Can Virtual Agents Scale Up Mentoring?: Insights from College Students' Experiences Using the CareerFair.ai Platform at an American Hispanic-Serving Institution

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Abstract. Mentoring promotes underserved students' persistence in STEM but is difficult to scale up. Conversational virtual agents can help address this problem by conveying a mentor's experiences to larger audiences. The present study examined college students' ($N = 138$) utilization of CareerFair.ai, an online platform featuring virtual agent-mentors that were self-recorded by sixteen real-life mentors and built using principles from the earlier MentorPal framework. Participants completed a single-session study which included 30 min of active interaction with CareerFair.ai, sandwiched between pre-test and post-test surveys. Students' user experience and learning gains were examined, both for the overall sample and with a lens of diversity and equity across different, potentially underserved demographic groups. Findings included positive pre/post changes in intent to pursue STEM coursework and high user acceptance ratings (e.g., expected benefit, ease of use), with under-represented minority (URM) students giving significantly higher ratings on average than non-URM students. Self-reported learning gains of interest, actual content viewed on the CareerFair.ai platform, and actual learning gains were associated with one another, suggesting that the platform may be a useful resource in meeting a wide range of career exploration needs. Overall, the CareerFair.ai platform shows promise in scaling up aspects of mentoring to serve the needs of diverse groups of college students.

Keywords: Virtual Agents · Mentoring · Dialog Systems · STEM Outreach · Hispanic-Serving

1 Introduction

Nearly every successful science, technology, education, and mathematics (STEM) professional was inspired and guided by different mentors across their career.

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Mentoring is particularly important for under-represented minority (URM) students' engagement and persistence in STEM fields [3]. As URM students belong to racial/ethnic groups that are not proportionally represented in STEM fields, they often have less exposure to STEM careers and have a greater need for mentoring. Unfortunately, mentors from backgrounds similar to URM students' will also be under-represented and often over-burdened [5]. Moreover, despite its effectiveness, traditional person-to-person mentoring is difficult to scale up, as mentors are limited by their schedules, and they hold only partial information about careers based on their own experiences. Even with the advent of and growth in online virtual mentoring programs [10], they typically differ only in modality (e.g., teleconference) and face similar problems with scaling.

To address this challenge, AI could be leveraged to help share STEM mentors' experiences on a wider scale. An earlier project for high school STEM outreach (MentorPal [11,12]) demonstrated that it was feasible to video-record real-life mentors answering questions often asked by mentees and use these to generate conversational virtual agent-mentors. Students could pick from suggested questions or type/speak their own questions, where natural language understanding would respond with the mentor's best-match answer. Building on this approach, the CareerFair.ai project is studying how a wide array of virtual mentors in a "virtual career fair" may increase interest and persistence in STEM-based career pathways, especially among students at Minority-Serving Institutions (MSIs). Unlike in prior research, real mentors could self-record and generate their virtual mentors in an online platform, enabling a wider set of mentors to be created. A mixed-methods study was conducted with students at a large U.S. Hispanic-Serving Institution (HSI), to understand their user experience and learning gains with CareerFair.ai, both overall and with a lens of diversity and equity.

2 CareerFair.ai Design

The CareerFair.ai platform provides two distinct capabilities: 1) Mentor Publishing: a self-recording web-based platform was developed so mentors could record, edit, and publish their own virtual mentors and 2) Virtual Mentoring: a portal where students can find and chat with virtual mentors and mentor panels.

Background. This research builds on findings with virtual agents showing that conversational agents using recorded human videos can compellingly convey personal experiences [16]. These and other types of interactive digital narratives better increase learning and engagement compared to traditional learning formats, such as readings or didactic presentations [9]. As a milestone in this area, the New Dimensions in Testimony project enabled museum visitors to converse with hologram recordings of Holocaust survivors to learn about their personal experiences, producing strong engagement in survivors' stories and lives [17]. As noted earlier, the MentorPal project developed and tested a small cohort of virtual STEM mentors with high school students, which showed immediate (pre/post-test) gains in students' knowledge about and interest in STEM careers

[12]. However, this earlier work indicated the need for expanding mentors, as students requested more occupations and more diversity to be represented.

