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14. ABSTRACT
The goal of this effort is to improve pre-college students' understanding and interest in Navy-relevant STEM careers, by building a tablet-based app that emulates one-on-one conversations with STEM professionals, so that each student can participate in a natural (voice-input) conversation with virtual humans whose answers are drawn from interviews with a real-life STEM professionals. An intelligent guide (Pal) will coordinate conversations with these virtual characters, helping students learn about STEM fields, career experiences, and job tasks.

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Mentor-Pal: Growing STEM Pipelines with Personalized Dialogs with Virtual STEM Professionals

Final Report (Period 7/1/2016 – 4/30/2019)

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N00014-16-1-2820

Overview

In an ideal world, all students could meet STEM role models as they explore different careers. However, events such as career fairs do not scale well: professionals have limited time and effective mentors are not readily available in all fields. The result is that students' understanding is minimal about what professionals in STEM fields do every day, what education is needed, and even what STEM fields exist. Moreover, since in-person interactions rely on finding people engaged in current STEM careers, students may form career goals for stagnant fields rather than growing fields (e.g., projected workforce needs).

To address this problem, we designed a scalable tablet-based and web-based app that gives students the opportunity to converse with interactive recordings of real-life STEM professionals. These conversational virtual agents will emulate a question-and-answer session with STEM professionals who have Navy ties and who are engaging, enthusiastic, and effective mentors. These interactions will allow students to have a lifelike informational interview with a virtual agent whose responses are directly drawn from a specific real professional's video-recorded interview.

Overall, the MentorPal project has been a strong success in terms of impact and technology advances. All primary goals were completed, including developing a well-accepted system with initial efficacy data. New approaches, methodology, and theory were developed which resulted in 10 peer reviewed publications. Research studies on three distinct use-cases were conducted (private tutoring/mentoring center, STEM fair, and Naval Postgraduate summer camp). Approximately 180 students were reached by MentorPal, and the technology should enable virtual mentoring at scale as a long term outcome. Additionally this technology has been transitioned into an N17 research effort with the Personal Assistant for Life-Long Learning (PAL3), where it will be used to deliver mentoring on career goals, leadership strategies, and family life adjustment.

This report starts with a restatement of the original scientific and technical objectives, followed by a brief description of the major accomplishments which were made toward those objectives. Following this, an extended brief on accomplishments is presented. Finally, the report concludes with a summary of awards won (2), peer reviewed publications (10), project personnel and students trained, and a table outlining the milestones that were accomplished during the project.

Scientific and Technical Objectives (from Original Proposal)

Core Idea: What makes students enthusiastic about a particular career choice? Often the opportunity to interact with a professional who is passionate about his or her career will have a big impact. The goal of this effort is to improve pre-college students' understanding and interest in Navy-relevant STEM careers, by building a tablet-based app that emulates one-on-one conversations with STEM professionals, so that each student can participate in a natural (voice-input) conversation with virtual humans whose answers are drawn from interviews with a real-life STEM professionals. An intelligent guide (PAL3) will coordinate conversations with these virtual characters, helping students learn about different STEM fields, career experiences, and learning/job activities.

Problem Statement: Students' awareness of career opportunities tends to be disproportionately influenced by their social circles and media portrayals of careers. Students, particularly those from historically underrepresented populations, often lack access to role models in STEM careers and knowledge about different STEM careers. In an ideal world, guidance counselors and teachers could organize events where students could meet STEM role models and try out examples of career tasks. However, events such as career fairs do not scale well: professionals have limited time, effective mentors are not readily available in all fields, and those who volunteer will tend to be connected to the school (e.g., parents, friends of staff). As such, the students who need these types of experiences most will be the least likely to receive them. The result is that students' understanding about what professionals in STEM fields do on a day-to-day basis, what education is needed, and even what STEM fields exist is minimal (Bieber et al., 2005). Moreover, since in-person interactions are based on availability of role models rather than expected demand (e.g., projected Navy or U.S. economy needs) for jobs, students may form career goals for stagnant fields rather than growing fields. Together, these barriers prevent many students from entering STEM, since students' opportunities are impacted by their career goals as early as high school (Wang, 2013). These systemic problems have ripple effects that reduce the STEM skills for Navy recruits.

