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Individual Development Plan, Mentoring Support, and Career Attitudes among STEM Graduate Students during the COVID-19 Pandemic

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Abstract

The COVID-19 outbreak has severely affected graduate education in science, technology, engineering, and mathematics (STEM) fields. It disrupted the learning and career development including in-person laboratory research activities and mentoring meetings. Since early 2000s, STEM graduate schools have been promoting the use of individual development plans (IDPs), which provide formalized mentorship, to support graduate students' academic and career success. It is unclear whether and to what extent the IDPs play a role in promoting mentoring and career-relevant outcomes among students during the crisis. This study presents some of the first evidence on the interrelationships of IDP status, mentoring support and satisfaction, and career attitudes with a diverse nationwide sample of STEM graduate students during the COVID-19 pandemic.

Keywords: Mentoring, Career Development, Graduate Education

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I. Objectives

In mid-spring 2020, due to the coronavirus disease 2019 (COVID-19) pandemic, thousands of the higher education institutions in the United States (and across the globe) suspended face-to-face classes, closed campuses, and only allowed essential activities and core facilities to continue. The COVID-19 outbreak has severely affected graduate education in science, technology, engineering, and mathematics (STEM) fields at many levels. It disrupted the learning and career development of STEM graduate students whose weekly routine typically includes in-person laboratory research activities and mentoring meetings.

Mentoring is critical to professional development for graduate students, prior to entering the workforce. Since early 2000s, graduate schools in STEM areas have been promoting the use of individual development plans (IDPs), which provide formalized mentorship, to support the academic and career success of graduate students (Clifford, 2002; Hobin, Fuhrmann, Lindstaedt, & Clifford, 2012). Previous studies have consistently shown that IDPs could be useful and effective for enhancing professional development of STEM graduate students, especially by fostering positive mentee-mentor relationships (e.g., Hobin et al., 2014; Vanderford et al., 2018). It is unclear, however, whether and to what extent did IDPs play a role in promoting mentoring and career-relevant outcomes among students in the time of crisis. This study presents some of the first evidence on the interrelationships of IDP status, mentoring support and satisfaction, and career attitudes with a diverse nationwide sample of STEM graduate students during the COVID-19 pandemic.

II. Theoretical Perspectives and Relevant Literature

The idea of the Individual Development Plan (IDP) was introduced in education in early 1970s (Foster & Foster, 1973). The IDP is a career planning tool that aims to promote mentor-mentee interactions and discussions that support mentees in self-assessing skills, exploring career paths, identifying career goals, and developing action plans to achieve those goals (Clifford, 2002; Hobin et al., 2012; Hobin et al., 2014; Vanderford et al., 2018; Thompson et al., 2020). In 2002, the U.S. Federation of American Societies for Experimental Biology (FASEB) started to popularize the concept of IDP in pre- and postdoctoral training programs. In 2014, the National Institutes of Health (NIH) launched a new policy expanding the use of IDPs by requiring the reporting of the IDP usage by graduate students and postdoctoral researchers in grant progress reports (NIH, 2014). A growing body of evidence has suggested that IDPs help facilitate

better mentor-mentee communication that can supports mentees in identifying their skills and knowledge, creating action plans, and pursuing their career goals and paths (Davis, 2009; Gould, 2017; Vincent et al., 2015). In this study (see Figure 1 for our theoretical model), we hypothesize that during the COVID-19 pandemic:

Hypothesis 1A: The frequency of mentor-mentee interactions is greater among STEM graduate students with an IDP

Hypothesis 1B: The level of perceived mentoring support is higher for STEM graduate students with an IDP

Hypothesis 1C: The level of positive career attitudes is higher for STEM graduate students with an IDP

