Received 05/11/11
Revised 09/22/11
Accepted 10/03/11

Understanding How Peer Mentoring and Capitalization Link STEM Students to Their Majors

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This study investigated the role of peer mentoring and voluntary self-development activities (i.e., capitalization) in anchoring science, technology, engineering, and mathematics students to their college majors. Online data were collected from 214 undergraduate students. As hypothesized, mentoring was positively related to capitalization, and both mentoring and capitalization were positively related to satisfaction with one's major, affective commitment to one's major, involvement in one's major, and willingness to be a mentor. Contrary to expectations, capitalization did not mediate the relationship between peer mentoring and student outcomes, suggesting that these constructs contribute independently to positive outcomes. Implications and future research directions are discussed.

Retention issues in the science, technology, engineering, and mathematics (STEM) areas of the U.S. economy are well documented. Dropout rates are high among undergraduates, particularly among women and minorities in the majors of computer science and engineering (National Science Foundation [NSF], 2010). This has contributed to a situation in which the United States is seeing fewer students successfully beginning STEM careers at a time when global competition is high, and the current economic climate has placed a premium on scientific and technological innovation (National Science Board [NSB], 2010). As a result, the issue of retention in STEM fields has attracted much research interest. A recent report by NSB (2010) stressed the need for the development and retention of talented individuals from all demographics to keep up with other developed nations, which are rapidly outpacing the United States in STEM development. Women continue to be underrepresented in these fields, and although minority groups represent a fast-growing subset of the U.S. college-age population, this is not reflected in the demographics of individuals receiving STEM degrees (NSF, 2010). Underrepresented groups have described STEM fields as having a "chilly" (Foster et al., 1994, p. 3), unwelcoming climate, which may contribute

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to their departure, suggesting that the source of the retention problem extends beyond the subject matter.

The careers and STEM literatures concur that career development does not begin with entry into the workforce (e.g., Major & Morganson, 2009; Watson & McMahon, 2005). The professional development experiences of undergraduates serve as a form of anticipatory socialization for the workforce (de Vos, de Stobbeleir, & Meganck, 2009). Moreover, identification with and attachment to one's field develop over the course of the life span, beginning in childhood and continuing through the college years and into the workforce (Ferreira, Santos, Fonseca, & Haase, 2007; Vondracek & Porfeli, 2011).

Professional identity can be indicated by positive attitudes toward one's career and work experiences, such as career satisfaction, career involvement, and affective organizational commitment (Blau et al., 2008). Among college students majoring in STEM, satisfaction, involvement, and commitment to one's major are corollary constructs. Given the ultimate goals of building and retaining a competitive STEM workforce, this research focuses on methods known to foster professional identity in the workforce that research suggests are also applicable at the college level. Specifically, the current study examines the contributions of peer mentoring and voluntary self-development participation (termed *capitalization*) to professional identity indicators among STEM majors. The relationships between these constructs and outcomes related to professional identity (i.e., satisfaction with major, affective commitment to major, and involvement with major) were independently tested, and a mediated model was examined to determine whether peer mentoring and capitalization work together to encourage professional identity development.

Peer Mentoring

Mentoring is an essential contributor to individual development in workplace and academic settings (Campbell & Campbell, 1997; Eby, Allen, Evans, Ng, & DuBois, 2008). Traditional mentoring involves a hierarchical relationship between a more junior professional (the protégé) and a more seasoned and experienced individual (the mentor). However, a mentor can also be a peer who is close to the protégé in age and position. The mentor provides career guidance and aids the protégé in learning, as well as providing encouragement and social support (Kram, 1983). Compared with more senior mentors, peer mentors are able to draw on more recent and relatable experiences, and individuals are often more comfortable approaching peers for mentoring needs (Parker, Hall, & Kram, 2008). Studies have observed an increase in outcomes such as satisfaction with one's university and affective commitment among students who experience peer mentoring (Sanchez, Bauer, & Paronto, 2006).

