environments, teaching issues and insights, professional development, work-life balance, as well as personal challenges and concerns. eAlliance members worked collaboratively to support professional goals, provide advice and

encouragement, and celebrate each other's achievements. In eJournal entries, participants described the range of topics addressed in their regular meetings.

We have covered lots of topics—from personal to professional. Two of us have made a career change since we started so we spent a lot of time talking over the pros and cons of those, encouraging and celebrating those. One of us is up for promotion. We talked about strategies for that. We have shared teaching materials. We have talked about our kids and helped each other with mothering advice. We talk about department and institutional politics and offer advice on how to deal with situations that arise. For example, one of us had a very negative interaction with the college provost and the others offered advice on how to handle it.

We talk a lot about teaching and students and issues that have arisen. We've talked about our reviews for promotion. We've talked about our research projects and the textbook that I'm writing. One common topic is how to deal with problem colleagues. We've also talked about our health, and our cats, of course. :-)

Distributed peer mentoring networks in the form of eAlliances provide women faculty in physics and astronomy a collaboration that supports many aspects of each individual. In this paper, we describe organizing principles for the project, reflections on what worked and what was unsustainable, and provide guidance to those interested in creating their own distributed peer mentoring networks.

Methods

Rooted in the theoretical work and methodological traditions of sociology, anthropology, and social psychology (Berger & Luckman, 1967; Blumer, 1969; Garfinkel, 1967; Mead, 1934;

Schutz & Luckman, 1974), qualitative and ethnographic methods are particularly appropriate for research in contexts where existing knowledge is limited and to uncover tacit knowledge and taken-for-granted assumptions (Cresswell, 1994, Glaser & Strauss, 2017). Classically, qualitative and ethnographic studies precede survey or experimental work because they can identify and explore beliefs, attitudes, and rationales shaping informants' actions while also accounting for the complex social and cultural systems shaping people's experiences and beliefs. Semi-structured, in-depth interviews and questionnaires explored research and evaluation questions important to this initiative, and the text documents were analyzed for recurrent patterns using computer software that allows for the multiple, overlapping, and nested coding of a large, complex volume of text data. This enabled the coding and categorization of patterns across the data set and reporting of findings using descriptive statistics. Our goal in this work was to use qualitative methods to understand women physics and astronomy faculty's lived context.

Organizing Principles

What Makes eAlliances Work?

Certain factors support the success of eAlliances and the effective mentoring of marginalized populations; i.e., women physicists and astronomers in higher education. The relative anonymity of group members and apolitical context of the eAlliance were inherent to the structure of the distributed peer mentoring network model. Additionally, good matching of members to an eAlliance based on common interests and characteristics—particularly career stage and type of institution—encouraged sharing of issues and concerns. The success of an eAlliance was also determined by group members' commitment to participating regularly in scheduled meetings or contributing to the group's asynchronous document.

“A Safe Space”

Because peer mentors in an eAlliance are distributed at other institutions, this model for mentoring naturally provided anonymity, and participants described their eAlliance as a “safe space” to share and discuss professional and personal issues and concerns. Since members did not know each other’s departments, colleagues, or families, they were able to speak openly and honestly.

- “We have all benefited from the ‘safe space’ to vent and to receive feedback especially when it was not appropriate to ask a colleague at our own institutions.”
- “It is very helpful to have someone outside our own institutions to talk to about sensitive topics. Within our institution, some topics are sensitive and may have the possibility of coming back to haunt a faculty member if [they] discussed them within their institution. This is especially true for toxic work environments.”
- “We have all expressed gratitude in being able to speak about situations or relationships with our fellow eAlliance group; since we live apart from each other and don’t really know the others’ colleagues and families, so having an outside perspective has been useful!”

Relatedly, as group members were at different institutions (largely of the same type), the distributed peer network afforded non-competitive and apolitical mentoring support.

- “We are committed to each other’s success and not competing with each other in any way.”
- “The eAlliance is a unique opportunity for cross-institutional, non-evaluative, affirmative mentoring and to connect women physicists/astronomers who may be the only one in their departments.”

Good matching

Also important to the success of an eAlliance was the matching of members to the group. Most often, sustainable eAlliances were comprised of members at the same career stage (i.e., pre-tenure, post-tenure) and at the same type of institution (i.e., liberal arts colleges, research universities, two-year colleges). These similarities promoted sharing among group members and contributed to the utility of the advice offered.