Proposed Solution: We propose to create a scalable tablet-based app that gives students the opportunity to interact with a variety of STEM professionals from different fields and backgrounds. We plan to do this by building conversational virtual agents that emulate a question-and-answer session between students and STEM professionals who have current or prior Navy ties and are engaging, enthusiastic, and effective mentors. These interactions will allow students to have a life-like informational interview with a virtual agent whose responses are directly drawn from an interview with a real-life professional in that field. At least in real-life contexts, such interactions are known to be effective for increasing motivation, engagement, and career self-efficacy (Herman, 2010).

Our proposed research will design simulated characters that support such interactions and evaluate their effectiveness. These agents will be designed using USC-ICT technologies that have been used to record the narratives of Holocaust survivors and present them in an interactive, conversational style. We have found that the conversational interaction can be so compelling that people forget that they are talking to a virtual character (Swartout et al., 2006; Traum et al., 2015). While such agents have previously been used as virtual coaches, it has not yet been attempted to model career counseling agents that are based on individual STEM professionals (a

key innovation of this project). To help ground students' understanding of STEM fields, each agent will be complemented with a variety of resources. These resources will include: example tasks for the student to attempt (e.g., diagnosing a circuit fault in electronics), videos of on-the-job performance, example resumes from that field, and statistics about salaries and growth in demand. These resources will be coordinated and personalized to each learner by using the Personal Assistant for Life-Long Learning, an intelligent guide to learning resources (PAL3; ONR W911NF-04-D-0005). By building onto the PAL3 platform for Navy life-long learning, Mentor-Pal should also be able to rapidly synchronize with emerging STEM needs for the Navy.

Measures of Success: The high-level goal of this project is to help students find a career that is a good match to their interests and goals. An ideal match should have a high congruence between a student's goals, the realities of a career, and the needs of society for such careers (e.g., key Navy and national needs). Since students have different interests and skill-sets, the goal is not that every student should be interested in a given field: instead, the goal is to increase students' understanding, curiosity, and confidence with respect to STEM careers (e.g., shifting from ambivalence or career daydreams toward aspirations or decisions). The impact of our intervention on students would be evaluated through a series of studies with high-school students. Specifically, this intervention is expected to improve three key outcomes:

1. Maturity and decidedness of plans toward specific STEM careers,
2. Motivation toward STEM careers, and
3. Self-efficacy with respect to STEM careers.

In Year 1 and into Year 2, small-scale trials for Navy-relevant STEM domains (starting with Electronic Technicians) would be conducted at K-12 sites in Southern California close to the researchers, to enable collection of observational and talk-aloud feedback from students. Assuming positive initial results, Year 2 would focus on scaling up to 4 STEM fields represented (i.e., modeling additional mentors who specialize in other key Navy needs). Year 3 would focus on increasing the number of users by transitioning to a broader set of educational institutions. The goal for Y3 is to support testing and transition to encouraging sustainable use by institutions invested in STEM learning (e.g., STEM internship programs such as those at the Naval Postgraduate School, the Naval Academy Alumni Mentoring Program, or NROTC use).

Summary of Major Accomplishments

1. ***MentorPal Prototype***: A working prototype was developed which could present virtual mentors to students, based on virtual human technology and advances in natural language processing. This system was well-accepted by students and was able to deliver engaging and relevant information about STEM careers.

2. ***MentorPanel Prototype***: Based on feedback and testing with students, a mentoring system which enables asking questions from a panel of mentors was developed. This system was preferred by students and represents a new genre for virtual agent mentoring which is likely to be superior in terms of helping a student find a mentor whose experience is relevant to their own.

3. ***Natural Language Dialog Systems (NLP):*** This work explored different types of dialog systems to deliver virtual mentoring. Specifically, research was conducted on neural networks to classify topics, metrics-based reduction of semantic space models (e.g., Word2Vec) to enable on-device natural language processing for mobile devices, and dialog strategies to handle uncertain question classifications gracefully (e.g., redirecting the user to another question).