Mentor Publishing. Considering the large number of career fields and their intersection with the diverse identities of URM learners, it was recognized that scaling up virtual mentoring must not be constrained by specific recording equipment or pre-scheduled recording sessions with research staff. To address this, a mentor publishing portal was built, to allow an unlimited number of mentors to record, edit, and preview their mentors flexibly. While it is not possible to describe this process in detail due to space limitations, this allows new mentors to opt-in to the CareerFair.ai platform on an ongoing basis and also to return to improve their virtual mentor at any time. While mentors can record any question, they are recommended to first answer questions from a carefully curated "STEM Careers" question set with 256 questions, organized by topic. The set combines questions that students *should* ask, based on existing research and professional insights, and questions that students said they *wanted* to ask, based on needs assessments conducted at the HSI where the current study was conducted ($N = 1197$). Mentors were invited to the project to allow students to explore different STEM careers, including those identified via needs assessments, and to increase exposure to mentors from under-represented or underserved backgrounds.

Virtual Mentoring for Students. On the student-facing CareerFair.ai platform, students are presented with an interface where they can view profiles of individual mentors as well as mentor panels, or a roundtable-style panel of mentors (Fig. 1). The header and footer show logos with links to the students' home institution and collaborating outreach organizations. When students click on a desired mentor or mentor panel, the "virtual mentor" interface is shown (Fig. 2), where students can pose questions free-form in a text box or choose questions

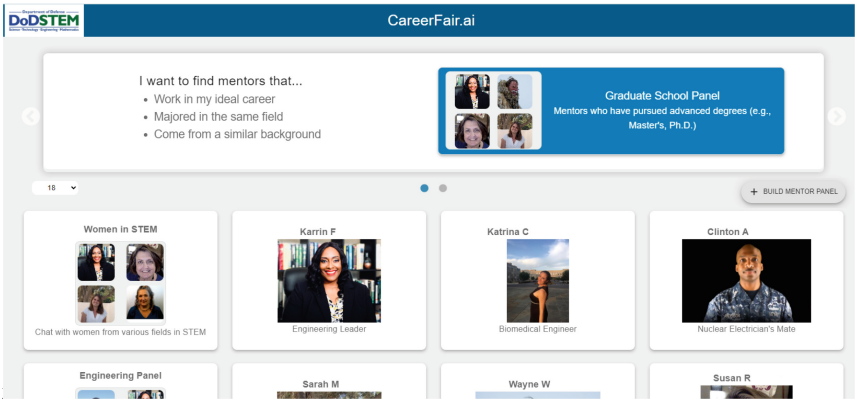

Fig. 1. The CareerFair.ai Home Page.

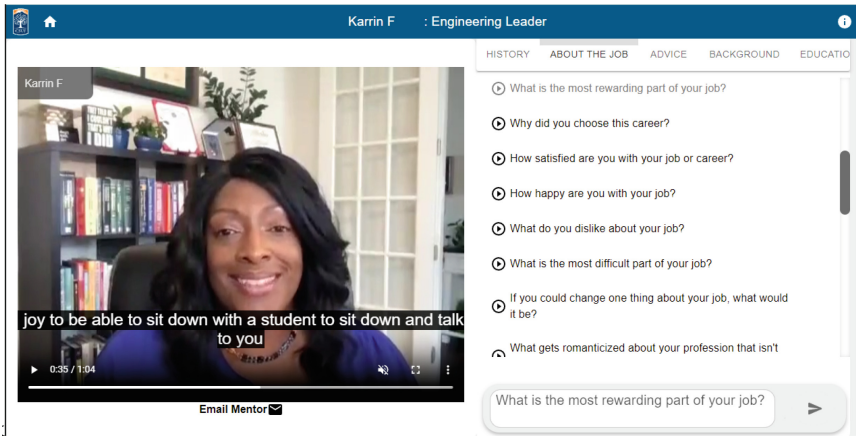

Fig. 2. The Virtual Mentor Chat Interface.

from sets of "suggested questions" grouped by topic on the right side of the screen. In response to the question, a videotaped response classified as the most relevant answer based on the natural language question answering model would play back on the left [11,12]. In the mentor panel format, the most relevant answer for each mentor on the panel would play back, one at a time, similar to a roundtable format where mentors take turns answering the same question.