- “This is the best program that I have been involved in. The people in my alliance are so similar to me that their advice and support is very useful.”
- “Starting with a common area of overlap (career stage + kids) gave us an instant starting point for how to focus our conversations. I liked how initially we were given some suggestions for topics; we started by reading and discussing ‘Elephant in the Laboratory’¹ and that helped us get to know each other.”

Commitment to the group

Another element contributing to eAlliances’ success was group members’ commitment to participating, both to give and get support and advice. While most eAlliances met by video-conference, such as Zoom, one group successfully mentored its members asynchronously through a continuously updated GoogleDoc where members posted questions, comments, advice, and feedback.² With time and regular meetings, participants created the trust necessary to mutually share in ways that helped each other negotiate both professional and personal issues. Many of the group members shared similar experiences, but each brought unique perspectives and insights.

¹ Monosson, E. (Ed.). (2008). *Motherhood, the elephant in the laboratory: Women scientists speak out*. Cornell University Press.

² See Cox et al., 2021, for a description of asynchronous distributed peer mentoring using a GoogleDoc.

- “I both benefited from and supported my eAlliance members, but we had to be committed to realize the full potential of this mutual mentoring model.”
- “Consistency has been key. Our group meets every other week. It’s been really important to build up relationships over time with consistent contact. I also think that being at similar career/life stages has been helpful, since we’re often navigating similar transitions within a few years of one another (babies, tenure, and now moving on to becoming department chairs. . . .).”

Participant observations illustrated that the distancing afforded by geographical/institutional separation is a key factor in the effectiveness of this mentoring model, providing group members a “safe space” to share with peers, free from departmental and institutional politics and fear of reprisal. Also important to the success of an eAlliance was good “match making” of members who share common interests and characteristics, and a commitment by each member to the well-being of the whole group through consistent participation in regular meetings.

Types of eAlliances

Using the organizing principles described above, the project leadership developed a database to help potential participants self-organize around common professional and personal attributes. After advertising the project at a number of professional meetings and through various professional networks, a handful of eAlliances quickly formed, driven mostly by pre-tenure faculty. The following quotations illustrated individuals’ motivations to participate in this initiative.

- “I always enjoy talking with other women in physics. I was interested in connecting with other women who had a similar profile to me (especially, having young children).”
- “Although the climate in my department is positive, it does not feel like the right place to ask for the kind of candid advice that I can get from other young female faculty who are navigating similar issues of work-life and general academic issues.”
- “It’s nice to have a support group of women who get it. Who are actually understanding the issues that you’re dealing with as women in physics. It’s somewhat nebulous. This is a group that’s different from my other women friends—where they know I’m a physicist and they either think that means I’m really smart, or they can’t figure out why anyone would want to be a physicist, right? This is a group that understands the laws of physics!”

After the initial flurry of self-organizing activity, however, the project leadership found it necessary to build groups by hand using information in the database to aid in this process. In addition to initial groups formed on the basis of pre-tenure status, eAlliances were formed around women physicists and astronomers who were post-tenure, at two-year colleges, Latina or Black, as well as one just for astronomers (see Table 2).

Table 2.

Types of eAlliances

<i>Types of eAlliances</i>	<i>Number of eAlliances</i>
Pre-tenure—Primarily Undergraduate Institutions (PUI)	4

Mid-career—PUI	2
Two Year Colleges	2
Mid-career—R1 Institutions	1
Mixed Career Stage & Institution Type	2
Women of Color	2
Total	11*
<i>*Some eAlliances fall into two categories</i>	

Challenges

Building a variety of eAlliances had its challenges. While some women were quick to use the database, we found that strangers did not like to self-organize, and required more support from the project leadership. We also had a couple of eAlliances that were more hierarchical due to a wider age range among group members and we found that those were less durable than those composed of true peers. Finally, while the time commitment was a challenge for all participants, it was particularly daunting for women of color who are overburdened with service demands at their institutions. These challenges had varying degrees of impact in the types of eAlliances that formed, as we discuss below.

Pre-tenure

It is not surprising that pre-tenure faculty were quick to join the project and form eAlliances. Pre-tenure faculty need mentors, and group members provided each other significant support. This support included goal setting and accountability, writing groups, and reviews of each other's grant proposals, papers, and tenure applications. The mutual support provided gains in confidence and validation for these early-career faculty. Most of these early-career women were not only navigating the tenure process, but also becoming parents.

