Highlighting the Barren Landscape of Postdoctoral Resources: A Content Analysis of University Websites

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Abstract—This research paper serves as a benchmarking study to investigate the types and availability of resources available to postdoctoral scholars on university websites. Postdoctoral education in engineering and computer science disciplines is a forgotten stage of the academic pipeline, with very few scholars investigating the learning and development that occurs through the transient postdoctoral years. The few studies that have been done report postdocs feeling "forgotten" and on a "postdoctoral treadmill," often without formal mentorship or guidance in developing the skills required to land academic careers. While most postdoctoral scholars do have supervisors to whom they report, most literature indicates that postdocs in engineering and computer science are still lacking mentorship in the peripheral skillsets essential for career success, and these effects are amplified for women and postdocs of color. Given a lack of interpersonal mentorship, it is plausible that postdocs turn to institutional resources for guidance and directions for professional development. To date, literature has not benchmarked the type or extent of resources available that are aimed at postdoctoral scholars. To this end, the purpose of this paper is to characterize university webpages using content analysis methods in order to understand the presence or absence of various types of support for postdocs at universities.

Keywords—postdoctoral studies, professional development, content analysis, university resources

I. Introduction

Despite the postdoctoral stage of professional development being a common avenue between the doctorate and earning faculty positions, very little educational research in computer science and engineering has explored development during the postdoctoral stage, especially from a disciplinary lens. This stage is an important, yet forgotten, segment of the academic "pipeline," and is therefore an important stage by which to address persistent issues of underrepresentation and lack of diversity among scholars in the United States. The national numbers for postdoctoral scholars in the United States reveal tragically low numbers of scholars from historically marginalized populations in the United States. According to the National Center for Science and Engineering Statistics (NCSES) Survey of Graduate Students and Postdoctorates in Science and Engineering [1] of the nearly 8600 postdocs in engineering, only 77 identify as Black/African American (of which 31 identify as women), and 127 are Hispanic (38 women). In computer science, of nearly 900 postdocs, 22 identify as Black/African American (9 women), and 8 as Hispanic/Latinx (2 women). Because the postdoc is often seen as a stepping-stone to faculty careers, diversifying and supporting postdocs is crucial to the mission of broadening participation in the professoriate.

Although best practices indicate that postdocs benefit from direct mentorship with their research supervisor [2]–[6], a network of other mentors and peer mentors [7], [8], and access to resources [9]–[11], these often occur in an *ad hoc* manner, leaving postdocs to figure things out for themselves. To this end, the objective of this paper is to benchmark what resources are available to postdoctoral researchers at various universities.

II. Literature Review

A. Related Literature

The postdoctoral stage of education is a temporary and transient stage of education that is characterized by a push to develop deeper disciplinary expertise and publish papers in order to achieve a faculty career. Postdoctoral positions are relatively unstructured, and as such, vary widely in the formal expectations for mentorship and supervision. To date, literature has not well-characterized the postdoctoral stage of education, particularly for engineering and computer science, with most literature centering around the physical sciences (e.g., biology, where multiple postdocs are expected before pursuing faculty careers.) While many universities have offices for postdoctoral affairs, the mentorship and education of postdocs is left to the supervisor. As such, literature documents postdoc experiences

that vary widely, with studies noting the opportunity for hostile working environments [3], [12]–[14] and isolation of postdocs[3], [14], [15], especially those moving to a new community only for a short period of time. Some institutions, aware of the informal educational experience held in tension with the importance of guidance, provide workshop series or other professional development opportunities to postdocs to mitigate the discrepancies in mentorship.

Even at institutions with robust postdoctoral professional development programming, participation is left to the postdocs However, as Omary [2] and Layton et al. [16] note, postdoctoral scholars often do not attend these trainings, either not realizing the importance of professional development until the end, or because short term research obligations trump longer term professional development opportunities. Without explicit support of these outside opportunities from research supervisors, postdocs may feel torn between their research duties and building complementary skillsets. The most common method for postdoctoral professional development is the Individual Development Plan (IDP), where scholars plan out the professional development opportunities that will serve them, as mapped to their future desired trajectories. Career coaching and effective employment of IDPs has shown to be highly beneficial for postdocs [17]. However, without explicit coaching, IDP development activities may still not adequately prepare postdocs if they are either unaware of potential opportunities or simply "don't know what they don't know."

