Changing Students' Lives with Personalized Executive Function Mentoring

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Abstract
Providing individualized supports using the UDL framework can be challenging in standards-driven teacher preparation programs. This paper describes how choice, flexibility, and creativity can lead to effective mentoring of undergraduate STEM majors and address executive function deficits. It describes how education teachers in the Exceptional Education Program at the University of Central Florida, built relationships and mentored undergraduate STEM majors using the UDL framework. While this talk focuses on higher education, lessons learned can be easily transferred to students in middle and high school. The manuscript is based on a recently concluded three-year study with 120 undergraduate STEM majors and their graduate student mentors.

Keywords
Universal Design for Learning, STEM Education, Postsecondary, Executive Function.

INTRODUCTION

Executive function (EF) is critical for careers in science, technology, engineering, and mathematics (STEM). Deficits in executive function inhibit content learning, self-efficacy, and self-determination (Dunn, Shannon, McCullough, Jenda, & Qazi, 2018). To be successful in STEM careers, students need 21st century knowledge and skills including authentic and dynamic problem-solving, collaboration, executive functioning, and critical analysis skills (Schwab, 2016). However, these cognitive and interpersonal skills can be challenging for students with executive function deficits (Koch, 2016).

Executive functions are defined as the process of physical, cognitive, and emotional self-control & self-regulation necessary to maintain an effective goal-directed behavior (Torske et al., 2018). They include working memory, flexibility, emotional control, initiation, planning, organization, and self-control (Diamond, 2013). Executive dysfunction is often associated with neurologic impairments related to the medial frontal cortex (Hsuan-Chen, White, Rees, & Burgess, 2018; Miyake & Friedman, 2012). While this presents a challenge to effective STEM learning and assessment, executive function skill development can be scaffolded by educators and parents. For example, smartphones can provide alerts for students to initiate tasks, transition to a new task, or contact a teammate or mentor (Basham & Marino, 2013). This can assist students, while solving ill-structured problems lacking explicit instructions or rule sets (White, 2013).

A UDL APPROACH TO MENTORING

Graduate students enrolled in a secondary exceptional education methods course served as mentors to undergraduate STEM majors during the study. They participated in virtual course modules on UDL and executive function. After demonstrating mastery of the content, they chose whether they wished to participate in the EF mentoring project. Individual graduate students were assigned to mentor one undergraduate STEM major. Doctoral students working at the Toni Jennings Exceptional Education Institute also provided mentoring for 3 – 5 students each semester. Graduate students employed elements of the UDL framework during their EF mentoring.

RESEARCH DESIGN

Two research questions guided the investigation: (RQ1) Are there differences in performance, as measured by GPA, between students with UDL EF mentoring and those without? (RQ2) Are there differences in STEM persistence, as measured by a change in major from STEM to non-STEM, between students receiving UDL EF mentoring and those without? A mixed-methods, matched pairs experimental design was employed during the project.

SAMPLE

Undergraduate STEM majors completed a 9-question application survey which asked students about the nature of their disability, their major, and what they hoped to gain by participating in the project. Students with executive function deficits (e.g., Autism spectrum disorders, Attention Deficit Disorder, Specific Learning Disabilities) were contacted by one of the project staff. Two hundred and seventy-four undergraduate STEM majors completed the screening and expressed interest in participating in the study. One hundred and twenty students were selected to participate, with 60 in the treatment condition and 60 in control. Project expectations were explained and IRB consent was obtained. The attrition rate for the study was 21%.

INSTRUMENTS

Participants took an electronic version of the Barkley Deficits in Executive Function Scale (BDEFS for adults). The BDEFS for adults is a computer administered standardized test consisting of two executive functioning tasks measuring working memory and inhibitory control. These include the n-back paradigm (i.e., working memory) and the go/no go

task (i.e., executive control). The test is designed to take 20 - 30 minutes to complete. Reported reliability (Cronbach's alpha) ranged from .75 to .98 for factor scores and from .68 to .99 for summary scores. Students' BDEFS scores served as a sorting mechanism for the matched pairs design

Semi-Structured Interviews: The students in the treatment condition participated in semi-structured interviews at the conclusion of the study. Questions focused on academic and social aspects of college life as a STEM major. Broad questions were designed to illuminate the institutional, situational, and individual barriers or scaffolds influencing the students' decisions. Specific questions asked students to identify how they engaged in the STEM community and why they chose to persist or withdraw. Students were asked to identify the types of technologies and community supports they find most beneficial when participating in STEM courses.

Post-intervention survey: A 16-item post-intervention survey was developed by the researchers to analyze critical aspects of the iCAN model. Content validity was established using a Delphi process with mentors, professors, experts in STEM fields, and participants (Fletcher & Marchildon, 2014).