4. ***Scalability Analysis & Mentor Pipeline:*** In addition to the research on the system itself, research was conducted to iteratively speed up the process of making each subsequent mentor, starting at nearly 6 months for the first mentor to under 6 weeks for the last mentor. Time and effort estimates were conducted for different phases of the process, as well as research looking at the ways that each stage could be optimized.

5. ***Research Studies:*** Data on the system was collected from three distinct populations about MentorPal, including a private mentoring and tutoring center, a STEM career fair, and a Naval Postgraduate Summer program. The formative research studies found solid results for user acceptance and value, and resulted in substantial improvements across each iteration. The efficacy study results showed increased interest in STEM careers and in military careers, as well as some gains in career confidence for specific domains. Overall, the results are promising and further research is warranted on impact at scale.

6. ***STEM Outreach Impact:*** Despite substantial initial technical development requirements, the research program reached a substantial number of students. Due to the students and parents who participated at the open career fair, the numbers cannot be stated exactly. Our headcount estimates placed the number of visitors at over 100, with the minimum bound as 80 students. As such, the total number of students to benefit from MentorPal was between 155 to 175. In addition, an estimated 50 parents engaged with MentorPal and we trained 6 undergraduates, 2 graduate students, and 3 visiting West Point cadets on AI, Machine Learning, and production of virtual mentors.

7. ***Research Impact and Recognition:*** The MentorPal project won two awards. The first was an annual *eLearning! 100 Award*, which recognizes excellence and innovation in learning technologies. The second was a Best Paper Award for the *System Lifecycle and Technologies* track at the *2018 SISO Fall Simulation Innovation Workshop*. It was also nominated for a best track paper at *I/ITSEC 2017*. Additionally, this research has resulted in 10 peer-reviewed publications, 2 additional refereed presentations (a poster and a long-form talk), and it has been invited to participate in an a special issue on Virtual Humans in Learning for a highly-ranked journal.

Expanded Accomplishments

This ONR-sponsored work has produced a MentorPal prototype and a pipeline process for creating mentors (Nye et al., 2017). Two types of results have been analyzed for MentorPal: effectiveness and scalability. Metrics of effectiveness and user acceptance of the virtual mentors are derived from user studies and application of MentorPal. Scalability analyses estimate the effort required to build a virtual mentor, in terms of effort and expertise.

MentorPal Design: MentorPal development produced a functional prototype relatively quickly (i.e., less than one year). This first design relied on an ensemble dialog model which included both NPCEditor (Traum et al., 2015) and a neural network classifier to match student free-text questions to effective answers (Nye et al., 2017). This more robust model was required due to the relatively small number of questions recorded for a mentor (<500) when compared to the more comprehensive NDT agents (>1500). MentorPal's initial version supported one-on-one conversations, where the user can either speak their questions, type their questions, or hit topic buttons to see suggestions for possible questions. While this mentor fit the basic criteria for the MentorPal project, opportunities to extend the system were quickly identified and implemented.

Two key advances were implemented that were not originally proposed in the MentorPal project. First, a "MentorPanel" was developed where a user could ask a single question but hear responses from up to four different mentors, as shown in Fig. 2 (Beck et al., 2018). This feature was inspired by the US Naval Academy Alumni Mentoring Program (AMP), which noted that when officers are considering major career decisions, AMP attempts to get four mentors: two who made each choice (e.g., separating vs. staying in the Navy), where one was happy with their decision and one was less satisfied. The MentorPanel enables this kind of compare and contrast functionality between different choices or different careers. Since the MentorPanel also includes a "lock" button for one-on-one conversation, the panel has been preferred overall by students.

The second major advance was the development of an initial web-based version of MentorPal, which was possible due to an NSF Research Experiences for Undergraduates (REU) grant at ICT which was running during the same time. Through the efforts by a particularly dedicated student, with support from the team, a version of the one-on-one virtual mentoring experience is currently hosted at MentorPal.org. This version currently contains only the neural network classifier, which is less effective than the ensemble with NPCEditor, though recent optimizations have been found to improve that performance and have been deployed to the server that make them about similar in performance from the user experience.

