# The Tech-Talk Balance: What Technical Interviewers Expect from Technical Candidates

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***Abstract*—Software engineer job candidates are not succeeding at technical interviews. Although candidates are able to answer technical questions, there is a mismatch of what candidates think interviewers assess versus what criteria is used in practice. This mismatch in expectations can cost candidates a job opportunity. To determine what criteria interviewers value, we conducted mock technical interviews with software engineer candidates at a university and collected evaluations from interviewers. We analyzed 70 interview evaluations from 9 software companies. Using a grounded theory approach, we compared interviewer interpretations of criteria including: performing a problem solving walkthrough, applying previous experience to problem solving, and the ability to engaging in conversation beyond writing code. From these findings, we provide implications on what candidates can expect to be evaluated on during technical interviews across companies, which can sometimes vary significantly.**

***Keywords*-career; interpersonal skills; technical interview; software engineer**

## I. Introduction

Janelle stayed up all night alone studying tree algorithms for her interview from the *Cracking the Coding Interview* book [1]. However, when she was asked to solve a Binary Search Tree (BST) algorithm, even though she knew exactly what to do, her confidence sank when she had to solve the problem on a whiteboard in front of her interviewer. She found out her interviewer did not just want her to know about CS Fundamentals, but was interested in her ability to communicate her problem solving skills and relate them to past experiences where she solved related problems. Suddenly, it occured to Janelle, that she was not nearly as prepared for the interview as she thought she was.

In efforts to prepare candidates for interviews, some have provided different types of resources such as blogs [2], [3] and created companies [4], [5] centered around preparing candidates for technical interviews. Unfortunately, no scientific approach has collected expectations for software engineering interviews. The aforementioned resources consider nontechnical skills, but fail to compare how those technical skills and interpersonal factors are rated in technical interviews across companies.

So the question remains: *What should software engineers expect in a technical interview?* To investigate this concern and gain a better understanding we asked the following research questions:

**RQ1** Are there company differences in interview criteria?
**RQ2** How do interviewers interpret criteria for software engineer job candidates?

In this paper, we gathered interviewer feedback in order to understand the expectations of interviewers and clarify how candidates should prepare for a technical interview. We collected data from 70 mock interviews with interviewers from 9 software companies. In this work, we find that technical interviewers *are* interested in interpersonal skills [6] of software engineering job candidates. We analyzed interviewer expectations from their reviews and outlined how candidates can prepare for future technical interviews beyond being technically sound.

The contributions of this paper are:

1) Surprisingly, technical interviewers place an emphasis on interpersonal skills and effective communication in the interview. Interviewers wanted to hire a person, not just a candidate who can solve problems.
2) According to interviewers, candidates are prepared technically, but encounter challenges translating their technical knowledge. Interviewers identified that candidates were not able make connections between previous work experiences.
3) It is important that candidates come prepared for a company-specific interview. We found that some companies emphasized specific technical skills.

## II. Methodology

We conducted mock technical interviews to better understand what companies expect from software engineer job candidates.[1] Study materials are available online.[2]

### A. Recruitment

**Candidates:** We recruited candidates by email through the undergraduate and graduate computer science student mailing lists at our university. The recruitment email included that mock interviews would be conducted with verified company interviewers. Interested students voluntarily completed an application online. In the application, candidates were required to submit their resume, class year, degree level, major, and preferred interview time slot. Candidates were not shown the companies listed for the time slot selected.

[1]This study was approved under IRB No. 9408.
[2]http://go.ncsu.edu/TechTalk-CHASE17