Question Answering. User-entered questions are classified using a logistic regression classifier. Similar to MentorPal [12], answer classification is based on a feature vector of sentence embeddings for the input question. However, while MentorPal used an average of individual Word2Vec embeddings, the current system instead uses Sentence-BERT [14]. As S-BERT captures relationships between words, this increased accuracy on our benchmark mentor test set from 73% ideal answers [12] to 82% ideal answers (i.e., exact match to a human expert). As mentoring questions can overlap, an exact match is also not strictly necessary, and in practice over 90% of inputs receive "reasonable answers" (i.e., an expert would rate the answer as responsive to the question). The mentor panel dialog controller also helps to improve answer quality, as mentors with higher confidence scores answer first. A question where no mentor has a confident match is responded to as off-topic (e.g., "I'm sorry, I didn't understand your question...").

3 Research Design

The present study examined students' user experience and perceived learning gains as a result of using the CareerFair.ai platform, both for the overall sample and with a lens of diversity and equity across different demographic groups

that may be underserved. Analyses included self-reported quantitative ratings and write-in descriptions, as well as from logged activity on the CareerFair.ai platform. Exploratory in nature, the study examined:

1. User experience and acceptance of the platform
2. Perceived impact as a result of using the platform
3. Anticipated and actual information learned and explored by users
4. Whether any of the above differed for underserved groups of users.

Participants. A sample of 138 students (35.8% STEM majors; 96.3% undergraduate, 36.5% first-generation college student, 45.7% Hispanic, 54.3% underrepresented minority per the National Science Foundation definition, 65.2% non-male) was recruited from California State University, Fullerton (CSUF), a large public HSI in the United States. The demographic characteristics of the sample were consistent with the student population at the institution.

Procedures. Participants in the study had access to three mentor panels (CSUF Alumni; Women/Womxn in STEM; Engineering) and up to 16 virtual mentors (range = 10–16; 44% of color and 44% non-male). Participants were recruited for an online Qualtrics protocol using word-of-mouth, referrals from collaborating campus organizations, and the Psychology research pool. After providing informed consent, they completed a pre-test survey, after which they were redirected to the CareerFair.ai platform. Participants were asked to actively interact with the platform for 30 min, after which a pop-up emerged to redirect them to the post-test survey. Data were checked for effort and valid responding by trained research assistants. All procedures were approved by the Institutional Review Board at CSUF.

Measures. Usability and acceptance of the platform were measured using a version of a Unified Theory of Acceptance and Use of Technology (UTAUT) measure [18], with nine items on ease of use, acceptance, and intent to use the platform (e.g., "I found CareerFair.ai easy to use", "Using CareerFair.ai is a good idea", "I would recommend CareerFair.ai to other students") rated on a 6-point scale ranging from 1 (*completely disagree*) to 6 (*completely agree*). Participants also rated: "I learned more about a career I am interested in" and "I learned more about new career opportunities that I would be interested in," using a 5-point Likert scale ranging from 1 (*strongly disagree*) to 5 (*strongly agree*).

Two measures were administered at both pre-test and post-test. Participants' perceived value of and expectations for success in STEM fields were assessed using the Value-Expectancy STEM Assessment Scale (VESAS [1]), which included 15 items (e.g., "STEM is an important field for me", "I feel I have what it takes to succeed in a STEM-related job") also rated on a 5-point scale for agreement. Scores for two subscales, perceived value of STEM fields and expectations for success in STEM careers, were obtained. Participants also

rated three statements on how likely they were to major, minor, or take additional classes in STEM on a 5-point scale ranging from 1 (*very unlikely*) to 5 (*very likely*).

