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ARTICLE

How 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 minutes 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.

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Introduction

Nearly every successful science, technology, education, and mathematics (STEM) professional was inspired and guided by different mentors across their career. Mentoring, which may include provision of both career-oriented support (e.g., providing career guidance, assisting with skill development) and psychosocial support (e.g., providing encouragement or role modeling) (National Academies of Sciences, Engineering, and Medicine, 2019; Robnett et al., 2019), is particularly important for under-represented minority (URM) students' engagement and persistence in STEM fields (Chemers et al., 2011; Syed et al., 2019). Promoting URM students' persistence in STEM fields is important in strengthening the STEM pipeline and mitigating threats to innovation, quality of research, and work performance in STEM that come with a lack of diversity in the workforce (The National Academies of Sciences, Engineering, and Medicine, 2019).

However, because 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 (Domingo et al., 2022). Moreover, despite its effectiveness, traditional person-to-person mentoring is difficult to scale up (National Academies of Sciences, Engineering, and Medicine, 2016), 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 (Neely et al., 2017), they typically differ only in modality (e.g., teleconference) and face similar problems with scaling. Thus, it is supremely challenging to make available to students a set of mentors that is sufficiently diverse and knowledgeable about different career pathways.

Application of Virtual Agents

To address this challenge, artificial intelligence (AI) could be leveraged to help share STEM mentors' experiences on a wider scale. One way in which AI could be harnessed to do so and better scale up mentoring is by creating conversational virtual agents representing real-life mentors ("virtual mentors"), which can effectively convey mentors' experiences to a wide range of audiences (Swartout et al., 2013), to serve as a first contact for students to get commonly asked questions answered. This was the inspiration behind MentorPal technology (Nye et al., 2017), which used video-recorded question-and-answer by real-life mentors to create video-based conversational virtual agents for mentors so that a large number of students could benefit from career information, personal anecdotes, and advice offered by each individual mentor.

Among the larger class of question-answering agents, MentorPal virtual mentors are part of a subset that are distinguished by responding with unmodified responses or excerpts (Budler et al., 2023). As generative AI becomes increasingly reliable for generating tailored or interactive responses (e.g., retrieval-augmented generation), virtual agents will increasingly rely on these capabilities (Li et al., 2023). However, in this case, real human recordings share the individual "voice" of a mentor, which is something that students and mentors both value due to its authenticity (i.e., the message is selected, but not modified by AI). With that said, emerging generative virtual agents offer complementary capabilities for rapidly updating and tailoring content for different learner groups. This paper presents findings from the existing, publicly available MentorPal system, but some discussion will also be presented about how generative AI advances can support or complement our work.

In an earlier project for high school STEM outreach using MentorPal (Nye et al., 2017, 2021), research 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, where mentors required a research team to support video recording and agent-building (typically requiring the use of studio equipment, an interviewer, video post-editing, and preparation of natural language understanding models), real mentors could self-record and publish their virtual mentors in an online platform, thus enabling a wider set of mentors to be quickly created.

As part of this effort, 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. Because exposure to professionals in STEM career paths can be highly influential in supporting college students' pursuit of and persistence in STEM (Martin et al., 2020), and such exposure may be limited but desired among first-generation college students and also from students from non-STEM majors (Okado et al., 2025), the CareerFair.ai project aimed to improve access to mentors from STEM and STEM-adjacent career paths to all students at the HSI regardless of major.

CareerFair.ai Design

The CareerFair.ai platform provides two distinct capabilities: 1) Mentor Publishing: a self-recording web-based platform was developed for the 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 (Swartout et al., 2013). These and other types of interactive digital narratives better increase learning and engagement compared to traditional learning formats, such as readings or didactic presentations (McQuiggan et al., 2008). 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 (Traum et al., 2015). 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 (Nye et al., 2021). 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 entitled "MentorStudio" was built, to allow an unlimited number of mentors to record, edit, and preview their mentors flexibly using their own equipment and facilities (e.g., using their own personal computer with a webcam) (Nye et al., 2023).