It certainly has been useful in the relationship between my professional and personal life. Many of us had children over the course of our time in the eAlliance and so we had a lot of discussions about managing our work while making space for family time, dealing with sick kids, closed day cares, etc.

Phan-Budd (2020) highlighted the difficulties for these women particularly around parental leave, childcare, and travel for both conferences and research. Given the multitude of challenges women faculty face as they grow their families, the support from group members was particularly appreciated. For instance, two members of an eAlliance were meeting up at a conference and one of them—a new mother—realized that she was missing a part for her breast pump; they went shopping for it together, something that would be unlikely to happen with typical colleagues. Too, as the pandemic began, women faculty with young children found their eAlliances to be invaluable for their own well-being:

It really did help me at the start of COVID, when I was having to recreate entirely new ways of teaching and figuring out how to do it all with small children in tow. This year, many of us actually got COVID. When I had COVID, group members sent some toys for my kids to play with in our isolation period, which was really nice! So, it was nice to have some people to talk with about that experience and just how to deal with the kids and the isolation and perhaps being sick, that kind of thing.

Group members gave each other permission to set boundaries, and to say “no,” when they needed to in order to cope. They shared their exhaustion from the shift to online teaching, children circling in the background or curled up, unseen, at their feet. Work-life balance was

impossible for many of these women to achieve, but commiserating with others helped (Phan-Budd, 2020).

Post-tenure

Some of our eAlliances were formed of exclusively post-tenure women. The need for career advice and mutual support does not end with tenure (Blaha et al., 2010; Daniell, 2008; List & Sorcinelli, 2018). Family issues remain and often become more complex as children grow. Research interests often change as graduate school momentum runs out. Leadership opportunities, both local and national, appear and need to be balanced against teaching and research responsibilities. In all these decisions, women benefit from the advice and support of peers. One eAlliance found that most members had questions about the direction of their research, and their careers, in general, now that they had achieved tenure: What next? Group members mentored each other, helping one another to evaluate their situations, and in the end, three of four in this eAlliance made major changes in her career path.

One [member of my eAlliance] decided to change research fields; one decided to change institutions; one even decided to leave academia. None of these decisions were easy, but the support of others in similar situations was helpful.

Another eAlliance was formed by women at research-intensive institutions explicitly to encourage women's leadership in physics. One of their strategies was to work collaboratively at regional meetings to effect change. While some of their plans had been delayed by the pandemic, they intended to continue this valuable work.

One issue that women in post-tenure eAlliances wrestled with revolved around the continued feelings of imposter syndrome, among their peers, within their institutions, and about their field of research.

I always feel like, “Maybe my research isn’t as meaningful.” . . . A lot of imposter syndrome. “Am I really a physicist or am I something else?” And hearing some of the struggles that I face echoed by women who seem to have their act together a lot more than I do, it does help quite a bit to feel that some of the stuff is universal and that the things we’re doing aren’t easy. . . . I think it does help with perspective. It helps me realize some of the really good aspects of my job and reinforce the fit to where I am. Makes me feel good about the choices that I have made.

Senior women in eAlliances also struggled with uncertainty resulting from changes in career focus post-tenure and the challenges of moving into administrative positions.

- “I’m also trying to figure out what I want to do next. Having my wise, energetic, and supportive colleagues in my eAlliance is helping me frame things—I have a clearer sense of what I am looking for in terms of next career steps (although by no means is it clear).”
- “I am now in an admin position that has a completely new portfolio and that can feel isolating, trying to navigate what is expected of me. One of my eAlliance members is also new to a similar admin position, so it’s great to chat with her about these issues.”

As women faculty achieve tenure, the need for mentoring on professional direction and career advancement continues but is more difficult to find. As participant quotes illustrate, belonging to an eAlliance was highly valuable to women physicists and astronomers seeking advice and support beyond tenure.