Regarding mentor selection, participants indicated which mentor they interacted with the most, which was coded for mentor being of color or non-male. Participants also indicated the mentor panel(s) used via a multiple-answer item.

Four write-in items were also administered and analyzed. At pre-test, participants described their expected learning gains by answering: "What do you most hope to learn or gain from using the CareerFair.ai website?" and "What kinds of questions do you hope to get answered by the (virtual) mentors?". These were coded for correspondence with available content or features on the CareerFair.ai platform (0 = *Not addressed*, 1 = *Addressed*). At post-test, participants described what they had learned and explored, in response to: "What were some things you learned from using the CareerFair.ai website?" and "Please describe main things that you explored on the CareerFair.ai site." Responses were coded for recurring themes, using inductive coding procedures with the phenomenological approach [15], and also deductively for correspondence with desired learning gains at pre-test (0 = *Does not correspond*, 1 = *Corresponds at least partially*).

The content accessed by participants on the platform was also logged. On the CareerFair.ai system, the mentor's response to each question is tagged with a Topic (e.g., "What is a typical day like on the job?" is associated with the Topic, "About the Job"). Topics for all the responses that were played back or viewed by the participant for at least 3 s were tallied for each user's session.

Analyses. Descriptive statistics were obtained, and changes in scores between pre-test and post-test were tested using repeated-measures analysis of variance (ANOVA). Point-biserial correlations were used to examine associations between themes (codes) found for the post-test write-in items and the frequency with which responses in each Topic were viewed. Potential differences by demographic groups were explored using chi-square tests of independence (for categorical variables) and ANOVA (for quantitative variables).

4 Results

User Acceptance. Participants rated the platform highly on the UTAUT measure, with overall mean across the nine items in the "Agree" range ($M = 5.15$, $SD = 0.58$; *Median* = 5.11, *Mode* = 5). URM students gave significantly higher UTAUT ratings ($M = 5.26$, $SD = 0.52$) compared to non-URM students ($M = 5.01$, $SD = 0.62$), $F(1, 136) = 6.90, p = .01$. For all but one item, average ratings fell in the "Agree" to "Completely Agree" range (means, medians, and modes between 5 to 6). The two highest rated statements were, "I found CareerFair.ai easy to use" and "Using CareerFair.ai is a good idea."

A few global items asked the participants about their overall impression of the platform. Consistent with the UTAUT ratings, a vast majority (96.4%) of the participants indicated that they would recommend the platform to others.

This did not differ by most demographic groups, though non-male students were significantly more likely to recommend the platform (98.9%) than male students (91.7%), $\chi^2(1, N = 137) = 4.42, p = .04$.

Mean ratings for learning about a career of interest ($M = 3.80$, $SD = 1.15$) and new career opportunities of interest ($M = 3.98$, $SD = 0.88$) fell in the Neutral to Agree range. The ratings generally did not differ by demographic groups, though STEM majors expressed higher agreement that they learned about a career they were interested in ($M = 4.12$, $SD = 0.95$), compared to non-STEM majors ($M = 3.63$, $SD = 1.22$), $F(1, 137) = 6.12, p = .02$.

Impact. Small but positive increases were observed between pre-test and post-test in participants' intent to major ($M = 3.21$, $SD = 1.39$ pre-test and $M = 3.41$, $SD = 1.40$ post-test), $F(1, 137) = 8.86, p = .003$, partial $\eta^2 = .06$, minor ($M = 3.07$, $SD = 1.19$ pre-test and $M = 3.32$, $SD = 1.16$ post-test), $F(1, 135) = 12.02, p < .001$, partial $\eta^2 = .08$, and take additional courses in STEM ($M = 3.25$, $SD = 1.16$ pre-test and $M = 3.53$, $SD = 1.12$ post-test), $F(1, 136) = 13.34, p < .001$, partial $\eta^2 = .09$. No differences were found for these effects across different demographic groups.