When mentors make an account, a guided setup process helps them share information such as their identities and experiences, a video introduction bio about themselves, and their "idle" video where they are waiting for a students' next question. Each video they record can be reviewed and uploaded to a serverless backend which extracts their video's transcript to train their mentor. Mentors can train their virtual counterpart by a single "Train" button and preview their virtual mentor to ask questions. Training a mentor builds a custom logistic regression classifier whose inputs are SentenceTransformer embeddings for the student's question (Reimers and Gurevych, 2019). Since mentors may have different question sets or custom questions recorded, training tunes the classifier such that certain embedding features are most important to respond to certain questions.

The MentorStudio platform 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. Thus, the project scales up the process of recording and generating "virtual mentors" by making the recording process flexible and accessible to a wider range of mentors than was previously possible.

In addition to developing the MentorStudio technology to greatly the improve the efficiency of the mentor recording and publishing process, multiple steps were taken to ensure that mentors published on CareerFair.ai helped meet student needs. Needs assessments were conducted annually at the HSI where the current study was con-

ducted (total N = 1197), and recruitment of mentors prioritized finding mentors in STEM careers of greatest interest to students as identified via needs assessments (e.g., software engineer/developer, various types of engineer, physician, data scientist), representing a variety of different STEM careers including those identified as being some of the fastest-growing by the Bureau of Labor Statistics, as well as increasing students' exposure to mentors from under-represented or underserved backgrounds. Mentors were also screened to ensure that they have prior experience and strong interest in mentoring underserved students. During the recording process, while mentors could add and record any question, they were 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. Thus, applications of this technology may help a large number of students learn about STEM career opportunities and strategies to enter those careers, which are often not widely known. In addition, the content recorded by mentors was reviewed by multiple trained student raters to ensure that it was sensitive to diverse perspectives.

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). A randomly selected mentor and mentor panel are suggested in the carousel in the upper part of the screen. 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 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