While the IDP could be a useful career planning tool for STEM graduate students, its benefits on professional development of mentees are limited in the absence of strong mentoring support. In the literature on vocational psychology and career development, a well-established Mentoring Input-Process-Outcome (MIPO) model posits that background characteristics of the mentee, mentor, or both (i.e., Inputs) are likely to affect the interaction and quality of mentoring (i.e., Processes), which is in turn expected to influence mentee outcomes (i.e., Outcomes; Curtin et al., 2016; Eby et al., 2013). Several meta-analytic reviews analyzing empirical studies on mentoring suggested that the frequency of mentor-mentee interaction and perceptions of mentoring support—both instrumental and psychosocial support—relate to mentoring satisfaction, which in turn link to a wide range of mentee outcomes (Allen et al., 2004; DuBois et al., 2002; Eby et al. 2013; Underhill, 2006). In this study, we hypothesize that during the COVID-19 pandemic:

Hypothesis 2A: The frequency of mentor-mentee interactions is positively related to mentoring satisfaction among STEM graduate students

Hypothesis 2B: Perceived mentoring support is positively associated with mentoring satisfaction among STEM graduate students

Hypothesis 2C: Mentoring satisfaction positively predict career optimism among STEM graduate students

III. Data/Methods

Data/Sample. This study designed and administered a 12-15 minutes questionnaire through an online survey platform—Qualtrics—on June 3-22, 2020. Survey invitations were emailed to the STEM graduates through deans and associate deans from colleges of engineering and science across the country. Informed consent from participants was obtained electronically prior to their participation in the survey. The

final analytic sample comprised 755 STEM graduate students from 51 institutions in 26 states, who reported having at least one mentor/advisor on campus in the spring of 2020. Of the total sample, 55.9 % were master's students, and 44.1 % were doctoral students. Nearly half (48.9%) identified as male, 45.0% identified as female, and 6.1% identified as transgender, genderqueer, gender-non-conforming, other genders, or did not report. With respect to race/ethnicity, 56.8% identified as non-Hispanic White, 31.3% were non-Hispanic Asian, 10.3% were Hispanic/Latinx, 3.4% were non-Hispanic Black, 3.4% were non-Hispanic multirace, 0.3% were non-Hispanic Native American, and 5.8% were other race/ethnicity or did not report. Approximately two-thirds of the respondents (64.6%) were U.S. citizens or permanent residents. Regarding the mentoring experience, 73.5% of respondents reported that their primary mentors were academic advisors or thesis/dissertation chairs, 13.8% were other faculty members, 5.2% were senior graduate students, 2.4% were staff members, and 5.1% were others. Among the respondents, 29.5% utilized the IDP with their mentors.

Measures. Our online survey collected an array of measures on students' IDP status, interaction frequency, perceptions, and satisfaction of mentoring, and career attitudes, in addition to individual demographic information. Table 1 reports descriptive statistics for all the variables.

Students reported having completed an IDP with their mentor were identified as students with an IDP, which is the focal group in this study. Three key mentoring measures are: mentoring interaction frequency, perceived instrumental support, and perceived psychosocial support. Students were asked to compare the changes in interaction frequency with their primary mentor via face-to face, video conferencing, email, phone, and social media, before and after the COVID-19 outbreak. The options include much less hours (-2), less hours (-1), about the same hours (0), more hours (1), and much more hours (2). The total changes in interaction frequency from in-person and virtual ways were defined as changes in mentoring interaction frequency during the pandemic. Perceived instrumental support and perceived psychosocial support were respectively measured by two sets of four indicators (shown in Table 1; Marie Taylor & Neimeyer, 2009; Ortiz-Walters & Gilson, 2005; Tenenbaum et al., 2001). Based on the experience before and during the pandemic, students rated a variety of supports from their primary mentor on a 5-point Likert scale ranging from 1 ("much less support") to 5 ("much more support"). The Cronbach's alphas for perceived instrumental support and perceived psychosocial support are .85 and .89, respectively. Mentoring satisfaction was assessed with a single item (i.e., "How satisfied were you with the support you received from your PRIMARY MENTOR during this past spring 2020 semester?"), and response options ranged from 1 ("extremely dissatisfied") to 9 ("extremely satisfied").