Similar to these findings, perceived value of STEM fields as assessed by VESAS evidenced a modest change from pre-test ($M = 25.66$, $SD = 2.71$) to post-test ($M = 26.35$, $SD = 2.89$), $F(1, 135) = 5.74, p = .018$, and a significant difference for this effect was found between first-generation and non-first generation students, $F(1, 133) = 6.47, p = .01$, partial $\eta^2 = .05$. Post-hoc analyses indicated that only first-generation college students, not non-first-generation students, evidenced a gain ($\Delta = 1.35$ points on average) over time. By contrast, there was no change in the subscale score for expectations for success in STEM careers, $F(1, 135) = 0.01, p = .91$.

Mentor Selection. From the CareerFair.ai home page, participants had an option to interact with individual mentors or with "mentor panels." Approximately two-thirds ($n = 96$; 69.1%) of the sample elected to use at least one mentor panel. In terms of selection and behavior, STEM majors ($n = 49$) were more likely than non-STEM majors ($n = 88$) to skip mentor panels (36.7%) or use Engineering mentor panels (20.4%), whereas non-STEM majors were more likely than STEM majors to use Alumni (20.5%) or Women/Womxn (27.3%) mentor panels, $\chi^2(4, N = 137) = 12.48, p = .01$. Non-male students ($n = 90$) were more likely than male students ($n = 48$) to use Women/Womxn (27.8%, as opposed to 12.5% among male students) or multiple mentor panels (27.8%, as opposed to 4.2%), whereas male students were more likely than non-male students to use the Engineering (29.2% vs. 2.2%) mentor panel, $\chi^2(4, N = 138) = 33.01, p < .001$.

In terms of the mentor most utilized, 49.3% of participants reported interacting the most with a mentor of color, whereas 76.1% reported doing so with a non-male mentor. No demographic differences emerged in focusing on a mentor of color, thus students from different groups were equally likely to focus on a

mentor of color. Non-male participants selected a non-male mentor at a significantly higher rate (87.4%) than male participants (55.3%), $\chi^2(1, N = 134) = 17.23, p < .001$, otherwise focusing on a non-male mentor was equally likely across different groups.

Of note, mentor selection did not generally influence self-reported user experience of using the platform, but those that interacted with a non-male mentor gave a higher overall UTAUT rating ($M = 5.21$, $SD = 0.57$), $F(1, 132) = 4.62, p = .03$, and rating that mentor panel better facilitated learning about careers compared to one-on-one interactions with mentors, rated on a 1 (strongly disagree) to 5 (strongly agree) scale ($M = 4.14$, $SD = 0.73$), $F(1, 87) = 7.24, p = .01$, on average compared to those that interacted with a male mentor ($M = 4.96$, $SD = 0.60$ and $M = 3.60$, $SD = 1.00$, respectively).

Self-reported Learning. Table 1 summarizes the recurrent themes found in participants' descriptions of what they learned from and explored on the CareerFair.ai platform. The most frequently mentioned themes were related to the mentor's career path, general advice or approach to careers, and specifics about the mentor's job. URM students and non-male students both reported learning about mentors' personal career paths (49.3% and 48.9%, respectively) more than their counterparts (32.2% and 27.7%, respectively), $\chi^2(1, N = 137) = 4.07, p = .04$ for URM comparisons, $\chi^2(1, N = 137) = 5.73, p = .02$ for gender comparisons. Additionally, first-generation college students more frequently reported learning about educational requirements for jobs (24%) compared to their counterparts (10.5%), $\chi^2(1, N = 136) = 4.44, p = .04$. Upperclassmen (21.3%) were more likely than others (0.0–7.3%) to explore different jobs on the platform, $\chi^2(2, N = 134) = 6.24, p = .04$. STEM majors were more likely to explore pragmatic strategies in career building (12.5%), $\chi^2(1, N = 135) = 5.77, p = .02$, and platform features themselves (20.8%), $\chi^2(1, N = 135) = 5.77, p = .02$ than non-STEM majors (2.3% and 6.9%, respectively), $\chi^2(1, N = 135) = 5.75, p = .02$. URM students explored personal challenges experienced by mentors more often (6.8%) than non-URM students (0%), $\chi^2(1, N = 136) = 4.35, p = .04$. Surprisingly, male students reported exploring work-life balance at a greater rate (12.8%) than non-male students (2.2%). $\chi^2(1, N = 136) = 6.15, p = .01$.