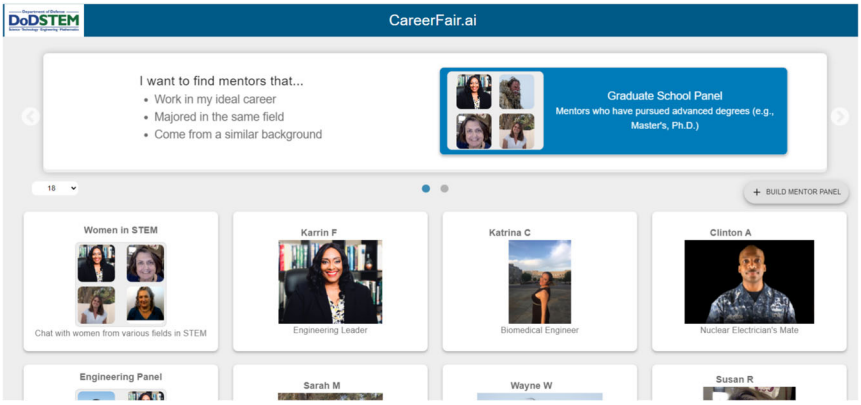

Fig. 1 The CareerFair.ai Home Page

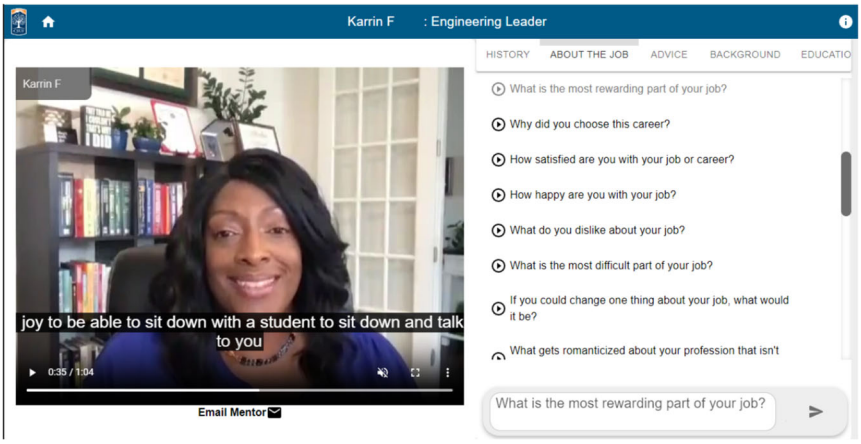

Fig. 2 The Virtual Mentor Chat Interface

would play back on the left (Nye et al., 2017, 2021). 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 earlier MentorPal research (Nye et al., 2021), 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 (Reimers and Gurevych, 2019). As S-BERT captures relationships between words, this increased accuracy on our benchmark mentor test set from 73% ideal answers (Nye et al., 2021) 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...").

Mentors below a minimum confidence only respond if directly selected (or no mentors meet the threshold) and they reply with a personal off-topic response (e.g., "I'm not sure if I answered that. Can you try a different question?"). As a result, the mentor panel dialog controller handles mentor-specific questions gracefully (e.g., "What was Antarctica like?"), as only the intended mentor should respond. Finally, in the mentor authoring interface, a Trending Questions panel displays examples of potentially-problematic user questions (e.g., low confidence, user selected "thumbs down" feedback). Examples are drawn from bins based on S-BERT cosine similarity between questions: only one question is shown from each bin to prevent duplication but questions from larger bins are listed first to prioritize common issues. Authors

(mentors) can manually select an ideal answer to candidate questions from the recorded set, can queue for question to record later, or can dismiss the candidate. This is designed to facilitate continuous improvement of the mentors.

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% under-represented 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, between April and December 2022. Sampling was conducted in such a way as to ensure that a wide range of majors and all Colleges were represented. Moreover, the demographic characteristics of the sample were consistent with the student population at the institution.

Procedures

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, interacted with the CareerFair.ai platform for 30 minutes, and completed a post-test survey, all in a single session. Participants entered the CareerFair.ai site through a link provided at the end of the pre-test survey on Qualtrics, and they were tracked using a user identification (user ID) generated by Qualtrics. On the CareerFair.ai platform, participants 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). The number of virtual mentors varied based on when the participant accessed the site, as new mentors were published on the CareerFair.ai site on an ongoing basis as mentors finished recording. To ensure compliance, access to the post-test survey was presented in a link contained in a pop-up set to display on the CareerFair.ai site after 30 minutes of active use and interaction with the site. 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 (Venkatesh et al., 2003), 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 their agreement with two statements: "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*).

To further elaborate on platform usability and acceptance, participants' written answers to write-in questions, "What did you like the most about the CareerFair.ai website?", "What are some features you wish that the CareerFair.ai website had? Please describe", and "Please feel free to add any additional comments, suggestions, or questions here" were examined by inductively coding responses to each question for recurring themes. In addition, those participants that endorsed experiencing "any technical difficulties or bugs while using the CareerFair.ai website" were asked to describe them using a write-in field. Finally, intent to reuse the site was also assessed using the item, "I plan to use the CareerFair.ai website again," rated 1 (*yes*) or 0 (*no*).

Two measures were administered at both pre-test and post-test to examine short-term or immediate gains from using the CareerFair.ai platform. Participants' perceived value of and expectations for success in STEM fields were assessed using the Value-Expectancy STEM Assessment Scale (VESAS (Appianing and Van Eck, 2018)), 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 related to learning outcomes 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 recur-

ring themes, using inductive coding procedures with the phenomenological approach (Saldaña, 2011), 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 seconds 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 related to learning gains and the frequency with which responses in each Topic were viewed. To explore potential issues related to diversity and equity, data were explored for differences based on the following demographic characteristics: race/ethnicity, first-generation college student, gender, and major (STEM vs. non-STEM). Potential differences by demographic groups were explored using chi-square tests of independence (for categorical variables) and ANOVA (for quantitative variables).