TABLE I
MOCK INTERVIEW PARTICIPATING COMPANIES

| Alias | Sector | Description | Size | Evaluations | Interviewers | |
|---|---|---|---|---|---|---|
| | | | | | Tech | HR |
| $C1_{WEB}$ | Internet Search | Internet-related services company specializing in search, cloud infrastructure, maps, and online advertising | Large | 10 | 4 | 0 |
| $C2_{LAW}$ | Legal and Risk | Legal and professional solutions for law firms, government agencies, and academic institutions, such as online access to documents and records from legal, news, and business sources | Large | 8 | 2 | 0 |
| $C3_{DAT}$ | Data Storage | Software, systems, and solutions for high-performance storage and enterprise data management | Large | 8 | 2 | 0 |
| $C4_{ENG}$ | Consulting | Engineering consulting company, providing IT consulting and product engineering solutions to automotive, industrial goods, life science, and utilities industries | Large | 6 | 4 | 0 |
| $C5_{STS}$ | Analytics | Software company for advanced analytics, such as business intelligence and predictive analytics | Large | 4 | 1 | 0 |
| $C6_{MKT}$ | Marketing | Software and automation solutions for the channel marketing industry | Small | 15 | 5 | 0 |
| $C7_{OPS}$ | Operations | Cloud-based operations management software for managing assets, improving workflow, and making data-driven decisions | Small | 12 | 6 | 0 |
| $C8_{INS}$ | Insurance | Insurance management company for the construction industry | Small | 4 | 1 | 1 |
| $C9_{FIN}$ | Financial | Private-equity firm providing software solutions for calculating valuations of enterprises and capital markets | Small | 3 | 0 | 1 |
| **Total** | | | | 70 | 25 | 2 |

**Interviewers:** We recruited interviewers from the *Department of Computer Science E-Partners* list.[3] These are organizations that have sponsored the department at our university. The third author of the paper, Director of Graduate Career Services for the Department of Computer Science, sent an email to the list of 63 companies.

### B. Interview Protocol

**Materials:** In the beginning of each session, each interviewer received a packet of their scheduled interviews, candidate resumes, and sample interview questions selected from *Cracking the Coding Interview* [1]. Interview questions related to traditional questions covered in the course work at our university from Chapters 1, 2, 4, 6, 7. Topics included but were not limited to arrays, linked lists, and object-oriented design. We did not require interviewers to solely use sample interview questions, but allow them to supplement pre-established questions. Interviewers applied their own discretion in selecting sample questions for the interview. We encouraged interviewers to give candidates a sense of what their own technical interview process would be at their company. Our goal was to understand whether or not companies have different approaches to interviews and expose candidates to that.

**Setting:** Interviews were conducted in person across 13 private rooms with a whiteboard across two days. Each interview lasted about 45 minutes. We allotted 30 minutes for the interview and 15 minutes for a reflection period where the interviewer was allowed to discuss feedback with the candidate.

[3]http://www.csc.ncsu.edu/corporate_relations/current-epartners.php

TABLE II
OVERVIEW OF CRITERIA DESCRIPTIONS

**PROBLEM SOLVING**
The candidate was able to talk through the technical problem, ask for assistance as needed, and demonstrate technical knowledge.

**NONVERBAL**
The candidate maintained eye contact during the interview. The candidate was not slouching or leaning back as though they were not interested.

**ORAL AND VERBAL CLARITY**
The candidate was able to effectively communicate clear answers to questions. You were able to comprehend what the candidate communicated.

**CLEAR AND CONCRETE EXAMPLES**
The candidate was able to provide clear, specific examples to back up statements about themselves.

**ENTHUSIASM**
The candidate displayed enthusiasm during the interview. Their demeanor showed they were excited about the opportunity to talk about themselves and what they have to offer.

**CONFIDENCE**
You have observed that the candidate believes in their skills and abilities based on the interview.

**Evaluation Form:** Following each interview, interviewers filled out an evaluation form to characterize candidate performance. We adopted a preexisting evaluation form to collect and interpret performance through a university-supported interview format. The evaluation form followed the style used in previous university career center mock interviews, supported

by the National Association of Colleges and Employers[4] data on what employers cite as important for new graduates. The form included six criteria and an open response section. Feedback criteria, as described in Table II, included problem solving abilities, nonverbal communication, oral and verbal clarity, providing clear and concrete examples, enthusiasm, and confidence. Each criteria consisted of a 4-point Likert scale rating with the option of (NA): (1) Need Improvement, (2) Fair, (3) Good, and (4) Excellent. After filling out the form, interviewers had the option to share the feedback with candidates, and then return the form back to the third author.

### C. Participants

Of the 87 candidates who attended their scheduled interview, 17 interviewers returned forms directly to candidates. We collected feedback from the 70 evaluation forms returned to the third author.

We received responses from 9 companies offering volunteer interviewers. The third author then paired interviewers with interview slots based on their availability. We anonymize and describe the participating companies in Table I. The size of a company was determined by their number of employees listed on their LinkedIn[5] profile. No interviewer was scheduled for more than four interviews a day to ensure adequate feedback. Companies participated with either one technical interviewer, one human resources interviewer, or a technical-human resources interviewer pair. Twenty-five of the twenty-seven interviewers identified as technical.