Associations with Content Accessed on the Platform. Participants asked an average of 20.71 questions ($SD = 12.38$) and a total of 2917 responses were viewed. More advanced undergraduate and graduate students asked more questions than lower-level undergraduates, $Welch's F(2, 10.45) = 4.37, p = .04$. The most commonly queried Topics were About the Job (35%), Background (21%), Advice (14%), and Education (12%). The codes for self-reported learning gains and explorations were compared against questions logged by CareerFair.ai.

Questions were classified by Topic under which it belongs and each student's questions were counted by Topic. Point-biserial correlations between the coded qualitative data and frequency of question-topics were examined and are presented in Table 1. Of the 18 codes, a majority (11 codes; 61%) showed significant

links to actual questions asked, with most of those associations being logically linked (e.g., self-reported learning and explorations related to career advice were both linked to asking more questions within the Advice Topic). The following codes were not significantly associated with specific Topics: In learning, General Career Approach (reported by 38%), Job-Specific Details (29%), Possible Jobs in STEM (25%); in exploring, Demographic-Specific Information (15%), Platform Features (12%), Possible Jobs (12%), and Obstacles Overcome (4%).

In examining participants' desired and actual learning gains, 77.6% of the participants ($n = 104$) had at least partial correspondence between desired (pre-test) and reported (post-test) gains. Of note, 91.9% of the participants at pre-test mentioned desired learning gains that could be addressed by the platform.

Table 1. Themes coded for self-reports and their correlation with question Topics

Theme/Code (*Description*)	Occurrence	Topics for Questions Asked
"What were some things you learned?"		
Mentor's Path (*Career and Personal History*)	42%	Development ($r = .17$), Education ($r = .19$)
Pragmatic/Strategic Advice	23%	Advice ($r = .36$)
Education	15%	Education ($r = .20$), Graduate School ($r = .41$), Lifestyle ($r = .18$)
Work-Life Balance	4%	For Fun ($r = .26$), Lifestyle ($r = .38$)
Platform (*Features or Content*)	4%	Motivation and Vision ($r = .21$)
"Main things that you explored"		
Job Details	41%	About the Job ($r = .26$)
Mentor's Path (*Career and Personal History*)	36%	Background ($r = .33$)
Advice	18%	Advice ($r = .42$)
Education-Related Information	15%	Education ($r = .20$), Graduate School ($r = .28$)
Work-Life Balance	6%	Computer Science ($r = .23$), For Fun ($r = .18$), Lifestyle ($r = .19$)
Pragmatics (*How-To's*)	6%	Advice ($r = .31$)

5 Discussion

The CareerFair.ai platform shows promise in scaling up some of the benefits of mentoring and providing diverse sets of students with an interactive and personalized way to learn about different career paths in STEM. The results suggest high levels of user acceptance and positive impact on such outcomes as interest in pursuing STEM coursework and perceived value of STEM fields. Of note, URM students gave higher user acceptance ratings than non-URM students, which suggests that the platform could be a welcome resource for diverse sets of students, possibly by addressing unmet needs that occur more frequently among

URM students [2] and critical needs related to diversity, equity, and inclusion, as discussed below. Outcomes related to intent to pursue STEM coursework and perceived value of STEM fields showed positive increases between pre-test and post-test assessments, with outcomes generally not being moderated by demographic factors; thus, the CareerFair.ai platform has the potential to positively influence interest and persistence in STEM for students from all backgrounds. Moreover, the only way in which demographic factors moderated these key outcomes was that first-generation college students showed a greater increase in perceived value of STEM fields after using the platform.