Results

Usability and 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 having learned 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. Perhaps unsurprisingly, STEM majors expressed higher agreement (in the Agree range on average) 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), $F(1, 137) = 6.12$, $p = .02$, though their average rating still fell between Neutral (3) to Agree (4) ranges.

Write-in responses regarding what the participant liked about the platform, desired features, and open comments were coded for themes, and the results are summarized in Table 1. While ease of use was the most commonly mentioned aspect of the CareerFair.ai site that participants liked, many also indicated liking the site's capabilities and

Table 1 Summary of write-in feedback regarding usability and acceptability of the CareerFair.ai platform, coded by theme

Theme/Code	Description	Occurrence
"What did you like the most about the CareerFair.ai website?" (n = 137)		
Ease of Use	Ease of Using Site	32.8%
Capabilities	Site Features or Behaviors	21.2%
Mentors	Insights Offered by Mentors	15.3%
Variety	Breadth of Occupations or Content Represented	15.3%
Diversity	Breadth of Demographic or Cultural Backgrounds Represented	2.9%
Match	Desired Type of Mentor Represented	2.9%
Panel	Desirable Mentor Panel Represented	2.9%
"What are some features you wish that the CareerFair.ai website had?" (n = 115)		
Variety	Breadth of Occupations, Mentors, or Content Represented	52.2%
Filter	Ability to Sort or Filter Mentors by Occupation or Characteristics	13.9%
Questions	Ability to Add New Questions	10.4%
Feature	Specific Feature Not Yet Available	9.6%
Interface	Improvement to the User Interface Design	8.7%
Existing	Feature or Capability Already Available	3.5%
Live	Ability to Chat Synchronously With a Mentor	2.6%
Demographics	More Mentors with Specific Demographic Characteristics	1.7%
Guide	Orientation on How to Use Site Features	1.7%
Resources	Provision of External Resources or Links	0.9%
"Please feel free to add any additional comments, suggestions, or questions here." (n = 63)		
Compliment	Positive Feedback or Compliment	58.7%
Suggestion	Specific Suggestion for Improvement or New Feature	12.7%
Variety	Breadth of Occupations, Mentors, or Content Represented	12.7%
Repeat	Repetition of a Suggestion Already Made in Previous Item	7.9%
Thanks	Expression of Thanks or Gratitude	6.3%
Interface	Suggestion for Improving User Interface	4.8%
Bug	Indication of a Technical Glitch, Difficulty, or Bug	3.2%
Question	A Question for the Research Team	1.6%

affordances (e.g., "I like that it is virtual. Everyone is on their own timeline and being virtual I think makes it assessable [sic] to everyone no matter the time. Also it was helpful for someone like me with social anxiety. Talking to people in real life can be challenging and having it in this format made it a lot easier to ask questions."; "I also LOVED that I have direct access to their emails [Email Mentor feature], it makes me feel valued and already answers my question of like 'would this person be okay with having a random person contact them;' the door is open for me to pursue guidance"; "I enjoyed how easy it was to find a mentor that fit my needs as well as the large amount of questions that were already answered by the mentor in the advice section. The pre-set questions and answers will likely be extremely helpful for students/people who are stuck in their path and don't even know the right questions to ask to move forward"). Some students also indicated liking what they had learned from their mentors (e.g., "How there is people of all types and all backgrounds to show how everyone struggles but can still be ok"; "I liked how there was many questions ... and how the mentors answered all of them very well, overall they were very helpful answers"; "I liked the fact that there are mentors for lots of different jobs and fields. It is a helpful resource for students who are struggling to figure out if they should continue in a certain career path. This website is helpful for that issue as they get to communicate with mentors that have been through the process that you as a student are going through").