Most of the literature has operationalized receipt of peer mentoring as participation in formal peer mentoring programs (Terrion & Leonard, 2007). However, there is evidence that naturally occurring, unstructured developmental relationships are strong sources of mentoring support (Seibert, Kraimer, & Liden, 2001), and, in some cases, protégés receive more support from informal mentors than from formal mentors (Ragins

& Cotton, 1999). Participants in an informal process may be more likely to connect with individuals to whom they relate interpersonally and who have similar interests and goals, resulting in a stronger relationship (Ragins & Cotton, 1999). Extrapolation from the workplace literature suggests that receipt of peer mentoring among STEM undergraduates is expected to be related to increased levels of positive outcomes, such as satisfaction with and affective commitment to one's major. In addition, students are also expected to be more involved in their major when receiving mentoring from their peers. Consistent with prior research, students who receive higher amounts of informal peer mentoring are expected to be more willing to act as a mentor in the future (Allen, Russell, & Maetzke, 1997).

Hypothesis 1: Peer mentoring will be positively related to (a) satisfaction with major, (b) affective commitment to major, (c) involvement with major, and (d) willingness to mentor others.

Capitalization

Capitalization is a form of proactive coping that involves making the most out of one's circumstances by participating in voluntary opportunities that provide professional growth and development (Judge & Hurst, 2007). This can include attending relevant presentations, joining organizations, or even networking with peers (Noe & Wilk, 1993). Workplace research linking capitalization to outcomes such as satisfaction, commitment, and involvement (Blau et al., 2008) is expected to be generalizable to an academic setting; qualitative research has identified a number of opportunities upon which students capitalize to develop their future careers (Holland, Major, Morganson, & Orvis, 2011). The development of a professional identity through involvement in career-relevant activities often begins during one's education (Hunter, Laursen, & Seymour, 2007). Students who engage in such capitalization are also expected to be more willing to act as a mentor to their peers because of their increased levels of involvement and experience.

Hypothesis 2: Capitalization will be positively related to (a) satisfaction with major, (b) affective commitment to major, (c) involvement with major, and (d) willingness to mentor others.

In the workplace literature (see Pan, Sun, & Chow, 2011), mentoring has been linked to voluntary learning and development (termed *personal learning* in Pan et al., 2011). Undergraduate peer mentoring programs have also been effective in encouraging students to participate in extracurricular activities (Santovec, 2004). Additionally, in a qualitative study of capitalization behavior, students identified the presence and support of their peers as important factors when making the decision to engage in capitalization (Holland et al., 2011). Given these findings, it is thought that mentoring will contribute to students' capitalization on major-related activities.

Hypothesis 3: Peer mentoring will be positively related to students' capitalization participation.

Furthermore, Pan et al. (2011) found personal learning to be a mediator between mentoring and workplace outcomes, suggesting that mentoring leads to positive outcomes, in part because of how it influences the learning and development process. Likewise, we expect that the hypothesized links between peer mentoring and student outcomes exist, in part because of the predicted relationship between peer mentoring and capitalization, such that students who receive peer mentoring report more positive outcomes because they engage in voluntary learning and development activities more often.

Hypothesis 4: Capitalization will partially mediate the relationships between peer mentoring and student outcomes, including (a) satisfaction with major, (b) affective commitment to major, (c) involvement with major, and (d) willingness to mentor others.

Method

Participants and Procedure

A total of 214 STEM undergraduate students were recruited from one historically Black university and one predominantly White university. Several engineering and computer science instructors informed their students about the study and offered extra credit in their courses to students who participated. The study was also listed in a university-supported online research participation system, which offered students extra credit in select courses in exchange for participating in university research projects. Participants completed an online survey outside of the classroom, responding to the measures described later in addition to several demographic questions.

Participants were an average of 20 years old (SD = 2.93) and had a mean grade point average (GPA) of 2.94 (SD = 0.59) on a 4.0 scale. The majority of the sample was male (59.3%) and African American (52.0%). All participants were STEM majors, primarily from engineering (48.1%) and computer science (22.9%); these majors were targeted because of their large size and the fact that the recruitment and retention of women and minorities is particularly problematic in these disciplines (NSF, 2010). Prior research indicates that students in these majors have a range of capitalization activities available to them and may consider capitalization particularly important (Holland et al., 2011).