Based on participants' selection of mentors, we found that gender influenced the way participants selected mentors. Non-male students were more likely to interact with the "Women/Womxn in STEM" mentor panel and/or a non-male mentor one-on-one. Moreover, the UTAUT ratings for the platform and for mentor panels were also higher among those who focused on interacting with a non-male mentor. A greater proportion of non-male participants expressed the willingness to recommend platform to others. These findings indicate the importance of increasing students with access to gender-minority mentors, a known need [4], as their insights are in demand especially among non-male students. Otherwise, minimal differences emerged across subgroups in choosing mentor panels or focusing on mentors of color, though STEM and non-STEM majors did show some differences in their utilization of available mentor panels.

Notably, participants' self-reported descriptions of the content they learned from and explored on the platform corresponded with both their desired learning gains at pre-test and with the actual content they had viewed on the CareerFair.ai platform. Consistent with earlier research on MentorPal [11], students engaged with specifics about the mentor's job, sought out advice, or asked questions related to education. The Topics associated with the actual questions asked correlated, by-and-large, in a very logical way. Thus, participants appeared to retain content from the platform, at least in some topic areas. These findings show promise for using an AI-based virtual agent to provide users with content that is more personally relevant and efficient to access than searching uncurated content online, scheduling appointments with career counselors or other parties that may only hold partial knowledge, or attending roundtables or other events where little of the content is tailored to the individual student. Thus, this tool may complement in-person mentoring by providing detailed follow-up, preparatory exploration, or interview practice.

In addition to the findings, the platform has further implications related to diversity, equity, and inclusion. One, because representation matters in providing students with role models that share similar backgrounds or values [6], a web platform like CareerFair.ai can support not just career mentoring but also a sense of belongingness by incrementally growing to host a broader and more diverse set of mentors than students can easily access in any one location. Second, students from underserved backgrounds may face additional barriers to accessing mentors, including stereotype threat [8] and limitations in resources (e.g., time, networks,

travel) to find and schedule meetings with mentors. The CareerFair.ai platform provides students with a free-of-charge resource where they can efficiently sample different mentors' perspectives and guidance without facing those types of barriers inherent in finding individual mentors. A recent needs analysis of URM students conducted by another research group [7] also noted the importance of rapport-building and suggesting resources for students of color; as the CareerFair.ai platform includes questions intended to build rapport (e.g., conversational and personal mentor recordings) and hyperlinks to external resources, these suggest convergence toward suggested features for effective "virtual mentoring."

The study had several limitations. While the number of mentors is growing, an earlier usability study indicated demand for additional careers [13]. Further research with larger sample sizes and at different minority-serving institutions is also recommended, to corroborate the findings. To best examine the naturalistic utilization of the CareerFair.ai platform, it may be useful to allow users to exit the platform when they wish, though the current usage time limit of 30 min was supported by prior work involving the MentorPal technology [12]. Moreover, longitudinal studies examining further use of the platform, retention of any information learned, and effects of the virtual mentors on participants' actual career exploration and planning behaviors are needed. Finally, because the virtual mentors play back pre-recorded responses, they are limited in their ability to address user-specific situations (e.g., a participant asks for advice specific to their own circumstance), and the platform is more likely to focus on informational aspects of mentoring and representation than social-emotional aspects of mentoring.

6 Conclusions and Future Directions

The CareerFair.ai platform – which features virtual agent-mentors that were self-recorded and published by real-life mentors – may help improve access to career information, guidance, and mentoring for a wide range of students. Students reported high levels of acceptance and evidenced good correspondence across what they wanted to learn from the platform, content that they accessed on the platform, and their self-reported takeaways. The platform provides a promising approach to scale up mentoring, particularly for first-generation and URM students. As noted, future research should examine the virtual mentoring under more naturalistic conditions and in coordination with live mentors; it may be appropriate to conceptualize the CareerFair.ai platform as a stepping stone towards direct interaction with a mentor and expand this role beyond its current capabilities (e.g., the "Email Mentor" button). Future research is needed to clarify to what extent the virtual mentors can disseminate different facets of mentoring activities and could be integrated with additional, face-to-face mentoring.

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