As with the local MentorPal system, the web-based version can support voice input, text input, and can generate suggested questions through topic buttons. MentorPal uses responsive web design, so it works on both desktop and mobile screens (see Fig. 3 for mobile). This use-case was strongly influenced by discussions with SPAWAR Atlantic's STEM Outreach team, which indicated web delivery was essential for reaching rural populations. MentorStudio will build up from the current web-based prototype, adding new capabilities for recording, revising, sharing, and delivering mentors.

Fig. 2: MentorPanel Interface

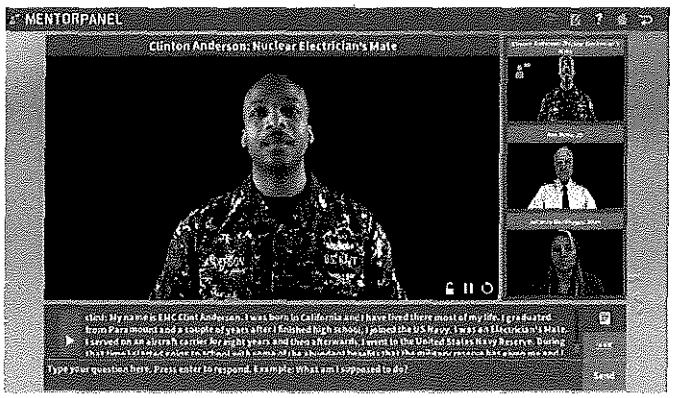
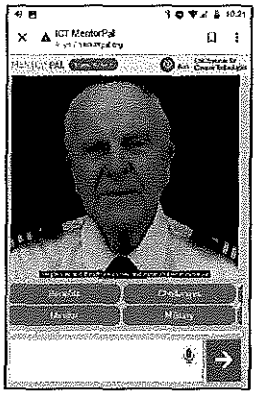


Fig. 3: MentorPal for Web (Mobile)



MentorPal Metrics and Evaluation Results: This work included two distinct phases: usability studies and efficacy studies. Due to a combination of new opportunities as well as logistical constraints, the total amount of participants to use MentorPal was higher than originally proposed but the mechanisms for controlled data collection were different. Total number of users was higher, due to identifying a STEM career fair (EngX, see Fig. 4) where a large number of students (80+) were able to interact with MentorPal (Beck et al., 2018). Differences in the data collection were primarily due to mentoring partner needs for shorter interventions, which was reflected in greater use of brief interviews and limiting the use of surveys during usability trials (full surveys were still used for pilot study data collection). Second, randomized assignment to conditions was not desired by tutoring centers (since this would exclude some students), so within-subjects pre-post comparisons were used, as opposed to the between-group studies.

Fig. 4: EngX Career Fair

Fig. 5: EngX Usability Straw Poll (N=44)

Please Circle the number that best describes how you feel.	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1. I think or worry about my future life almost every day.	4	5	22	6	7
2. Having easy access to better career advice would be useful.	0	0	17	18	9
3. I liked the on-line mentors and learned from them.	0	0	7	26	11
4. The mentor's answers were on-target and useful.	0	0	18	16	10
5. The responses seemed "conversational" and real.	0	0	10	15	19

Reactions from students have been consistently positive, with occasional constructive critique (e.g., "it repeated the same answer"). Feedback from usability studies was addressed through revisions. The main unresolved requests were for mentors in additional fields, either in STEM (biotechnology) or other careers (e.g., singing). The EngX fair had the largest number of users (between 80-100) and a snapshot of reactions from responses to an in-vivo poll are noted below in Fig. 5. These results are solidly positive about the usefulness, likeability, usefulness, and conversationalness of the mentors (questions 2-4). Results from efficacy studies were equally promising. A sample of 31 high school students attending STEM internships at the Naval

Postgraduate School interacted with MentorPal for 25-30 minutes and completed a pre-survey and a post-survey. Usability results from efficacy studies are shown in Fig. 6. Overall, students found the system easy to use and reported that it both improved their knowledge and slightly improved their confidence about careers. They also strongly felt MentorPal was a good idea.

Fig. 6. Efficacy Study Post-Survey Usability Results (1-Strongly Disagree to 6-Strongly Agree).