Two career attitudinal outcomes examined in this study are career optimism and job search self-efficacy. Career optimism, referring to the tendency for students to expect the best career outcome or to emphasize positive aspects of their career since the COVID-19 outbreak, was measured by two items (shown in Table 1) on a scale from 1 ("strongly disagree") to 5 ("strongly agree"; Rottinghaus et al., 2005). The Cronbach's alpha is .85. Job search self-efficacy during the COVID-19 outbreak was measured by three items (listed in Table 1). Based on the impact of the COVID-19 outbreak, students rated these three items on a 5-point Likert scale from 1 ("much less confidence") to 5 ("much more confidence"; Manuti, 2012). The Cronbach's alpha is .91.

Several demographic variables were included as covariates in our models, including gender, race/ethnicity, socioeconomic status (SES), disability status, citizenship status, age, and degree level (see Table 1). The MacArthur Scale of Subjective Social Status (Adler et al., 2000) was used to measure student's SES. Students were given an image of a ladder with ten rungs to choose from 1-10 that best describes their SES. Ten stands for people who have the most money, most education, and best jobs, while one represents people who have the least money, least education, and worst jobs or no job.

Analytic Strategy. To test the theoretical model (Figure 1) and hypotheses of this study, structural equation modeling (SEM) was employed. SEM allows for identifying the interrelationships among observed and latent variables simultaneously, while accounting for the measurement errors of observed items. The analysis was conducted in Mplus 8.4 using the weighted least square mean and variance (WLSMV) estimator, given the IDP status is the binary outcome predicted by the covariates. In the estimations for mentoring frequency, instrumental support, psychosocial support, career optimism, and job search self-efficacy, our SEM model also controlled for the demographic covariates listed in Table 1. Missing data ranged from zero to a high of 8.08% for Mentoring Satisfaction. We used the full information maximum likelihood (FIML) approach to handle the missing data and improve the estimation (Mazza et al., 2015).

IV. Results

The theoretical model in SEM showed a good fit with the data, RMSEA = .035, CFI= .955, and SRMR = .067. Figure 2 presents the SEM results with statistically significant paths (solid lines), and the standardized coefficients are also denoted along with the paths. Overall, most hypotheses of this study were fully or partially supported. Specifically, compared with their peers without an IDP, students with an IDP reported interacting with their mentor more frequently (H1A) and receiving a higher level of instrumental support from their primary mentor (H1B) during the COVID-19 pandemic. However, IDP was not statistically predictive of psychosocial support from primary

mentor (H1B) and career attitudes, as measured by career optimism and job search self-efficacy (H1C), during the COVID-19 crisis.

Furthermore, our data reveal that both instrumental and psychosocial support from mentors were positively related to mentoring satisfaction (H2B), which in turn positively predicted students' career optimism and job search self-efficacy (H2C) during the COVID-19 pandemic. Although mentoring interaction frequency was not statistically significantly associated with mentoring satisfaction (H2A), it was positively correlated with the other two critical mentoring factors—instrumental support and psychosocial support—during the COVID-19 crisis.

V. Significance of the Study

This study makes several theoretical, methodological, and practical contributions to the literature on IDP, mentoring, career development, graduate STEM education, and crisis responses. At the theoretical level, it builds upon the literature on vocational psychology and career development to develop a novel theoretical framework that links IDP, mentoring support, and career attitudes. Our comprehensive, theory-driven model was largely supported by the empirical evidence. At the methodological level, this study is one of the first to measure and analyze the linkages of the IDP usage with various dimensions of mentoring and career attitudes with a diverse, nationwide sample of STEM graduate students. Our findings have greater generalizability, improving on most prior work on IDP and mentoring that relied largely on a small sample from a single program or institution (see review by Hernandez, 2018). At the practical level, this study offers robust theoretical perspectives and empirical evidence indicating that IDP could be useful in promoting mentoring interaction and support, which in turn enhance career-relevant outcomes of STEM graduate students, especially in the time of crisis such as the COVID-19 pandemic.