In terms of desired features, by far the most commonly requested feature was the addition of more mentors or representation of more careers, followed by an ability to sort or search mentors and an option to ask, add, or suggest new or personalized questions. When participants were invited to enter additional comments, a majority of respondents simply offered compliments, though several participants provided concrete suggestions (e.g., "Make the top scroll bar easier to use ... Perhaps keep the scroll bar shown at all times and allow the scroll wheel on the mouse to move the scroll bar"; "I wish more people [mentors] had links to websites where students can start learning more about the field or an introduction to the field and maybe some subject matter related to their fields"; "I think this website should be advertised more around campus because the information I was able to get in 30 minutes was very helpful compared to me going around and asking different people a similar question and getting 5 different answers").

Relatively few students (n = 16, 11.6%) reported encountering any technical difficulties or bugs while using the CareerFair.ai site. Issues or lags with video playback was the most commonly reported concern (e.g., "Lagging on videos and scrolling"; n = 9), followed by difficulties due to Internet connectivity (e.g., "Internet issues causing the website to go down"; n = 2), failure by the virtual mentor to answer questions in expected ways (e.g., "Some answers were unavailable or did not apply to question asked"; n = 2), problems with interface (e.g., "When selecting categories for questions, the shadow that appears as you hover over the category only appears for the first category; it does not follow the mouse pointer"; n = 2), and failure of the timer to redirect the user to the post-test survey ("Took about 50 min to receive the pop up notifying I have fully completed the 30 minutes"; n = 1).

When asked about their intent to return to and reuse the CareerFair.ai, 90.5% of participants (n = 124) indicated that they planned to use the site again. No differences

were observed by demographic characteristics or major (STEM or non-STEM) in participants' intent to return to the CareerFair.ai site.

Impact

As shown in Table 2, significant positive increases were observed between pre-test and post-test in participants' intent to major, $F(1, 137) = 8.86$, $p = .003$, minor, $F(1, 135) = 12.02$, $p < .001$, and take additional courses in STEM, $F(1, 136) = 13.34$, $p < .001$, with medium effect sizes. These effects did not differ across 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

Table 2 Changes in intent to pursue STEM training before and after using CareerFair.ai

Intent To (in STEM)	Pre-Test Score	Post-Test Score	Partial η^2
Major	3.21 (1.39)	3.41 (1.40)	.06
Minor	3.07 (1.19)	3.32 (1.16)	.08
Take Additional Courses	3.25 (1.16)	3.53 (1.12)	.09

Mean scores for pre-test and post-test are reported, with standard deviations in parentheses

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 UTAUT rating for mentor panels ($M = 4.14$, $SD = 0.73$), $F(1, 87) = 7.24$, $p = .01$, 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 3 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 3. 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

Table 3 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)

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.

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, as well as positive impact on such outcomes as interest in pursuing STEM coursework and perceived value of STEM fields. Positive increases in these outcomes between pre-test and post-test assessments were found for the entire sample, with outcomes generally not being moderated by demographic factors, suggesting that the CareerFair.ai platform has the potential to positively influence interest and persistence in STEM for students from all backgrounds.

In terms of the potential for the CareerFair.ai platform to support STEM career exploration and persistence among underserved or under-represented students more specifically, there are two findings that are particularly noteworthy: (1) First, URM students gave higher user acceptance ratings than non-URM students; (2) Second, first-generation college students showed a greater increase in perceived value of STEM fields compared to their counterparts after using the platform, which was the one instance in which demographic factors moderated outcomes related to one's intent to pursue STEM coursework and perceived value of STEM fields. These findings suggest that the CareerFair.ai platform could be a welcome resource for diverse sets of students, possibly by addressing unmet needs that occur more frequently among URM students (Chelberg and Bosman, 2019) and critical needs related to diversity, equity, and inclusion, as discussed below.

Selection of Mentors 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 for 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 (Dawson et al., 2015), 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. Students' racial/ethnic background did not show associations with mentor or mentor panel selection, which may be consistent with literatures showing that surface-level similarity or demographic matching may be not as influential for mentees as deep-level similarity such as shared values, attitudes, or even interests (Hernandez et al., 2017).