Measures

Peer mentoring. Peer mentoring was measured by a 20-item scale adapted from Tenenbaum, Crosby, and Gliner (2001), whose original scale was designed to measure mentoring in graduate school. Some items were adapted to be more applicable to an undergraduate mentor. For example, "Shared history of his/her career" was changed to "Shared their background and experiences in their major." This study used the approach used by Higgins and Thomas (2001) to examine the role of informal mentors. Participants were asked to think of peers who provide them with help or support related to their development in their major, and the mentoring measure was completed in reference to their most influential peer. Participants indicated on a scale ranging from 1 (*not at all*) to 5 (*to*

a very large extent) the extent to which mentoring was provided by this peer. Sample items are "Conveyed empathy for the concerns and feelings you have discussed with him/her" and "Helped you prepare for a test or quiz." Tenenbaum et al. demonstrated construct validity evidence for the original measure via its relationships with expected outcomes, such as affective commitment, learning satisfaction, and satisfaction with adviser. The Cronbach's alpha was .93 in Tenenbaum et al.'s study, and the adapted scale had an alpha of .98 in this study.

Capitalization. Capitalization was measured using a 25-item scale based on Maurer, Weiss, and Barbeite's (2003) learning and development activities scale. Maurer et al.'s workplace-oriented measure was modified using pilot data and results from a recent qualitative study (i.e., Holland et al., 2011) to reflect activities available to undergraduate students, rather than those available to employees. Participants indicated on a scale ranging from 0 (*never*) to 21 (*21 times or more*) how frequently they participated in various activities within the past semester (e.g., "Participated in a voluntary study group with other students" and "Read an optional book or journal that was relevant to your major"). Maurer et al. demonstrated construct validity evidence for the original scale through its link with intentions to participate in development activities, as well as with perceived personal and organizational benefits derived from participation. The Cronbach's alpha was .90 in Maurer et al.'s study, and the adapted scale had an alpha of .88 in this study.

Satisfaction with major. Satisfaction with one's major was measured using an adaptation of a three-item Job Satisfaction subscale from the Michigan Organizational Assessment Questionnaire (Cammann, Fichman, Jenkins, & Klesh, 1979). The items were adapted to refer to participants' major rather than an employee's job. Participants indicated on a scale ranging from 1 (*strongly disagree*) to 7 (*strongly agree*) their level of agreement with statements such as "All in all, I am satisfied with my major." Construct validity evidence for the original Job Satisfaction subscale has been demonstrated through positive relationships with established antecedents (e.g., job complexity) and consequences (e.g., job performance) of job satisfaction (Bowling & Hammond, 2008). The Cronbach's alpha for the original Job Satisfaction subscale was .84 in a recent meta-analysis (Bowling & Hammond, 2008), and the adapted subscale had an alpha of .85 in this study.

Affective commitment to major. Affective commitment to major was measured with Wessel, Ryan, and Oswald's (2008) six-item affective commitment scale. Participants indicated on a scale ranging from 1 (*strongly disagree*) to 7 (*strongly agree*) their level of agreement with items such as "I am enthusiastic about this major." Wessel et al. demonstrated construct validity evidence for the original scale through its correlations with outcomes such as perceived major fit and probability of changing major. The Cronbach's alpha for this scale was .83 in Wessel et al.'s study, as well as in this study.

Involvement with major. Involvement with one's major was measured using a 10-item adaptation of Kanungo's (1982) Job Involvement Scale. The items were adapted to refer to participants' major rather than an employee's job. Participants indicated on a scale ranging from 1 (*strongly disagree*) to 7 (*strongly agree*) their level of agreement with statements such as "The most important things that happen to me involve my pres-

ent major." Construct validity evidence for the original scale has been demonstrated through its positive correlations with expected outcomes, such as job satisfaction and job effort (Paterson & O'Driscoll, 1990). The Cronbach's alpha was .87 in Kanungo's study, and the adapted measure had an alpha of .85 in this study.

Willingness to mentor others. Willingness to mentor others was measured using an adaptation of Ragins and Scandura's (1999) four-item scale. Items were adapted to refer to willingness to mentor "another student." Participants indicated on a scale ranging from 1 (*strongly disagree*) to 7 (*strongly agree*) their level of agreement with statements such as "I would like to be a mentor to another student." Construct validity evidence for the original scale has been demonstrated through its relationships with quality of mentoring relationships and perceived accountability for mentoring (Eby, Lockwood, & Butts, 2006). The Cronbach's alpha was .90 in Ragins and Scandura's study, and the adapted scale had an alpha of .93 in this study.