Usability Survey Construct / Question (Average of N=31)	**Rating**
Ease of Use ("I found MentorPal easy to use.", "Interacting with MentorPal was clear and easy to understand.")	4.6
Improves Knowledge ("Using MentorPal will help me learn about careers more quickly.", "I think MentorPal will improve my knowledge about careers.")	4.4
Improve Confidence ("Using MentorPal will increase my confidence in careers." "MentorPal will help me be more confident about careers.")	4.0
Good Idea ("Using MentorPal is a good idea.")	4.8
Increased Interest ("MentorPal made me more interested in certain careers.")	3.7

Changes in interest for careers across pre-post measures were more equivocal. Interest in STEM careers increased overall (+0.13; $p=0.08$) as did interest in military careers (+0.19; $p=0.06$) but these differences were relatively small. On specific careers, MentorPal showed the expected results, which was more polarized opinions toward less-familiar careers (supercomputing, logistics).There was a slight trend toward greater interest in supercomputers (+0.1; $p=0.13$) and a significant decrease in interest in logistics (-0.42; $p<0.01$). These students were generally familiar with the other STEM careers (CS, EE), as they were in the final weeks of internships at NPS. The decreased interest in logistics was somewhat expected for this population, since they were primarily interested in traditional math/science rather than more hands-on careers.

As proposed, we also worked with the developer of the CAPA Career Confidence Inventory to create a reduced item set which enabled measuring elements of confidence and interest in specific tasks relevant to different career types in the RIASEC set (Betz & Borgen, 2010). For this sample size, the results are not yet conclusive, but there appear to be some indications that Individual Engagement increased (+0.72; $p<0.01$), attitudes toward Realistic careers increased (+0.5; $p<0.01$), and that attitudes toward Enterprising careers such as sales decreased (-0.91; $p<0.01$). Based on results thus far, we feel confident that students feel that MentorPal is valuable for learning about careers and also see small shifts for pre-post results of career attitudes. A broader sample of users is required to better understand its efficacy, since students who have less familiarity with STEM careers will likely show a greater change in career attitudes.

Scalability Estimates + Projection: During the Mentor development process, estimates of time for different stages of development were recorded. Figure 7 shows estimates of our per-mentor content development time for the final mentor (the most efficient), as compared to what we estimate would be possible in MentorStudio. Rough estimates showed a floor of approximately 145h for the final mentor (the most efficient one) in MentorPal. In practice, at least two researchers attended each recording session to help identify follow-up questions and understand how to improve the process, which meant closer to 175h-200h/mentor.

Figure 7: Estimated Hours to Develop an Additional Virtual Mentor

Development Step	Estimated Hours (Final Mentor)	Projected Hours (Optimized Tools)
Create questions that are specific to a career or mentor	15*	5
Video recording of the Mentor (360 - 400 questions)	18	18
Video postproduction (e.g., sound, lighting levels, marking timestamps to split video into clips)	16†	2
Clean up automated transcripts	36*	15
Revise mentor content based on real student questions	25*	15
Administrative effort (scheduling, setup for 6 sessions)	15	15
Total (Self-Recorded Mentor)	**125**	**70**
Total (One Interviewer +20h)	**145**	**90**
Total (Two Interviewers + 40h)	**165**	**110**

**Steps with an asterisk required AI or CS skills, while those cross† required audio-video expertise.*

This analysis showed us two areas to improve efficiency: reducing expertise and automated tools. Expertise levels are important for cost, due to hourly rates. For example, 200h of a talented student worker ($20/h) would be $4k in direct costs, while 200h of an expert AI consultant ($100/h) would be $20k. As such, large cost savings can be gained by replacing expert researcher time with student or non-expert staff time. Secondly, many time costs could be cut in half with better tools or automation. As shown in Fig. 7, the greatest estimated time-savings are automating conducting the interview (+20h), generating mentor-specific questions (+10h), video postproduction (+14h), and cleaning up transcripts (+21h). In ideal conditions, we estimate the hours to create a mentor could drop from 145h for MentorPal to either 90h (interview) or 70h (self-recorded). We could also eliminate the need for specialized AI or video production knowledge. At present, comparable virtual agents tend to cost $100k-300k to develop.