Content Learned 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 (Nye et al., 2017), students engaged with specifics about the mentor's job, sought out advice, or asked questions related to education. In addition, students in the present sample reported learning about the mentor's career path and history. The Topics associated with the actual questions asked correlated, by-and-large, in a very logical way with content that the participants reported having learned and explored at post-test. 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 (Fealing et al., 2015), 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 (Martin-Hansen, 2018) 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 (Mack et al., 2019) 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."

Limitations

The study had several limitations. While the number of mentors is growing, an earlier usability study indicated demand for additional careers (Okado et al., 2023), and this was reflected in the students' write-in responses regarding desired features or improvements in this study as well. Thus, while students' recommendation to add mentors may reflect their acceptance of CareerFair.ai style outreach and its potential to be even more useful with enhanced content, further research is needed with additional representation of mentors and careers to examine its potential impact. 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 minutes was supported by prior work involving the MentorPal technology (Nye et al., 2021). 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. While some studies have found that longitudinal effects of instrumental mentoring, including informational support, may predict later academic outcomes or self-efficacy more strongly than social-emotional support (Robnett et al., 2019), to

access a wider range of mentoring behaviors, students would need to request direct contact with mentors through the "Email mentor" function or otherwise find additional mentors. By having interacted with "virtual mentors" and having been exposed to potential questions to ask and an array of mentor opinions, CareerFair.ai users can be expected to be better equipped than before to ask questions of and interact with prospective mentors as well.

Due to the limitation of video-based virtual mentors to respond to a broader range of questions, it is reasonable to ask: when might a mentor who uses a large language model (LLM) conversation agent be appropriate instead? While limited evidence exists for the quality of LLM career information, some students are already seeking assistance of LLMs such as ChatGPT, Gemini, Claude, or Copilot. When considering these general-purpose tools, their strengths are probably complementary to CareerFair.ai. Retrieval-augmented generation (RAG), particularly with high quality web search such as Google Gemini, should help students ask questions about recent trends and opportunities, which pre-recorded mentors could not known. In terms of accuracy, these both have strengths: CareerFair.ai mentors offer accurate career advise but specific details may slowly become out-of-date, while a high-quality RAG model should stay updated but individual responses may be inaccurate (e.g., hallucinated, sycophancy) or biased (e.g., trained on data that is not representative of the population) (Perković et al., 2024; IBM Technology, 2023). Specialized uses of LLM and RAG systems should also be useful for interactive career planning conversations that CareerFair.ai does not currently address (e.g., walking backward from a “dream job” into a roadmap of the critical accomplishments to get there).

Thinking into the *very-near* future, innovators may wish to extend video-based virtual mentors with deepfake responses (e.g., RAG, but with a virtual human response). For some roles, such as a virtual teaching assistant, deepfake agents might allow shorter and more personalized responses to student questions (e.g., “As we talked about earlier, ...”). They might allow allow the virtual agent to discuss things that a mentor wrote about (e.g., in a blog or a book) but that they did not record. However, for a virtual career mentor we currently believe that combining real video footage with agent avatars holds substantial risks, regardless of the avatar audio/visual quality. MentorPal virtual mentors capture and convey insights from real-life mentors with experience in and knowledge of their field, so students access personalized information that is already vetted. LLM question-answering or summaries may lose key context or produce inaccurate information. Additionally, role modeling will be less effective if the virtual mentor is perceived as more LLM than human: what is meaningful about an AI talking about its struggles in a college it never attended? Last, co-mingling real and artificial video footage is likely to erode trust in the authenticity of the agents and mentors. As a result, current technology and socio-cultural factors suggest that video-recorded virtual mentors offer an effective approach with distinct advantages versus generative AI. However, general-purpose LLM tools offer complementary capabilities that address other career needs, such as “recent job trends” or “planning out courses for your major.”

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; recommending follow-up resources). 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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Declarations

Competing Interests The authors declare no competing interests.

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