Covariates. Several demographic variables to be used as potential covariates were measured. Participants reported their age, GPA, and current number of credit hours. Participants also reported a number of demographics, coded as follows: class level (freshman = 1, sophomore = 2, junior = 3, senior = 4), employment status (unemployed = 0, employed = 1), enrollment status (part-time = 0, full-time = 1), transfer status (yes = 0, no = 1), gender (male = 0, female = 1), and race (Caucasian = 0, minority = 1). Note that because 86.4% of the sample was either Caucasian or African American, race was coded as "Caucasian" or "minority."

Results

Means, standard deviations, correlations, and alpha reliabilities for all study variables are presented in Table 1. Hypotheses were tested using hierarchical multiple regression analyses. Potential covariates that were significantly correlated with the outcome variable of a given regression analysis were entered into Step 1 of the analysis, with hypothesized predictors entered in Step 2.

Main Effects

Satisfaction with major. In Step 1, race significantly predicted satisfaction with one's major ($\beta = -.20$, $p = .004$), indicating that minority students reported lower levels of satisfaction than did Caucasian students. Peer mentoring significantly predicted satisfaction with major above and beyond the covariate of race ($\beta = .33$, $p < .0005$, $\Delta R^2 = .11$), supporting Hypothesis 1a. Capitalization significantly predicted satisfaction with major above and beyond one's race ($\beta = .15$, $p = .028$, $\Delta R^2 = .01$), supporting Hypothesis 2a.

Affective commitment to major. In Step 1, race significantly predicted affective commitment to one's major ($\beta = -.15$, $p = .026$), indicating that minority students reported lower levels of commitment than did Caucasian students. Peer mentoring significantly predicted affective commitment above and beyond one's race ($\beta = .32$, $p < .0005$, $\Delta R^2 = .10$), supporting Hypothesis 1b. Capitalization also significantly predicted affective commitment over and above one's race ($\beta = .15$, $p = .045$, $\Delta R^2 = .01$), supporting Hypothesis 2b.

TABLE 1

Means, Standard Deviations, Intercorrelations, and Alpha Reliabilities of Study Variables

Variable	*M*	*SD*	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1. Age	20.18	2.93	—														
2. Class	1.88	1.00	.57**	—													
3. EMPS	0.35	0.48	.31**	.38**	—												
4. ENRS	0.97	0.17	−.34**	−.16*	−.11	—											
5. Gender	0.30	0.46	.06	.03	−.07	.05	—										
6. Race	0.66	0.48	−.05	.21**	−.08	.12	.14*	—									
7. TRANS	0.85	0.36	−.51**	−.34**	−.24**	.25**	−.08	.11	—								
8. GPA	2.94	0.59	.00	−.14	−.02	−.03	.07	−.26**	.01	—							
9. Credit	14.45	3.41	−.25**	−.25**	−.11	.33**	.01	.09	.26**	.19**	—						
10. PM	4.24	1.36	−.16*	.01	.16*	.07	.13	.11	.05	−.05	.12	(.98)					
11. Cap	3.74	2.13	.08	.24**	.23**	.01	.14*	.07	−.05	−.11	.11	.22**	(.88)				
12. SM	5.63	1.05	.04	−.04	.13	−.09	.03	−.19**	−.04	.11	−.06	.30**	.13	(.85)			
13. ACM	5.38	0.94	.01	−.05	.10	−.08	.00	−.15*	.02	.12	−.07	.30**	.12	.81**	(.83)		
14. IM	4.29	0.89	−.03	−.08	.08	−.07	.01	.03	−.01	−.03	.08	.27**	.17*	.47**	.55**	(.85)	
15. WMO	5.04	1.33	−.08	.00	−.06	.03	.11	.13**	.09	.20**	.21**	.28**	.16*	.26**	.28**	.17**	(.93)

Note. $N = 214$. The Cronbach's alpha internal consistency reliability estimates are reported on the diagonal. Class level coded as freshman = 1, sophomore = 2, junior = 3, senior = 4. Employment status (EMPS) coded as unemployed = 0, employed = 1; enrollment status (ENRS) coded as part-time = 0, full-time = 1; gender coded as male = 0, female = 1; race coded as Caucasian = 0, minority = 1; transfer status (TRANS) coded as yes = 0, no = 1. Class = class level; GPA = grade point average; credit = credit hours; PM = peer mentoring; cap = capitalization; SM = satisfaction with major; ACM = affective committment to major; IM = involvement with major; WMO = willingness to mentor others.