Two-year Colleges

Two-year colleges provide unique challenges for women in STEM. Many departments are small, and usually multi-disciplinary, which leads to isolation, especially for individuals from historically minoritized groups. There are proportionately more women as full-time faculty members at two-year colleges (23% in 2012; White & Chu, 2013) compared with four-year granting institutions (16% in 2014; Porter & Ivie, 2019); however, isolation is a greater problem at two-year colleges, where 60% of institutions offering physics courses have one or zero full-time faculty members (White & Chu, 2013). Most two-year STEM programs have little to no support for instructional labs, so faculty are often tasked with maintaining equipment, in addition to heavy course loads, staying current in pedagogical techniques, mentoring and evaluating part-time instructors, and supporting students beyond academic needs. Two-year colleges also tend to have higher turnover rates, both in faculty and in administration, making it especially challenging to maintain long-term continuity in academic programs. Although two-year colleges can vary greatly, members found enough similarities that helped them feel less alone.

Absolutely the eAlliance has helped me feel less isolated! While we are in the same kind of institution (2-year college), our colleges are quite diverse in campus, numbers, philosophies. Still, we find similarities, and that helps mitigate isolation. While each of our administrations might impose different “initiatives” that we disagree about as faculty, knowing that this is happening in other places, and in different ways, is helpful. It helps bring perspective, and also to see what trends are happening.

An eAlliance was formed of women physicists and astronomers teaching at large two-year colleges. This eAlliance was successful in proposing the distributed peer mentoring network

model as part of a broader initiative for faculty development at two-year colleges. The NSF-funded Organization for Physics at Two-Year Colleges (<https://optycs.aapt.org/>) now includes the opportunity for two-year college physics faculty to join peer mentoring groups.

A second two-year college eAlliance was formed but did not meet as frequently as initially planned and will not continue when the project ends. Although group members were all at two-year colleges, the institutional structures were sufficiently different that it was difficult to offer each other relevant advice. As well, too wide a span in members' career stages led to a more hierarchical (than horizontal) mentoring structure—a factor that also inhibited the successful formation of other eAlliances.

Astronomers

Astronomy and physics are very closely related fields, yet astronomers do not always feel included in the physics community. Over the course of the project, 30 astronomers registered on the project database and 18 eventually became members of a mutual mentoring group. Most astronomers became part of an eAlliance composed of both physicists and astronomers, and most were faculty in joint departments of Physics and Astronomy, though there was one eAlliance composed exclusively of early-career astronomers.

All of the women astronomers participating in the Plan D initiative experienced isolation and were glad to provide and receive support from their eAlliances as they managed professional opportunities and challenges and helped each other seek work-life balance. One participant commented: “This co-mentoring group has been an important connection for me in navigating being the only astronomer at my school and the only early career person at my school.”

While some participants did experience an increased connectedness to the physics community, summative evaluation indicates that some of the astronomers were less likely to see

themselves as more connected to the larger physics community, preferring “to stick to” their particular field of study.

- Astronomers—it’s a small world for sure. There’s an astronomy culture. And so it was important for me to kind of stick with that and have a connection to that.
- [As a result of participating in this initiative] I feel a little more connected to the physics community because I know a bit more about [the American Association of Physics Teachers] and have peers in my group who are physicists. But I still feel a lot more connected to my subfield (astrophysics) and don’t really take part in any other physics-wide initiatives or events.

Some astronomers felt that AAPT wasn’t the natural venue for their professional meetings and instead preferred to attend American Astronomical Society (AAS) meetings.

Women with Other Marginalized Statuses

Attracting women of color and others from under-represented groups who are particularly marginalized in physics and astronomy departments was an important goal for the eAlliances project. Being Latina, Black, Indigenous, LBGTQ+, or a woman with disabilities can increase the feelings of isolation (Armstrong & Jovanovic, 2015; Atherton et al., 2016). We predicted women from these groups would benefit from mutual mentoring with others from the same ethnicity, race, sexual preference or identity, or disability. Throughout the initiative, project leadership worked to attract women from these marginalized groups, contacting them through professional organizations, such as the American Physics Society (APS) Committee on the Status of Women in Physics (CSWP), American Astronomical Society (AAS) Committee on the Status of Women in Astronomy (CSWA), National Society of Hispanic Physicists (NSHP),

National Society of Black Physicists (NSBP), and Society for Advancement of Chicanos/Hispanics and Native Americans in Science (SACNAS).