Further, there are many competencies that are discipline- or field-specific that cannot be taught through generalized professional development workshops and require communication and mentorship with a research supervisor. These skills might involve learning the intricacies of grant writing with different funding agencies, building social connections with others in the discipline, or handling multiple budgets. Literature has not well-characterized the knowledge, skills, attributes, and competencies required for postdocs (especially in computer science and engineering) and how these competencies may differ from those meant to be learned through the doctorate (Authors, in press.) Because many of these competencies are somewhat hidden and require facilitation from a mentor willing to "unpack" the expectations and norms of specialized disciplinary knowledge and formal and informal processes, the sponsorship and mentorship from senior colleagues is incredibly important.

This guidance is even more critical for postdoctoral scholars from groups that are traditionally underrepresented in engineering, as literature has documented that navigating interpersonal and informal expectations and norms is difficult from populations that differ from the normative populations. Engineering and computer science in the United States, for example, are predominantly male and white, such that people from other groups may not feel included or privy to knowledge that circulates in-group networks, especially after hiring practices which are documented to be biased [18]. Prior literature has documented that at all levels, for women and people of color, mentorship and sponsorship is essential. However, at the postdoc level, there is both less research attention and potentially less formal attention paid to mentorship than at the doctoral level or the faculty level (though

that, too, leaves room for improvement.) Without quality mentorship, it is plausible that postdocs may rely on institutional resources available via websites to serve as proxy guidance and mentorship in navigating their postdoctoral research position, but literature has also documented the wide disparity in formal resources available to postdocs. Given that postdocs are often left to develop strategies to succeed on their own, the purpose of this paper is to conduct a benchmarking study capturing and categorizing the types and extent to which postdoctoral resources are available on university websites, specifically those with high engineering and computer science research productivity. To this end, the research questions this paper seeks to answer are as follows:

(1) What are the most employed sources of information aimed at postdoctoral development available on university websites?
(2) Compared to recommendations from literature in postdoctoral mentorship, what gaps in institutional resources can be identified?

We approach this research through a Vygotskian lens of learning and development. Vygotsky [19] posits that, facilitated by language, an individual learns best within a Zone of Proximal Development, doing more with assistance from a "more knowledgeable other" than can be done on one's own. Although Vygotsky's theories of learning were developed from and applied to early childhood research, in this research we consider postdoctoral mentors to be a more knowledgeable other, and through apprenticeship, postdocs most effectively are socialized into nuanced disciplinary expectations and norms. However, given that literature indicates that many postdocs are lacking in mentorship, in this work we view the role of university resources as operating as a static "More Knowledgeable Other" that serves to scaffold postdoc learning in the absence of more effective mentorship from a formal research supervisor. Vygotskian theories (and derivative theories, such as activity theory) of learning have been applied to other contexts involving mentorship and competency development in higher education and engineering education [20], [21].

Because the landscape of resources to date has not been characterized, this paper serves as a benchmarking study to investigate what resources exist (or do not exist) and offer recommendations for standardizing effective materials that can serve to augment any existing personal mentorship that postdocs have.

III. METHODS

To systematically evaluate the available resources, we conducted a study employing digital document analysis and content analysis methods to evaluate what resources are available to postdocs and advisors at universities across the United States. We selected the top 25 doctoral-granting universities in engineering programs per the ASEE Engineering by the Numbers 2019 report [22] as well as the top 25 universities based on research expenditures in engineering according to the most recent NCSES data for 2018 [1]. With

significant overlap between the two lists, this resulted in 31 total universities whose publicly available websites would be analyzed through content analysis methods.

We visited the university webpages of these 31 institutions for postdoctoral support, creating a detailed tabulated list of resources and links available on each site that were aimed toward postdoctoral scholars. Following conventional and summative content analysis methods as outlined by [23], [24], we kept a careful list of available links to internal and external resources as well as contextual factors of interest, including broken links or outdated information. We also mined any appropriate postdoctoral support documentation from the relevant website to analyze for common themes and patterns. Content analysis methods typically focus on quantifying qualitative data, noticing patterns and trends in the extent to which certain topics are mentioned in a corpus of qualitative data, for example. To conduct the content analysis, two researchers created the "codebook" of information that is of interest to this study, and subsequently investigated each of the websites to determine whether that information was available.

In the analysis portion, there were some analysis choices that were made that impacted the analysis. For example, we explicitly chose to not include the institutional links that are in the "footer" of all webpages (e.g., links to university offices) because they are 'boilerplate' on all university webpages, rather than designed specifically for postdoctoral scholars' reference. We also had to set boundaries on how far into other platforms we would analyze (e.g., some postdoctoral societies operate mainly on social media platforms) and we chose to limit our analysis to what is university-sanctioned, outward-facing materials for the purposes of our research questions.