### D. Analysis

We conducted both quantitative and qualitative analysis of all feedback forms. This includes both Likert scale ratings and open response comments.

To understand how different companies evaluated candidate ratings (RQ1), we performed a two-tailed Fisher's exact test across all companies for each of the six item evaluation criteria: problem solving, nonverbal, oral and verbal clarity, clear and concrete examples, enthusiasm, and confidence ($\alpha < 0.05$). For each significant result, we performed a Steel-Dwass post-hoc analysis to identify which companies were significantly different ($\alpha < 0.05$). Essentially, the Steel-Dwass analysis is a non-parametric multiple comparison procedure that compensates for the overall experiment-wise error rate [7]. Finally, we performed a correspondence analysis, a non-parametric variant of principal component analysis (PCA), to cluster the companies in two-dimensional graphical form. The primary purpose of correspondence analysis is to produce a simplified (low-dimensional) representation of the information in a large frequency data set. The resulting scaled space is used to derive coordinates of the first and second components as coordinates, thus geometrically capturing the relationships between companies, the way in which they are classified, and their position relative to each other based on the given criteria [8].

[4]http://naceweb.org

[5]http://www.linkedin.com/

TABLE III
COMPANY DIFFERENCES IN EVALUATION CRITERIA RESPONSES

| **Criteria** | $p$[1] | Post-hoc pairs ($p$)[2] |
|---|---|---|
| Problem Solving | 0.001* | $\mathbf{C1_{WEB}}$/$C3_{DAT}$ (0.0159) |
| | | $\mathbf{C1_{WEB}}$/$C7_{OPS}$ (0.0433) |
| Nonverbal | 0.0007* | $\mathbf{C1_{WEB}}$/$C6_{MKT}$ (0.0057) |
| | | $\mathbf{C1_{WEB}}$/$C2_{LAW}$ (0.0057) |
| Oral/Verbal Clarity | 0.1142 | — |
| Clear, Concrete Examples | 0.0392* | — |
| Enthusiasm | 0.0079* | $\mathbf{C1_{WEB}}$/$C6_{MKT}$ (0.0250) |
| Confidence | 0.0448* | $\mathbf{C1_{WEB}}$/$C2_{LAW}$ (0.0356) |
| | | $\mathbf{C1_{WEB}}$/$C3_{DAT}$ (0.0356) |
| | | $\mathbf{C1_{WEB}}$/$C7_{OPS}$ (0.0262) |

[1] Fisher's exact test across companies. Asterisk (*) indicates statistically significant result for criteria ($\alpha < 0.05$).
[2] Post-hoc Steel-Dwass analysis. All significant pairs identified $C1_{WEB}$ as being different from the corresponding paired company.

To unpack interviewer interpretations of criteria, we used a grounded theory [9] approach to analyze comments (RQ2). We used Atlas.TI [10] data analysis software to qualitatively perform multi-phase coding. First, we conducted first-cycle descriptive coding on open responses to describe the context of each comment. In the second phase, we performed axial coding to recognize core phenomenon and relate interviewer interpretations to criteria.

## III. RESULTS

### A. RQ1: Are there company differences in interview criteria?

Fisher's exact test identified overall significant differences in five of the six evaluation criteria (Table III): problem solving ($p = 0.001$), nonverbal ($p = 0.0007$), clear and concrete examples ($p = 0.0392$), enthusiasm ($p = 0.0079$), and confidence ($p = 0.0448$). For each criteria identified as significant by Fisher's exact test, a post-hoc Steel-Dwass analysis identified company pairs that contribute to the differences. All post-hoc pairs identified $C1_{WEB}$ as being significantly different than some other company. The test did not identify any other pairs as significant.

The correspondence analysis in Figure 1 confirms and elaborates on this result. Correspondence analysis are interpreted by comparing each axis independently. Stated plainly, the difference in the x-coordinates of companies can be studied or the y-coordinates of companies can be studied. However, the values do not have units to calculate euclidean distance.

Specifically from this figure, the analysis shows that $C1_{WEB}$ is an outlier, with the other companies clustering together in terms of evaluation responses. To explain these differences, we qualitatively investigate how company expectations differ between $C1_{WEB}$ and the non-$C1_{WEB}$ companies and to understand how candidates failed to meet those expectations.