Despite these efforts, participants in the first eAlliance cohort were predominantly white cisgender women. In the second cohort, we were able to create eAlliances of Latinas and of Black women. Although individuals emphasized feeling an affinity with members because they shared the same ethnic or racial identities, and reported benefits from interacting with their group, the eAlliances formed exclusively of under-represented women did not cohere in the end. However, members from both Latina and Black women eAlliances reported sporadic connections to group members by email and text when they had something to share or needed quick feedback or advice. In the third cohort, the project leadership tried to form an eAlliance of lesbians and non-binary people but was unable to recruit enough participants. One of the early eAlliances, however, welcomed and supported LGBTQ+ individuals participating in the initiative.

Qualitative analysis of responses to electronic journal questions and in-depth interviews showed that eAlliances formed on the basis of race, ethnicity, and sexual or gender identity did not succeed primarily because group members could not find a common time to meet. Besides teaching, research, and service responsibilities, multiply-marginalized faculty are commonly more active in their academic and wider communities, bearing a greater sense of responsibility to recruit and mentor minority students at their institution (Jimenez et al., 2019). Overly full schedules simply precluded coordination of a common meeting time and the members never met together as a full group. Small numbers meant that if one (or two) member(s) did not show up for a meeting, there wasn't a group to meet.

We were trying to schedule a meeting and we all have wildly different schedules, and different time zones. Someone's, "I can only do Tuesdays and Thursdays," and someone's, "I can only do Friday afternoon. That's it." So what then? And then some people didn't participate all the time and it was, there was no one left.

Practically, the small numbers of women physicists and astronomers with other marginalized identities made it difficult to find enough participants that could be matched by similar career stage or type of institution. Thus, in addition to problems scheduling time to meet, eAlliances formed on the basis of multiple marginalized statuses meant including a wide span in group members' career stage, creating a hierarchical mentoring structure, where younger group members early in their careers benefited from the mentoring offered by group members more advanced in their careers. While clearly beneficial to the younger eAlliance members, this hierarchical mentoring could leave more senior members with the feeling that participating in her eAlliance was an add-on to an already over-subscribed schedule.

Several group members in these eAlliances also mentioned that they knew one another prior to being matched to their eAlliance, and they connected individually at conferences when possible.

Overall, eAlliances formed based on tenure status *and* type of institution were highly successful, and eAlliances formed solely on the basis of shared race, ethnicity, or sexual or gender identity were not. Results from the summative evaluation showed that a more effective strategy to support and ameliorate the isolation of women with multiple marginalities would be to integrate them into groups organized by similar career level, or other professional and personal interest—factors supporting successful eAlliances.

The Benefits of a Distributed Peer Mentoring Network

In summative interviews, a large majority of participants (70%) said they were highly satisfied with the initiative and offered, on average, about 14 observations each regarding the benefits of participating in a distributed peer mentoring network.

Amelioration of Isolation and Greater Connection

Despite the barriers to travel during COVID-19 (which included half of the grant period), the project was very successful for the majority of eAlliance members. Results from both the formative and summative evaluations, consisting of multiple participant eJournal entries and in-depth interviews with 70% of initiative participants, show that all members who were actively engaged with their eAlliance reported that their feelings of isolation had been ameliorated.

- “I love being in a[n] eAlliance. It has absolutely made me feel less isolated—having other women who really get it in a way no one else in my life does. And there are other women in my department—several in fact. But none of them have young children, as I do. And also, there is a real usefulness to being able to talk to someone . . . rather like therapy—you can say more things more honestly. I think the eAlliances are an amazing resource and way to support women.”
- “I definitely feel less isolated because of my eAlliance. Truly, these women are the only people in my life who share important aspects of my life experience. We are all in midlife, with children, and working at institutions that value teaching. We are all at junctures in our careers . . . some changing research areas, getting promoted, or changing jobs. We have helped each other think about where our careers have come from and where we want to go.”
- “Any individual facing isolation would benefit from this mutual mentoring.”

In addition to feeling less isolated, over half of participants submitting the final eJournal stated that they now felt more connected to the physics community as a result of participating in Plan D.

I can't even begin to list the wonderful ways in which this group has helped me feel more connected to the physics/astronomy community. These women are friends, colleagues, writing buddies, and even collaborators. My research direction has even shifted a bit as a result of the eAlliance, and I've made many other connections through this group.

It is worth noting that several participants reported that they continued to feel isolated in their own departments and institutions, highlighting their need for this initiative.