The content collected through this analysis was sorted into five major categories with subthemes within those categories as outlined in Table 1. While not all information provided on some university postdoc websites fit into these categories, we found that these categories were sufficient to capture most of the resources provided though the websites. Data was collected in spring of 2021.

As a mechanism for characterizing the helpfulness of each resource, after collecting the sites, each was labeled with a value from 0 to 4 based on the type of information provided. Table 2 explains the scaling system. These rankings are employed to demonstrate the usefulness of the resources, not simply whether they existed, as well as to identify exemplar universities, as will be described in the results section.

Table 1: Major categories, subthemes, and examples used in the content analysis of the postdoc websites.

Category	Subtheme	Examples of Site Content
New Postdocs	Adjusting to a New City	Housing, transportation, things to do
	Orientation and Onboarding	Required trainings, checklists, orientations
	Appointment Policies	Description of benefits, policy handbooks
	Family Support	Resources pertaining to childcare, spouse/partner groups
Career Development	Writing/ Communication Support	Writing help, presentation practice
	Funding Support	Finding funding, travel grants
	Teaching Support	Teaching opportunities, certificates, teaching institutes
	Job Opportunities	Job listings, academic or industry career preparation
	Mentoring Students	Mentorship guides aimed advising students
Community	National Groups	Any national postdoc associations
	On-Campus or Local Groups	Postdoc groups local to the university
	Well-Being Programs	Physical or mental health resources
	Mailing Lists	Bulletins, newsletters
	Mentorship Programs	Resources for faculty mentoring postdocs, individual development plans (IDPs)
Academic Infrastructure	DEI Resources	Resources aimed at encouraging diversity, equity, and inclusion
	Conflict Mediation	Support for addressing conflict
	Covid-19 Resources	Information regarding Covid-19 as it pertains to postdocs
	Administrative Support	Other campus resources, research support
Abandoned Resources	Broken Links	Links that do not work or go to pages that no longer exist
	Out of Date	Time dependent information that has not been updated in over two years

Table 2: Numerical categorization of the type of resources provided through the university websites for postdoctoral scholars.

Scale Value	Resources Type
0	No resources available
1	Resources provided are for the wrong population (e.g. for graduate students or faculty) or are outsourced to a non-university source
2	Resources are not specific to postdocs but are local to the university or surrounding area
3	Resources are for postdocs, but are stagnant (e.g. pdf of relevant information)
4	Events, workshops, or other interactive resources that are up to date

As with any study, there are limitations to this research. This study is not a comprehensive investigation of all the institutions (academic, government, and industrial) at which postdoctoral scholars in computer science and engineering conduct postdoctoral research positions, such that this research focuses on the academic track. The research analysis decisions we made in terms of not analyzing postdoctoral associations' social media pages, etc. certainly affects the type and extent of data reported, but we posit that these methods and content analysis of these informal information dissemination mechanisms perhaps warrant other future work that is thorough and aimed at social media and textual analysis methods.

IV.   RESULTS

In total, of the 31 institutions mined for resources, twenty-eight universities had available postdoctoral resources at some level, but three universities offered no resources at all. Twenty-four schools had established postdoc associations, and two universities had postdoc groups associated with a specific college or department, but not for the entire university. While these schools have webpages dedicated to information for postdocs, the resources are still limited. Only twenty-two universities have resources regarding job opportunities, only twenty schools offer information regarding living in their city, and eight schools do not provide any orientation or onboarding resources for incoming postdocs.

Because of the lack of diversity at the postdoctoral level, we explicitly focused attention on commitments to diversity, equity, and inclusion. Resources regarding diversity, equity, and inclusion were sparse, with only twelve universities offering groups or resources for postdocs explicitly focused on racial or ethnic diversity, five schools offered something similar for LGBTQ, and only four universities had postdoc groups specifically designed to support women.

From a content analysis perspective, one of the most compelling findings from our analysis was the apparent lack of attention to postdoctoral resources' websites, with many exhibiting outdated webpage design or links to programs or applications whose deadlines are past. Few were updated with recent events, with only nine universities offering resources and advice regarding working within Covid-19 restrictions. Moreover, many of the websites had several broken links, such that postdocs or supervisors could not access any resources, even if they were interested. Broken links included postdoctoral associations, mentorship and teaching resources, affinity groups, and policies (twenty-four broken links total). Resources were considered "out of date" if they were dated over two years ago. For example, some sites featured a research symposium from 2017 and call for nominations for mentorship awards in 2018.