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Table 1. Summary Statistics for STEM Graduate Students (*n* = 755)

Variables	Mean	S.D.	Min.	Max.	Miss. (%)
Individual Development Plan (IDP)	0.30	0.46	0.00	1.00	0.00
Mentoring frequency					
Face-to-face	-1.19	1.01	-2.00	2.00	1.32
Video conferencing	0.60	1.26	-2.00	2.00	1.06
Email	0.19	0.91	-2.00	2.00	1.19
Phone	-0.03	0.85	-2.00	2.00	1.32
Social media	-0.14	0.70	-2.00	2.00	1.19
Instrumental support					
Finish my assignments/projects	0.06	0.78	-2.00	2.00	1.99
Improve my writing skills	-0.03	0.76	-2.00	2.00	2.65
Prepare for my presentations	-0.05	0.77	-2.00	2.00	2.52
Explore my career options	-0.09	0.79	-2.00	2.00	2.52
Psychosocial support					
Discuss my concerns about academic projects	0.15	0.80	-2.00	2.00	2.65
Pursue my learning interests	0.02	0.73	-2.00	2.00	3.18
Work toward my career goals	0.02	0.75	-2.00	2.00	2.78
Talk about my anxiety in career outlook	0.00	0.84	-2.00	2.00	3.31
Mentoring satisfaction	7.06	2.13	1.00	9.00	8.08
Career Attitudes					
Career optimism					
More excited when I think about my career	2.65	1.03	1.00	5.00	0.26
More eager to pursue my career dreams	2.97	1.08	1.00	5.00	0.26
Job search self-efficacy – "Finding a job…"					
For which I am qualified	-0.56	0.85	-2.00	2.00	0.26
In a company/institution that I prefer	-0.67	0.88	-2.00	2.00	0.53
For which I am prepared	-0.46	0.84	-2.00	2.00	0.53
Demographics (Covariates)					
Male*	0.49	0.50	0.00	1.00	0.00
Female	0.45	0.50	0.00	1.00	0.00
Other gender/did not report – gender	0.06	0.24	0.00	1.00	0.00
White*	0.45	0.50	0.00	1.00	0.00
Asian	0.31	0.46	0.00	1.00	0.00
Black/Hispanic/Native American	0.14	0.35	0.00	1.00	0.00
Other race/did not report - race	0.09	0.29	0.00	1.00	0.00
Socioeconomic status (SES)	6.46	1.73	1.00	10.00	4.90
Non-disabled*	0.82	0.38	0.00	1.00	0.00
Disabled	0.14	0.35	0.00	1.00	0.00
Did not report – disability status	0.04	0.20	0.00	1.00	0.00
US citizen/permanent resident*	0.65	0.48	0.00	1.00	0.00
International student	0.30	0.46	0.00	1.00	0.00
Did not report – citizenship status	0.05	0.22	0.00	1.00	0.00
Age	27.30	5.61	18.00	73.00	4.37
PhD student	0.44	0.50	0.00	1.00	0.00
Master's student*	0.56	0.50	0.00	1.00	0.00

Note. *n* = sample size; S.D. = standard deviation; Min. = minimum; Max. = maximum; Miss. = missing data. * = reference group.