Support, Advice, and Perspective

While ameliorating feelings of isolation and promoting connections with the physics community were important outcomes of the Plan D initiative, participants most often reported that the primary benefits of engaging in an eAlliance were derived from the opportunity to share issues openly, receive support and advice, gain greater perspective on their own situations, as well as learning “how things worked at other institutions.” Participants commonly referenced the tremendous value and relief found in having their eAlliance serve as a “validity check” of their own perceptions.

- “Hearing everyone else’s challenges and situation is very helpful. I might have thought I am not cut out for this job if I didn’t have access to this information.”
- “I have found it personally and professionally very positive. I feel a sense of shared experience and support that I did not have before. I can talk about thoughts and decisions to a group of women who totally understand and are supportive and

thoughtful in their responses. For one of the women in my group who is in a very hostile department, I have a feeling that this group is very much a lifeline for her. But even without being in such a drastic situation, I feel a sense of camaraderie that I did not have before.”

- “The communal problem-solving is an amazing resource and helps reduce the sense of isolation.”

Holistic Mentoring

Virtually every participant said that the benefits of participating in an eAlliance extended well beyond the professional gains they received. Comments revealed that participants highly valued the ability to address the personal with the professional in their eAlliance and appreciated that the distributed peer mentoring network model enabled this holistic mentoring.

- This eAlliance program has shown me the value of mentoring at all levels of one’s career and life. As women in physics, we are often marginalized. In the man’s version of professional life, emotions and feelings are often seen as a weakness. Women derive strength from sharing feelings and emotions. Having been in a “man’s world” for all of my professional life (first as engineer and then physics faculty), I had shied away from sharing my feelings. My eAlliance group has shown me that feelings are important. It is healthier to deal with emotional stress than to tuck it neatly away from view. Maintaining a professional countenance is important in many professional settings, but not at the expense of one’s personal well-being.”
- “It nurtures the whole. Our conversations might be about teaching, but they might be about a terminally ill family member.”

Holistic mentoring included permission to seek a reasonable work-life balance and encouragement and support to give up unrealistic self-expectations and “trying to be SuperWoman.” This was particularly true once the pandemic hit—forcing teaching online and working from home.

- “My eAlliance has been super supportive. They all have young children and so we are all in the same boat. It is nice to see that I don’t have to be Super Woman. I can just take care of my kids and teach and not do any scholarship, and that is okay. That is just what I have to do right now, and that is enough.”
- “The greatest benefits I received ended up being the emotional and mental support through personal challenges and pandemic issues I could never have imagined. In my generation, a woman was supposed to be Super Woman—doing all things for everyone (bring home the bacon, fry it up in a pan, etc.). To ask for help was to show weakness. I have rarely asked for help because surely, I can do this! (whatever ‘this’ happened to be). This eAlliance gave me the ability to be supported with so many challenges I never anticipated. And I never had to confess to needing help.”
- “Right now, I just can’t do it all, or even any approximation to it all. So, when that is the case, the question is, ‘What do you not do?’ Those are questions that are really awkward to ask my other colleagues. It’s awkward to say, ‘Well, can my teaching be a little bit less stellar this semester? Can I scale back my service?’ But those are exactly the kinds of crucial questions we’ve been talking about in our eAlliance this season. It is helpful to see what other people aren’t doing, and it makes it easier for me to let some things go, as well.”

Increased Networks

Another benefit described by participants was the opportunity to meet other women physicists and astronomers. Participation in the Plan D initiative afforded members introductions to and connections with other women physicists and astronomers—through their own eAlliance, as well as to the larger, collective group of all eAlliances. These networked connections enabled broader support, wider perspectives, and more useful advice to participants.

- “One thing the eAlliance provides that I can’t get otherwise is connections to women physicists across North America. (Our eAlliance is spread out from NY to the West Coast.) It’s great to get different perspectives on issues, but still commiserate over common problems.”
- “eAlliances are wonderful! It has been so helpful to have a facilitated way of building up a professional network of women around the country and some structure to help guide our interactions (especially initially). It just seems so simple to me: there are no women at my career stage in physics or astronomy at my university. I have a reasonably broad network that I’ve built up through grad school, postdocs, or at conferences . . . but since I now only see those people very occasionally, I don’t often reach out, out of the blue, for the sort of support and information-sharing and problem-solving that I wish I had more locally on a weekly/monthly basis. My male colleagues don’t even know that they have it, but I have to cultivate it.”