### B. RQ2: How do interviewers interpret criteria for software engineer job candidates?

To answer RQ2, we outlined how interviewers interpreted evaluation criteria and expectations of candidates that arose from that. Each of the following sections is labeled as:

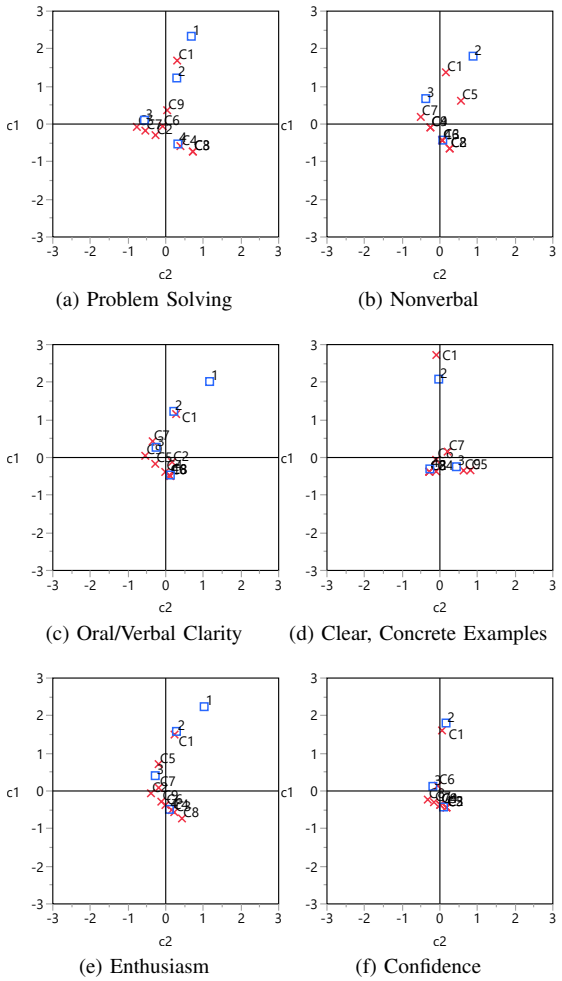


Fig. 1. Correspondence analysis for 4-point Likert scale evaluation criteria. The correspondence analysis reveals two distinct clusters for the companies, with $C1_{WEB}$ being an outlier for evaluation criteria. The x-axis and y-axis demonstrate the first and second dimension output from the analysis, respectively.

[Original Criteria]→[Interpretation from Interviewers]

**Problem Solving→Algorithms.** When hiring candidates for a job, the top concern is whether candidates have sufficient technical skills to handle problem solving. One way to demonstrate this knowledge is with a walkthrough of the approach. Interviewers, such as one from $C7_{OPS}$, wanted to know if candidates knew how to communicate their code and *"be vocal when talking through technical problem solving questions (R35)."* However, some interviewers from $C1_{WEB}$ were curious if candidates were familiar with specific data structures such as, *"shortest path, memory v.s. space trade-offs, underlying memory layouts, etc. (R37)."*

$C1_{WEB}$ interviewers did not mind offering help if a candidate did not know how to solve a problem, but their intention was to understand the *candidate's approach*; not the candidate's approach after receiving hints. As one interviewer elaborated, *"interviewers will use hints to guide you away from certain paths. Small hints are not a problem but if an interviewer has to give larger hints, they will not be able to assess your abilities (R62)."* This emphasis on assessing technical abilities is similar to what we identified in the quantitative criteria analysis.

**Nonverbal→Interest.** Interviewers noticed when there was poor communication during the interview. One interviewer from $C4_{ENG}$ mentioned the importance of *"maintaining eye-contact when speaking (R70)."* In addition to eye contact, an interviewer from $C2_{LAW}$ took note of one candidate's *"great poise and communication style on the white boarding exercise (R1)."* Interviewers held candidates showing interest and learning from the interview experience in high regard. A $C2_{LAW}$ interviewer took notice when a candidate asked *"good questions and took notes (R14)"* and called the interview *"all around great."*