We believe that an online studio for this could reduce the cost to <10% of such custom mentors. While qualitatively different uses may still require research-created mentors (e.g., mentors for health issues, such as suicidality), the proposed work can make virtual mentors widely accessible. Some of these steps can be directly automated, such as video postproduction (e.g., normalization, splitting up clips). However, others require additional AI tools. For example, self-recorded mentors will need help to identify follow-ups questions, which are hard to do alone due to expert blind spots.

Awards and Honors

- *ELearning! 100 Award Winner* (2018). MentorPal. Award presented in Orlando, FL.

- *Best Paper Award at SISO – SIW 2018 in the System Lifecycle and Technologies Track*, for Davis et al., (2018), Enhancing Menteeship: Improving Career Selection for Potential DoD Personnel.

Publications

1. Nye, B., Swartout, W., Campbell, J., Krishnamachari, M., Kaimakis, N. and Davis, D. (2017). MentorPal: Interactive Virtual Mentors Based on Real -Life STEM Professionals . in the Proceedings of the *Interservice/Industry Simulation, Training and Education Conference*, Orlando, Florida

2. Davis, D.M., Kaimakis, N.J. & Spaulding, H. (2018). Critical Thinking Training: Proven New Technologies for Engaging DoD Personnel. In the Proceedings of the *ModSim World Conference*, Norfolk, Virginia.

3. Kaimakis, N.J., Davis, D.M., Breck, S. & Nye, B.D. (2018). Domain-Specific Reduction of Language Model Databases: Overcoming Chatbot Implementation Obstacles. In the Proceedings of the *ModSim World Conference* , Norfolk, Virginia.

4. Burns, D.P., Davis, D.M. & Nordhagen, J. N. (2018). Systems Engineering: Optimizing Creation of Virtual Conversational Human. In the Proceedings of the *ModSim World Conference* , Norfolk, Virginia.

5. Beck, S., Carr, K., Davis, D. M., Nordhagen, J. N., and Nye, B. D. (2018). Virtual Mentors in a Real STEM Fair: Experiences, Challenges, and Opportunities .In the *AIED 2018 Third International Workshop on Intelligent Mentoring Systems (IMS 2018).*

6. Davis, D. M., Predovich, K.B., Stassi, F.J., Spaulding, H., Shaw, K & Nye, B.D. (2018). Enhancing Menteeship: Improving Career Selection for Potential DoD Personnel. In the Proceedings of the *SISO Fall Simulation Innovation Workshop*, Orlando, Florida:SISO.

7. Davis, M.C., Stassi, F.J. & Davis, D.M.. (2018). Innovative Education Technologies: Optimizing Future Information Comprehension Capabilities. In the Proceedings of the *SISO Fall Simulation Innovation Workshop*, Orlando, Florida:SISO

8. Yao, K-T., Davis, D. M., Liu, J. J., & Kaimakis, N. J. (2018). New Technologies to Enhance Computer Generated Interactive Virtual Humans. In the Proceedings of *the SISO Fall Simulation Innovation Workshop*, Orlando, Florida:SISO

9. Davis, M. C., Young, N.L.H. & Davis, D. M. (2019). "Enhancements for Homeschooling and ADL: Virtual Humans, Technologies and Insights". In the Proceedings of *the ModSim World Conference*, Norfolk, Virginia.

10. Davis, D.M., Phelps, C. L. & Stassi, F. Y. (2019). "Pedagogical Tools to Enhance Analytic Skills: Interactive Virtual Tutorial Environments ". In the Proceedings of *the ModSim World Conference*, Norfolk, Virginia.

Other Presentations, and Press

1. Nye, B.D. (2018). Continuity and Engagement in an Open Ecosystem: Challenges and Approaches, In the Proceedings of *iFEST, Innovation, Instruction & Implementation, Federal eLearning Science and Technology*. Arlington Virginia, August, 2018.

2. Davis, M.C. & Davis, D.M. (2018). Identifying Shortcomings in Data Comprehension: Advanced Technology for E-Learning Enhancement. Poster session presented at *iFEST,*

Innovation, Instruction & Implementation, Federal eLearning Science and Technology, Arlington Virginia, August, 2018. Featured live demonstration of MentorPal.