As discussed, as way to characterize the priority and effort the universities place on postdoctoral resources, we characterized each resource on a scale from zero to four, as discussed in table 2. For example, a university that simply provides a link to information compiled by the National Postdoc Association is technically providing a resource, but it involves little effort on the part of the university, and would subsequently be represented by a score of 1. On the other hand, an up-to-date page advertising monthly workshops designed for postdocs demonstrates a commitment of time to postdocs by the university and subsequently would earn a score of 4.

Since we have no way of experiencing every workshop created for postdocs, we cannot know how valuable or well-executed the event is, only that the university decided it was worth more than providing a link to get that content to their postdocs. Some resources do not need a score of 4 to be effective. The Adjusting to a New City category is full of resources that are links to local housing, transportation, and entertainment information, none of which is specific to the postdocs and therefore websites with this information usually scored a 2 on our scale. The Appointment Policies category is expected to be about postdocs, but not expected to be anything more than a page of relevant information, so websites often scored a 3 in this category. Scoring high values in the career development categories shows that the university puts a priority on the support and development of professional skills in their postdocs. Exemplary schools in this area are Cornell University, University of Minnesota, and University of Maryland. Commonly neglected resources (i.e. categories where university websites often scored a 0) were regarding Mentoring Students, Well-Being Programs, DEI Resources, Conflict Mediation, and Covid-19 Resources. Figure 1 shows the distribution of resource types by category.

New Postdoc Resources

Adjusting to New City	Orientation and Onboarding	Appointment Policies	Family Support
11, 0, 18, 2, 0	8, 0, 0, 15, 8	7, 0, 0, 22, 2	12, 0, 11, 4, 3

☐0 ☐1 ☐2 ■3 ■4

Career Development

Writing and Communication Support	Funding Support	Teaching Support	Job Opportunities	Mentoring Students
7, 4, 8, 2, 10	6, 1, 5, 14, 5	9, 2, 9, 5, 6	9, 3, 4, 7, 8	18, 5, 0, 3, 5

☐0 ☐1 ☐2 ■3 ■4

Community

National Groups	On-campus Groups	Well-being programs	Mailing Lists	Mentoring Programs
10, 20, 0, 1, 0	5, 1, 1, 7, 17	14, 0, 13, 2, 2	11, 1, 1, 4, 14	8, 7, 1, 11, 4

☐0 ☐1 ☐2 ■3 ■4

Academic Infrastructure

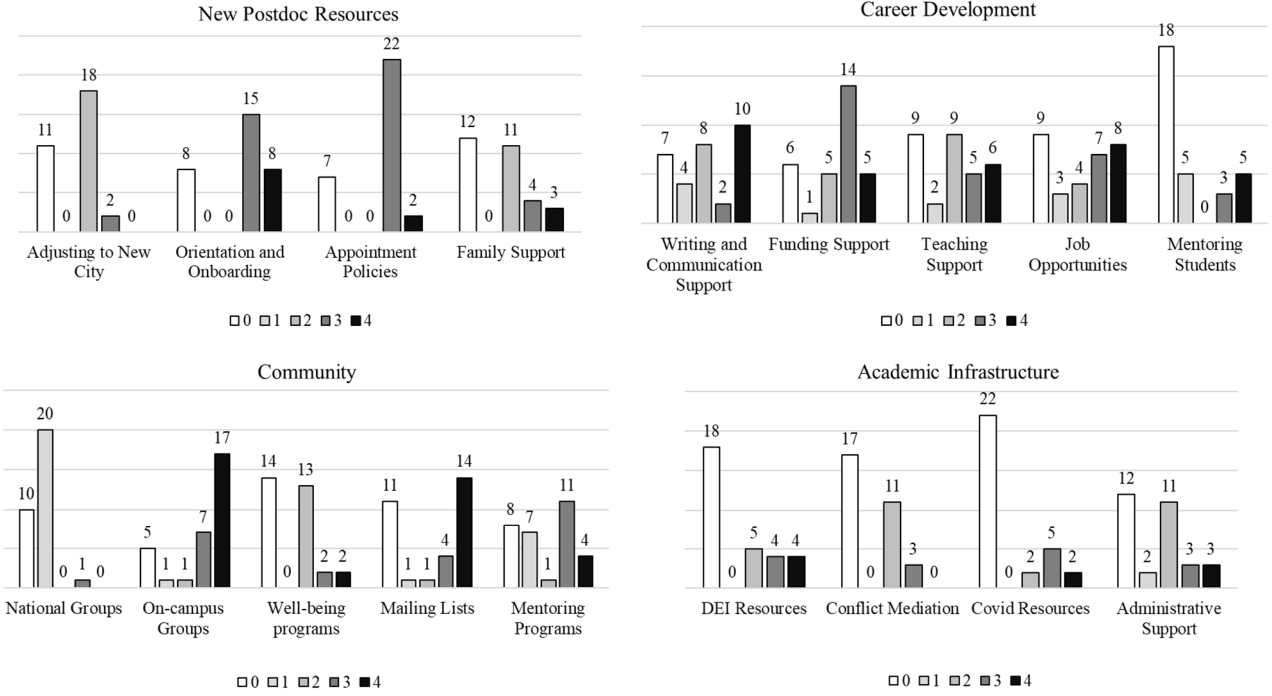| DEI Resources	Conflict Mediation	Covid Resources	Administrative Support
18, 0, 5, 4, 4	17, 0, 11, 3, 0	22, 0, 2, 5, 2	12, 2, 11, 3, 3