Unexpected Friendships

Another benefit of participating in an eAlliance cited by many was the unexpected development of true friendships. They expected professional support and advice, and in turn found collegiality and trust.

- “Best friends forever! I found a supportive community that accepts me for who I am. I feel valued and have gained much confidence. I have lifelong colleagues and friends. I found a place I belong.”
- “My eAlliance has been there for me through four close family deaths in 1.5 years, a major health issue, a mother with Alzheimer’s, a sibling’s volatile divorce, a nephew’s brain cancer. I had no idea I was in for all of this. But they were there when I needed them. Despite the many challenges, we have also celebrated together. We have found the joy in life together. We have become close friends and confidantes. I do not feel a sense of isolation. I feel supported and I feel needed.”

Retaining Women

eAlliances provided some protection for women who were working in toxic conditions. Sharing and comparing experiences allowed individuals in unhealthy work environments to realize their experiences were not imagined and that they were not alone. Without the support, reality-checks, and advice from their peer mentors, some of these women indicated that they would have left physics entirely.

- “Being the subject of unwanted attention is always an uncomfortable situation and becomes toxic if the perpetrator holds a more senior position. I would not be where I am without my eAlliance. It is so important to have support from people who get it.”
- “I think I have gained more confidence in my ability to read situations in which I am involved. Especially in my former institution, where a lot of ‘gaslighting’ happened. Getting feedback from my eAlliance has helped me work through a toxic situation and recognize my own resilience and ability to note the negative behaviors . . . having

a safe place to offer reflections, guidance, experiences, and problem-solving together as a team . . . it has been beneficial for me.”

- “At the start of our eAlliance, it was crucially important for me to see the common elements in our experiences. I’ve gotten more and more political and feminist, and part of that came from seeing that a lot of the negative experiences I had were not just my experiences. You start thinking that rather than powering through yourself, you should get out there and start changing the culture. And then you think about groups even more marginalized, and all of the sudden you are doing TEAM-UP³, etc., etc.”

Some women found support and courage through their eAlliances to change positions. For example, one participant felt unvalued and increasingly excluded in her workplace. Drawing on the reassurance from her eAlliance, she was able to leave her institution. Not only was the empathy from other eAlliance members important, but the objective assessment of her skills and portfolio gave this individual confidence that she would be able to secure a new position.

There’s at least one other case in our group of somebody who is not in a great working environment who switched, and they may well have switched without the group, but the group was useful in terms of reinforcing to them that, ‘Yes, they were reasonable to find that this was unacceptable.’ Right? That standard, ‘Is this happening to me because I’m a woman? Is this happening to me because the person’s a jerk? And does it actually matter?’

By their own accounts, women physicists and astronomers took away multiple benefits from participating in an eAlliance, not the least of which was the amelioration of isolation and increased connection to and networks among the physics community. Somewhat as a surprise,

³ American Institute of Physics TEAM-UP Project website at <https://www.aip.org/diversity-initiatives/team-up-task-force>

participants also found and greatly appreciated much-needed holistic mentoring and unexpected friendships. eAlliances also proved important in supporting women to negotiate whether they should stay in toxic work environments or in departments where they felt under- or de-valued. The myriad benefits cited by participants in the Plan D initiative demonstrates the effectiveness of the distributed peer mentoring network model in lessening women physicists' and astronomers' feelings of isolation and in supporting their career advancement and overall wellbeing.

Results and Generalizability

Evaluation of this Plan D initiative shows that eAlliances were successful in offering effective peer mentoring to support women physics and astronomy faculty professionally and personally: many noted promotions and tenure, and progress in their writing, research, and teaching; participants also detailed support from their eAlliance through the birth of a baby, serious health challenges, struggles with work-life balance, and mental health stresses brought by COVID-19. In providing summary statements of their experience in this initiative, participants offered their thanks and gratitude and noted how valuable participating had been for them.

- “Thank you for providing this fantastic experience! I don’t even want to think about how I would have gotten through the past few years without the support of my eAlliance.”
- “I wanted to join the eAlliance to meet other women faculty in physics and astrophysics to feel less isolated, and this eAlliance has done exactly that. In fact, now I have a great and larger network of women faculty that I can call upon when needed. I could not be more grateful for providing that network.”