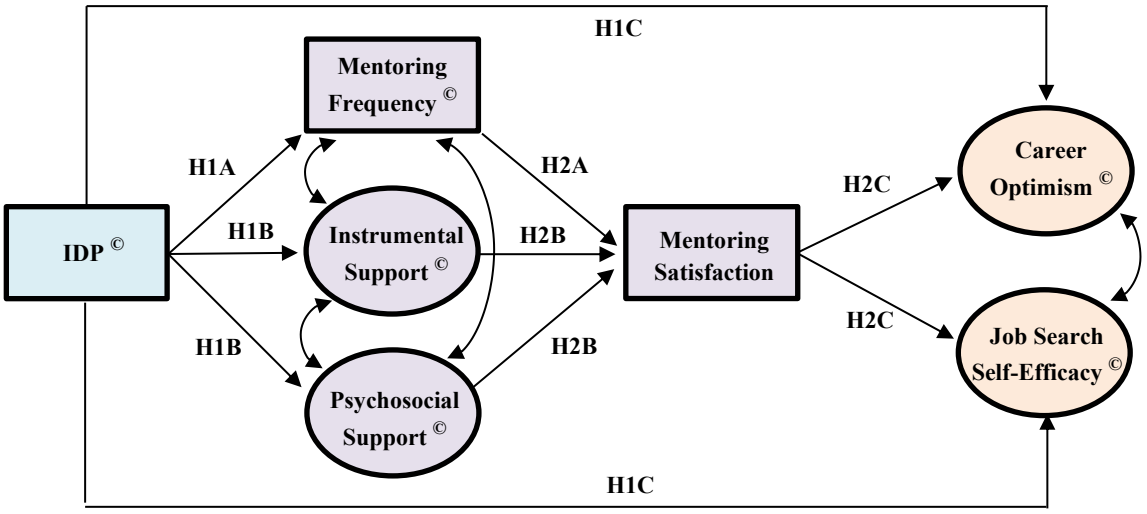

Figure 1. Theoretical Model (and Hypotheses) Linking IDP, Mentoring Support, and Career Attitudes of STEM Graduate Students during the COVID-19 Pandemic

Note. IDP = individual development plan; H = hypothesis. Latent variable = oval; observed variable = rectangle. © = controlled for demographics (see Table 1).

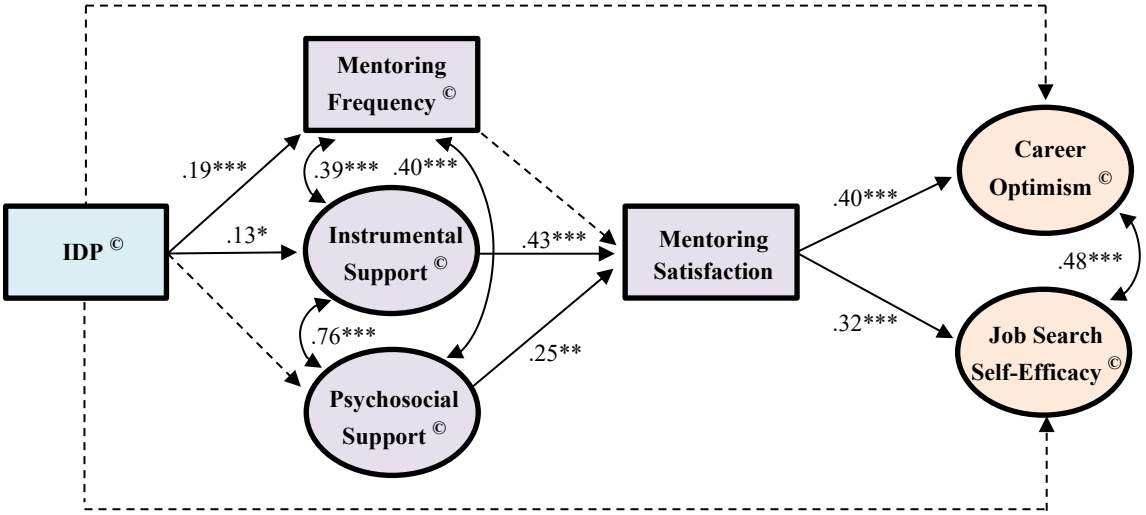

Figure 2. SEM Results of Interrelationships among IDP, Mentoring Support, and Career Attitudes of STEM Graduate Students during the COVID-19 Pandemic

Note. SEM = structural equation modeling; IDP = individual development plan. Latent variable = oval; observed variable = rectangle. © = controlled for demographics (see Table 1). Values are standardized path coefficients. Dashed paths are not statistically significant. For reasons of clarity, all the covariates, factor loadings, and uniquenesses are not shown. All the factor loadings are over .700. R^2 for mentoring frequency = .08**; R^2 for instrumental support = .05*; R^2 for psychosocial support = .03*; R^2 for mentoring satisfaction = .45***; R^2 for career optimism = .25***; R^2 for job search self-efficacy = .21***.
*p<.05, **p<.01, ***p<.001.