Project Personnel

Leadership:

Benjamin D. Nye, PhD (PI) - Director of Learning Sciences

William Swartout, PhD (co-PI) – ICT Chief Technical Officer

Julia Campbell, EdD - Research Scientist

Milton Rosenberg - Special Projects Manger

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Larry Kirchner – Senior Developer

Kayla Carr – Junior Developer

David Cobbins – Content Developer

Mark G. Core, Ph.D. – Natural Language Processing Researcher

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(Listed in order of project service duration)

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Madhusudhan Krishnamachari

Samuel Breck

Gaurav Bose

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Vivian Liu (University of California, Berkeley)

Kenny Shaw (Georgia Tech)

Mohammad Sanad Rizvi (Nat'l Inst. of Engr., Mysore)

ICT Consultant:

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Mentors:

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Dan Davis, CDR, USN-Ret, Consultant, USC

Julianne Nordhagen, ENS, USN, Pilot Training, NAS Pensacola

Carlos Rios, SPAWAR-SYSCEN

Project Schedule and Milestones

The total period of performance was 7/1/2016 – 4/30/2019, where the end date was extended through a no-cost extension from 12/31/2019 to enable further technical development and explore additional data collection opportunities. Unfortunately, due to scheduling, no additional remote sites had data collected during the extension period. Key accomplishments planned for each quarterly milestone for this effort are noted in the following table. These milestones were largely achieved on schedule, thanks to the hard work of many different researchers and a number of particularly talented students who were training on the project. In terms of scope of the project, technical accomplishments exceeded the planned milestones: with a web-based version implemented and a MentorPanel implemented. In terms of studies completed and students reached for STEM impact, a greater total number of students were reached than proposed but a lower number than expected participated in the final remote site study. Research on mentor development, interviews, analysis, and outreach proceeded according to original parameters.

Table 1: Project Milestones and Planned Achievements.

Milestone	Label	Date	Planned Achievements for this Milestone
1	Y1-Q1	9/30/2016	• Add speech recognition to PAL3 system • Develop interview structure & survey (~750 questions) • Collect structured interview from Mentor 1 • RQ1.1: Quarterly Report Y1-Q1
2	Y1-Q2	12/31/2016	• Complete PAL3 Virtual Mentor Resource Type • Add supporting resources for Mentor 1 • Build & internally test Virtual Mentor 1 Dialog Model • Finalize & confirm Y2 mentors • RQ1.2: Quarterly Report Y1-Q2
3	Y1-Q3	3/31/2017	• Mentor-Pal pre-alpha version ready • Analyze usability test data for Mentor 1 • Follow-up interview(s) for Mentor 1 • IRB for Y2 Small-Scale Evaluation & Site • Start collecting structured interviews for Mentors 2-4 • RQ1.3: Quarterly Report Y1-Q3
4	Y1-Q4	6/30/2017	• Finish collecting structured interviews for Mentors 2-4 • RA1: Annual Report Y1 • RDat1: Annual Naval STEM Program Data Form Y1
5	Y2-Q1	9/30/2017	• Usability testing for Virtual Mentors 1-4 • Follow-up interview(s) for Mentor 1-4 • Mentor-Pal alpha-2 version ready (revise & refine) • RQ2.1: Quarterly Report Y2-Q1

6	Y2-Q2	12/31/2017	• Complete Small-Scale Evaluation • Confirm Remote Site(s) for Evaluation • RQ2.2: Quarterly Report Y2-Q2
7	Y2-Q3	3/31/2018	• Analyze Small-Scale Evaluation • IRB(s) for Remote Site(s) Evaluation • RQ2.3: Quarterly Report Y2-Q3
8	Y2-Q4	6/30/2018	• Mentor-Pal beta version ready (revise & refine) • Main Follow-up Interviews Completed • RA2: Annual Report Y2 • RDat2: Annual Naval STEM Program Data Form Y2
9	Y3-Q1	9/30/2018	• Complete Remote Site Evaluation • Report on Transition Opportunities • RQ1.1: Quarterly Report Y3-Q1
10	Y3-Q2	4/30/2019 (NCE from 12/31/2018)	• Analyze Remote Site Evaluation results • Write Documentation & Training Materials • RFinal: Final Report • RDat3: Annual Naval STEM Program Data Form Y3

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