- “Peer mentoring is essential and this experience well-surpassed any kind of professional training/workshops I have attended. Having other folks who are ‘in it with you,’ dealing with the day-to-day is essential. We still shared professional resources and recommended professional workshops, etc., with each other, but the more casual conversations, where we could each bring issues up and get direct, personalized feedback, was immeasurably valuable.”

Faculty at all career stages and institutional types participating in the Plan D initiative noted multiple, varied important benefits and were grateful to have had the opportunity to participate. Many wished the initiative could keep going. As further testament to the initiative’s success, in answering the question of whether their eAlliance planned to continue meeting beyond the end of the initiative, a large majority indicated, yes, their eAlliance would continue to meet. Specifically, over three quarters (77%; $N = 27$) of those participating in a summative interview ($N = 25$) said their eAlliance will keep meeting beyond the end of the project. Overall, it is clear that eAlliances—distributed peer mentoring networks—is an effective model supporting isolated women physicists and astronomers.

Finding a place of belonging is vital for those from marginalized groups to continue to contribute and thrive, not only for women in physics and astronomy. eAlliances were seen as an effective answer to support any individual who is marginalized and isolated.

- “I would expect that any group in the minority that feels imposter syndrome would benefit from peer mentoring.”
- “It is a form of mentoring that is not designed for a limited demographic. This method would work well for the LGBTQIA+ community.”

- “I think really everyone could benefit, even men (e.g., members of minoritized racial and sexuality groups, fathers, etc.). These networks provide invaluable support for aspects of our identity that could potentially be a source of stress and stigmatization, rather than identification and self-efficacy in the field. “
- “I can imagine this working for any community of people who feel like ‘the only one’ of something.”

Tips for Implementation

For those interested in implementing a distributed peer mentoring network program, the following elements were identified by project leadership and the evaluation as important to organizing and promoting successful eAlliances.

1. *A method to gather demographic information and other group attribute preferences from individuals.* Build on professional commonalities as the foundation (i.e., same career stage, same type of institution), while recognizing that this can grow into a more holistic mentoring.
2. *An administrator to match members to groups based on commonalities among interested individuals.* Groups based solely on algorithmic matching are less likely to succeed than those initiated by a third party who can see affinities. Successful groups formed in the eAlliance project relied on personal invitations and human connections.
3. *A low stakes meeting at a pre-existing conference or professional event.* A pseudo-social gathering helps to facilitate group formation and initial in-person meetings for newly formed groups. We found that forming eAlliances around a professional meeting that participants would naturally attend was highly successful. When adopting this distributed peer mentoring network model, it would be a good idea to

ask, as part of the intake information, about which conference a participant considers as a professional home.

4. *A group with geographically separated members is vital.* The distributed network provides safety among group members by removing competitiveness and dueling interests, and by providing an outside perspective.

Summary

The eAlliance project built successful peer mentoring networks of women physicists and astronomers. Qualitative analysis of interviews and electronic journal entries show that these mentoring networks are necessary and valuable, and reduce isolation for these marginalized and minoritized faculty. The Plan D initiative demonstrates that mutual mentoring is an affordable tool for mitigating the factors that lead women to leave physics and astronomy, such as isolation and non-belonging.

Forming small groups of four to five women across geographical regions, but with common institution type and career level, proved to be major factors supporting the success of eAlliances. In addition, the success of an eAlliance was dependent upon members' commitment to meeting regularly and consistently, and to their willingness to provide mutual mentoring.

The protective nature of distributed peer mentoring networking demonstrates both the benefit and the need for horizontal, non-hierarchical mentorship, and that such mentoring can mitigate effects of being a member of a minority group. In this project, distributed peer mentoring networks proved to be a highly effective model that can be easily replicated by organizations wanting to improve belonging and inclusiveness within their populations. For instance, professional societies wanting to support, retain, and improve diversity in their fields, might implement distributed peer mentoring networks as a low-cost, high-return option toward

building an inclusive environment. In the following quotation, one participant summed up the importance of her eAlliance mentoring experience this way:

I was looking for ways to combat feelings of isolation and having an eAlliance has helped tremendously! So many issues each of us faces are analogous, if not identical. Even if we haven't experienced a particular issue, I learn from them through their experiences. I think this helps me grow as a human, and to be more empathetic. Being part of others' experiences, such as being dismissed (likely due to gender) by colleagues, helps each of us find strength within ourselves. Sometimes, it takes someone else to show you your worth when it is often too easy to feel negatively.

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