PROCEDURE

A protocol was developed and shared with all project mentors to ensure treatment fidelity. Mentors met with students over the course of one semester. Six semesters (i.e., Fall 2015, Spring, 2016, Fall 2016, Spring 2017, Fall 2017, Spring 2018) were included in the study. Mentors shared the BDEFS results with their mentees. The pairs worked together to collaboratively identify short and long-term goals for the semester. Mentors then developed UDL lessons to teach mentees a skill (e.g., task initiation via prompts from their cellular phones). Mentors spoke with mentees weekly using virtual conferencing software such as Zoom or Adobe. Meeting times and dates were recorded. Meeting times ranged from 90 – 248 minutes per semester. The average number of meetings between mentor and mentees was eight. Mentors created detailed field notes and reported their data to project staff on a biweekly basis or more frequently when requested. Sixty case studies for students in the treatment condition were completed in response to this protocol. Case studies identified EF areas of competence and those in need of bolstering, along with UDL methods for teaching EF skills.

RESULTS

RQ1: STEM Performance - GPA was collected at the conclusion of the spring 2018 semester. An independent-samples t-test was conducted with GPA as the dependent measure and condition (i.e., treatment vs control) as the independent variable. The analysis included 120 participants, 60 in each condition. SPSS Version 25 (2017) software was used during the analysis. There was a significant difference in scores with students in the treatment condition (M=3.23, SD=0.41) outperforming the control (M=2.75, SD=1.18) condition; $t(118)= -2.94$, $p = .004$.

RQ2: STEM Persistence – STEM persistence was established through an examination of the unofficial student transcripts at the conclusion of the spring semester in 2018. Again, 120 participants were compared across the treatment (n=60) and control groups (n=60). Despite several of the students in the treatment condition reporting they might change majors, none did. There was a statistically significant difference in the number of students with disabilities who changed majors with students in the treatment condition (M=1.0, SD = 0.00) out-performing those in the control (M=1.13, SD= 0.34); $t(118) = 3.01$, $p = .003$. The percentage of students who changed majors in the treatment group was 0%, while students in the control condition changed to a major outside of STEM approximately 8% of the time.

Analysis of the 60 case studies and post-intervention surveys allowed the project team to identify which UDL supports and mentoring strategies were most effective for STEM majors. These are presented in Table 1 & 2. STEM majors reported the use of digital reminders and calendars as critical to their success followed by speech-to-text and note-taking software.

Table 1. Ten most effective UDL strategies for EF.

Short and long-term goal setting
Study groups and sessions (effective communication)
Assistive Technology (text-to-speech; speech-to-text)
Visual scheduling (Gantt chart/JIRA/Basecamp)
Writing support center
Create a schedule (digital calendar / planner / reminders)
Timer for achieving tasks
Cornell notes
Sit in front of class
Positive self-talk

Table 2. Ten most effective mentoring strategies for EF.

Build trusting relationships
Active listening
Mindfulness
Cognitive reframing
Direct and non-direct questioning
Positive reinforcement
Wait time / patience
Prompting
Humor
Growth Mindset

DISCUSSION

STEM majors reported accessibility services and mentoring from graduate students in the exceptional education methods course were the most beneficial supports they received.

Most students felt face-to-face meetings were most beneficial. This was an unanticipated finding. The project team thought students would prefer virtual meetings in order to add flexibility to the mentoring process. Future research should examine whether this finding was the result of network and software challenges or a belief that face-to-face meetings provide more personalized instruction.

The earliest mentor models from this project relied heavily on virtual conferencing technologies to ensure treatment fidelity and dosage. Some students appreciated this flexibility. Others reported limitations during the video conferencing such as a lack of sound or video feed. These problems were amplified in Fall of 2016 with the effects of Hurricane Matthew and again in 2017 with Hurricane Irma. It became apparent that significant limitations exist with the technologies the students were using and the infrastructure network on which it was being applied. As a result, the project team gave students the choice to have meetings in face-to-face, online, or hybrid settings. Students reported this flexible approach allowed them to maximize their effectiveness in their STEM majors.

Empirical evidence supports the hypothesis that mentoring can enhance executive function skills for individuals with disabilities (e.g., Anastopoulos & King, 2015). Specifically, mentoring has been found to enhanced goal-setting and motivation (Eddy, Canu, Broman-Fulks, & Michael, 2015; Prevatt et al., 2017). Mentoring can increase mindfulness (e.g., Gu, Xu, & Zhu, 2016), and planning (Fleming, McMahon, Moran, Peterson, & Dreessen, 2015). In addition, mentoring can enhance college students' organizational skills (LaCount, Hartung, Shelton, Clapp, & Clapp, 2015). In the current UDL intervention, mentors worked with students weekly in a semi-structured manner to elicit these types of behavior changes.

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