**Oral/Verbal Clarity→Fluent Speech.** When making a first impression, the first words a candidate speaks are often the most important. As reflected in the survey descriptions, a $C7_{OPS}$ interviewer conveyed difficulty deciphering what a candidate said since the, *"communication sometimes was too fast and difficult to understand with [the] accent (R8)."*

A $C9_{FIN}$ interviewer described oral clarity in a review as a candidate *"talked quite a bit, but stayed on topic (R29)."* Interviewers also interpreted oral clarity as a balance between being technical and communicating that technical knowledge. It was not helpful to a $C7_{OPS}$ interviewer when candidates failed to maintain clarity: *"Excellent interview! Try to slow down a bit when talking; there were a couple times that you tripped over your words (R26)."*

**Clear, Concrete Examples→Connected Experiences.** Another way of demonstrating a candidate's fit is their ability to communicate clear and concrete examples. An interviewer from $C6_{MKT}$ mentioned the *"excellent communication and story of his experience (R46)."*

Although the survey description mentioned "examples of the candidate themselves", some interviewers interpreted that to be code examples. An interviewer from from $C2_{LAW}$ admired a candidates willingness to give more examples: *"Best of all from today. He added more examples for me. Asked a lot of relevant questions that he wanted to know (R18)."* Another interviewer from $C3_{DAT}$ enjoyed a similar interaction: *"Wonderful questions! Great enthusiasm and communication levels. Very personable and detailed examples given (R33)!"*

**Enthusiasm→Visible Excitement.** How a candidate displayed enthusiasm is one measure of interest and engagement in the interview. A $C8_{INS}$ interviewer mentioned the *"great energy (R49)"* of one candidate while a $C5_{STS}$ interviewer mentioned how *"calm (R7)"* another was.

Interviewers wanted to know candidates were excited throughout the interview. One $C2_{LAW}$ interviewer elaborates on this: *"Enthusiasm was a 3 during interview 4 after interview when we were talking. Smile more, use hands to move around - will help ease nervousness (R19)."*

**Confidence→Belief in Retained Knowledge.** Nervousness can be perceived as a detractor from confidence, described in the evaluation form as "belief in ones abilities". Confidence was interpreted as measure of comfort in retained knowledge. We found similar interpretations of confidence in comments as one $C7_{OPS}$ interviewer mentioned: *"He was extremely confident. Answered the questions exactly as designed. Demonstrated the knowledge that he has acquired in school (R15)."* One interviewer from $C3_{DAT}$ recommended that candidates *"own"* their expertise: *"Be confident :) You have great experience and knowledge, be proud (R32)!"*

## IV. Discussion

Our results help us make informed outcomes of the current state of technical interviews from the interviewer perspective.

**Most companies have consistent expectations for candidates across industry and size (RQ1).** Together, our quantitative and qualitative analysis suggest that not all companies emphasize the same attributes for candidates. First, compared with other companies in our study, $C1_{WEB}$ evaluates candidates more stringently in terms of problem solving, examples, and confidence than the other companies in our interviews. We identified the same in our qualitative analysis. $C1_{WEB}$ was the only company to encourage candidates to be familiar with distinct data structures such as hash maps and BST. The non-$C1_{WEB}$ cluster also mentioned more interpersonal factors thus reinforcing differences between these interview styles.

Second, these results also suggest that for companies other than $C1_{WEB}$, interview practice for any *one* of the companies is likely to transfer to the other companies within the cluster. Conversely, the results also suggest that if an individual prepares for interviews in the non-$C1_{WEB}$ cluster, they are less likely to perform well at $C1_{WEB}$.

**Interviewers care about technical soundness and the ability for candidates to communicate it (RQ2).** An interviewer recommended that one participant know one language inside and out and continue using the same one for the interview. Expertise in one language can make it easier for candidates to be familiar with functions, syntax, and memory management issues. This can eliminate distractions when refining solutions to technical questions. Being technically sound in a language embodied confidence and comfort in one's abilities simultaneously according to interviewers.

A candidate asking thorough questions is another way that has been shown to demonstrate sharpened technical skills. However, it was not enough to know the fundamentals. Interviewers were interested in whether candidates could walk through and connect fundamentals to an interviewer's questions through an engaging dialogue. If a candidate did not know how to solve a coding question, interviewers were interested in knowing whether or not a candidate could navigate to the answer. This valor was a quality that was not listed as an evaluation criteria, however, interviewers were interested in candidates demonstrating this quality rather than asking for hints throughout the interview. Interviewers did not want evasive answers such as, "I am not sure", they wanted candidates to demonstrate that they could ask the right questions to work through the challenge.