☐0 ☐1 ☐2 ■3 ■4

Figure 1: Distribution of types of resources for postdocs offered by universities. The numbers above the bars indicate the frequency of the occurrence, and the color of the bar indicates the usefulness of the resources provided.

The category of On-campus Groups had the fewest 0's, meaning only five schools provided no information regarding local groups for postdocs. We found eight schools with no information regarding orientation or onboarding for new postdocs, with all the other universities offering relevant information on the webpage or through events and seminars. Some other concerning findings: six universities did not provide any information regarding postdoc appointment guidelines, fourteen schools provide no information on any well-being programs, nine schools do not offer resources for teaching, and eighteen school offer nothing for postdocs to find or improve mentoring relationships.

A trend we noticed while conducting this analysis was the perpetuation of confusion regarding what exactly a "postdoc" is in terms of where postdoctoral scholars should seek resources. Lacking an office specifically for postdoctoral affairs, six schools offered postdoc resources out of the graduate student affairs office, even in these large research-oriented universities. In many more cases, postdocs are directed to information, webpages, or workshops designed for graduate students. This happened most frequently in the career development category, but is problematic, since postdocs are likely trying to improve those skills beyond a graduate student level. On one university website, a workshop for graduate student career planning was advertised next the faculty training on mentoring and recruiting students. Following the links showed that postdocs were not the intended audience for either event. If the postdoc position is meant as a "stepping-stone" to an academic career, it is necessary for them to leave behind their graduate student identity. This is difficult to do if their own university still treats them like graduate students.

V. Discussion and Conclusion

Through the Vygotskian lens of the facilitation of knowledge mediated by a "more knowledgeable other," postdoctoral mentors and the universities' resources are both considered as more knowledgeable others as mentorship and sponsorship is essential to the postdoctoral experience. As postdocs are in a transition state from doctoral to faculty and it is often temporary fixed-term appointments, less formal attention has been provided to postdocs. As such, they may have to rely on institutional resources as the "more knowledgeable others" to facilitate their learning development. From the analysis of the university resources for postdocs, most resources aimed at postdocs are on-campus or local groups, documentation on postdoctoral appointment policies, and funding support. While peer mentorship via on-campus or local groups are valuable but should not replace formal professional mentorships or institutional resources as core resources, echoing other work by [14], [25]–[27]. While funding-based resources are useful to many new postdocs, they may not continue to be sufficient in providing the required resources to support postdocs professional growth throughout their appointment.

Resources that support postdoc professional growth fall mostly under career development with some additional subthemes under new postdocs and academic infrastructure. The importance of professional development for postdocs cannot be overstated, however, there are still three institutions offering nothing for postdocs. Within those who provide university resources, most employed career development resources are funding, writing, and communication support. Teaching and mentoring are two other major tasks that need to be trained during the postdoctoral phase of education. It is

surprising to find out that one third of the institutions do not (at least on their websites) advertising formal teaching support. Even fewer schools provide programs to train postdocs how to effectively be a mentor to students. As postdoctoral training is designed to better facilitate the Ph.D.-to-faculty transition, universities and supervisors should not neglect competencies other than conducting research. We encourage universities to include more programs in teaching and effective mentoring to fulfill these needs.