**Interviewers took notice in candidates who made the investment to prepare (RQ2).** Following mock interviews, some interviewers expressed interest in pursuing candidates for formal interviews. This demonstrated that interviewers did take notice in candidates that have put in the work to prepare. One interviewer mentioned they will *"be in touch regarding [an] internship (R2)."*

This mock interview experience resulted in a successful endeavor not only for companies to be exposed to the early job candidates, but for candidates to gain valuable interview experience. In a follow up dialogue with candidates, one mentioned the opportunity for growth, *"The program is great. I would love to do it again after 3 months to check how much have I improved."* Universities and other organizations should continue to support mock interviews and encourage candidates to practice tailoring their approach for companies before the formal interview.

## V. Related Work

Companies use many styles of interviews to evaluate candidates. Conway and colleagues collected data from on campus interviews and found that having a variety of approaches to an interview helps evaluators extract both situational and patterned behavior in candidates [11]. Though the aforementioned study was able to simulate an interview environment, the study lacked technical interviewers from a variety of companies. In this work, we are interested in the expectations of software engineering candidates. Ford and colleagues emphasizes the importance for interviewers to monitor both nonverbal cues in addition to technical skills for a complete candidate evaluation [12]. For example one reason for emphasis on nonverbal cues such as eye contact [13], [14], is the challenge to get technical experts to talk [15]. Monitoring the use of nonverbal cues to interpret candidate skills is a factor we found to be prevalent throughout interview comments.

Candidates are poor at gauging their own performance during technical interviews [16]. Lerner found that candidates were focused on issues that did not matter as much to the interviewer. There are recommended best practices to prepare [17] and knowing what to expect during interviews can help candidates succeed. In our study, we qualitatively analyze responses and identify what interviewers are identifying in candidates and outline what candidates can expect. Companies have acknowledged that preparing for the interview leads to preparing for the job [6]. In addition, some universities have found that giving behavioral and technical questions to candidates ahead of time is a great way to prepare [18]. Supporting this is an emphasis on the value of interpersonal skills in the technical setting from non-technical recruiters [19]. Our work differs by demonstrating that technical interviewers are also interested in the combination of both interpersonal skills as well as technical abilities.

## VI. Limitations and Future Work

**Internal.** The results we identified may have different causes. First, all candidates self-selected to participate in the mock interview. It is likely that these candidates may have been more serious about the technical interview or even more prepared. In the future we will extend direct invitations to random sample of students. Another threat we face is the fact that some interviewers shared their information with candidates. In addition, interviewers may have been primed by the content of the feedback form. This may have caused some interviewers to be more reserved and restricted in their feedback and not provide much constructive criticism. In a follow up study we will be sure to include different feedback forms that candidates will not review.

**External.** The format of the mock interview provides a couple issues when generalizing to other communities. All candidates came from the same university and ideally have a similar approach and experience to technical interviews. Furthermore, although our statistical analysis identified $C1_{WEB}$ as a distinct cluster from the other companies, it is only a single data point. Thus, we should be cautious in overgeneralizing these results without identifying additional companies within this cluster. In the future, we plan to have candidates from a range of universities with a varied educational backgrounds in computer science.

**Construct.** Consciously taking part in a mock interview may have a smaller effect on stress and anxiety than a formal interview. There is also the opportunity for candidates to be more reserved since there are no tangible outcomes such as a job offer. We are currently preparing studies where we can monitor interviews conducted by companies and their selected candidates.

## VII. Conclusion

Preparing for a technical interview can be difficult, especially when there are different expectations across companies. There is a disconnect between what interviewers are looking for and how candidates are preparing and performing. In order to help technical interview candidates become more aware of their interviewers' expectations, we conducted a study to characterize feedback given on their performance. We present a quantitative and qualitative comparison of mock interview criteria and how interviewers applied that criteria when giving feedback on candidate interview performance. We provide implications on how we can learn and incorporate evaluation of candidates in the preparation process. Further work is needed to see if changes in preparation help candidates succeed.

## Acknowledgments

We thank the Alt-Code research group for their support. This material is based upon work supported by the National Science Foundation under Grant No. DGE-1252376.

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