Several identified gaps in institutional resources are worth noting. Well-being programs are one of the areas that are identified as neglected resources, with fourteen out of the thirty-one schools offering no resources along these lines. Prior work [2], [16] pointed out postdocs may feel torn between their research duties and building complementary skillsets during their appointments, and that isolation disproportionately impacts women postdocs [28], [29] and postdocs of color [3], [14], [30]. However, only half of the identified top engineering and computer science schools in this study offered well-being programs with the majority only listing generic external or universities' well-being programs information on the postdoc websites. These omissions are concerning in terms of the populations to which they may matter more. For example, postdocs with families, including women, may be more in need of information about Adjusting to a New City and Family Support (comprising childcare and information on local schools). Universities should be mindful that lacking those two categories of resources may further disenfranchise women postdocs with families, especially given literature critiquing the academic motherhood penalty [31], [32].

A. Implications for Postdocs, Postdoctoral Supervisors, and University Administrators

Given the lack of scholarship on postdoctoral education, we sought to explore the landscape of resources "in practice," especially given that some funding agencies, such as the NSF and NIH, require postdoctoral mentoring plans as part of successful grant proposals. At the institutional level, a first step toward supporting postdocs is to fix broken or outdated links. These abandoned resources show current and perspective postdocs that little effort has gone into maintaining the websites, so they can expect little effort in supporting them. Fixing these resources is an easy way to prevent a negative first impression. Providing a wide variety of resources can also go a long way in building a positive relationship with the postdocs. Many links about local attractions, housing, childcare, and entertainment show the postdoc that the university understands that they are real people and not just research producers.

Postdoctoral scholars must be proactive and agentic in seeking resources that serve their professional development needs. It is important to build rapport with postdoctoral supervisors as well as to build a broad network of mentors to receive effective mentorship in the limited time of a typical postdoctoral appointment. We also recommend searching for any on- campus or local groups for postdocs to serve as the supplemental source of guidance to provide additional support, as an active postdoctoral community can help bridge the gaps through peer mentorship.

Postdoctoral supervisors should firstly be aware of the resources (or lack thereof) available at the university level, so that professional development opportunities can be sufficiently planned. Supervisors should encourage their postdocs to engage with the resources to the extent they are available. Following from other research, supervisors should be aware of the pressure of "immediate productivity" and seek to encourage postdocs to invest their time wisely in trainings and workshops to encourage higher levels of effectiveness later. Whether or not Individual Development Plans are part of formal programming, supervisors should actively seek to review and mentor postdocs through an IDP, following suggestions from other researchers [17], and if a mentoring plan has been submitted as part of a grant, we encourage supervisors to share that with the hired postdoc to facilitate ongoing conversations on professional development. This way, both parties are aware of the expectations regarding mentorship in the position and can potentially modify it to better suit each other needs.

Finally, university administrators and curators of website content should be careful with respect to what the amount and type of content available on postdoctoral websites "says" to postdocs, understanding that the content of websites visibly corresponds to outward facing support. Universities should actively reject pasting links to other institutions' materials and resources as the sole source of information and support. Similarly, the "invisibility" of postdocs is only reinforced by websites that offer resources for both grad students and junior faculty, confirming a sense of postdoctoral purgatory without offering position-specific guidance.

In conclusion, little research has focused on the postdoc position as a significant part of the academic pipeline in engineering and computer science. This study examines the resources provided to postdocs through university websites as a way of understanding the perceived effort and priority these universities put on supporting their postdocs, focusing on the universities most highly ranked for research in engineering and computer science. The main findings of this content analysis include that of the 31 universities whose research was studied, three did not provide any resources whatsoever for their postdocs. Other resources were categorized within four major categories of resources pertaining to New Postdocs, Career Development, Community, and Academic Infrastructure and rated depending on the type of resource provided. We also made note of any broken links and out of date resources. The results show that while a few schools provide many resources designed for postdocs, many more tend towards providing links to external sources that may or may not be geared towards postdocs at all. Providing resources meant for graduate students to postdocs furthers perceptions that the postdoc is graduate student "plus," rather than a faculty member in training. University websites can certainly be improved in what they offer their postdocs, but supervisors and postdocs alike can take action in searching out and taking advantage of professional development resources and improving mentoring relationships to supplement.

findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Science Foundation.

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