*$p < .05$. **$p < .01$.

Involvement with major. None of the potential covariates were significantly related to this outcome. Peer mentoring ($\beta = .27$, $p < .0005$, $R^2 = .08$) and capitalization ($\beta = .17$, $p = .012$, $R^2 = .03$) both significantly predicted involvement with major, supporting Hypotheses 1c and 2c, respectively. It is worth noting that in all the aforementioned analyses, we observed a larger effect size (i.e., the ΔR^2 or R^2 values) for peer mentoring than for capitalization.

Willingness to mentor others. Step 1 indicated that students with a higher GPA ($\beta = .17$, $p = .015$) and more credit hours ($\beta = .19$, $p = .009$) were more willing to serve as a mentor than were those with a lower GPA and fewer credit hours. Peer mentoring significantly predicted willingness to mentor others beyond these covariates ($\beta = .29$, $p < .0005$, $\Delta R^2 = .08$), supporting Hypothesis 1d. Capitalization also significantly predicted this outcome above and beyond the covariates ($\beta = .15$, $p = .028$, $\Delta R^2 = .02$), supporting Hypothesis 2d.

For Hypothesis 3, class level ($\beta = .18$, $p = .015$), gender ($\beta = .15$, $p = .026$), and employment status ($\beta = .17$, $p = .023$) were significant predictors of capitalization, indicating that students closer to degree completion capitalized more than students in lower class levels, as did women and employed students. Peer mentoring significantly predicted capitalization beyond these covariates ($\beta = .17$, $p = .012$, $\Delta R^2 = .03$), supporting Hypothesis 3.

Mediation

The Baron and Kenny (1986) approach was used to test whether capitalization mediated the relationships between peer mentoring and the investigated student outcomes. The previous regression analyses demonstrate the conditions necessary to test for mediation. The predictor (peer mentoring) was significantly related to each outcome (satisfaction with major, affective commitment to major, involvement with major, and willingness to mentor others). Furthermore, the predictor was significantly related to the mediator (capitalization), and the mediator was significantly related to the outcomes. After capitalization and peer mentoring were entered together, the beta values for peer mentoring decreased for satisfaction with major ($\beta = .29$, $p < .0005$), affective commitment to major ($\beta = .29$, $p < .0005$), involvement with major ($\beta = .25$, $p < .0005$), and willingness to mentor others ($\beta = .26$, $p < .0005$). However, Sobel (1982) tests indicated that none of these decreases were significant, suggesting that mediation was not present. Thus, Hypothesis 4 was not supported.

Discussion

Examining mechanisms expected to be transportable between the work and educational contexts, this study examined peer mentoring, capitalization, and professional identity outcomes in a STEM undergraduate context, as well as the relationship between informal peer mentoring and capitalization. To date, no prior research has examined these constructs in concert.

This study partially supported theories regarding undergraduate capitalization. Specifically, this work extends the workplace literature

(see Blau et al., 2008) by demonstrating that students' engagement in capitalization activities is positively related to several professional identity outcomes. Students who capitalize more often on self-development opportunities are more satisfied, invested, and involved in their major. Thus, capitalization seems to be an important mechanism for anchoring undergraduates to their major field of study and eventually their future careers. Additionally, this study provides evidence that an increase in capitalization participation, as well as professional identity outcomes, can be fostered by peer mentoring outside of a structured setting. Although many of these relationships have been established in studies of formal student mentoring relationships (Rodger & Tremblay, 2003; Sanchez et al., 2006), linking such outcomes to peer mentoring as measured in this study helps to establish the importance of informal mentoring. Students who experience the benefits of mentoring from friends and classmates may feel more comfortable in their major and confident in their abilities, adding to these positive outcomes and increasing their likelihood of capitalizing on available opportunities. In sum, these findings suggest two avenues for professional identity development among STEM students, which is valuable to educators and practitioners alike because of their potential for addressing the STEM retention problem and its impact on the U.S. workforce (NSB, 2010).

Note that the relatively larger effect sizes associated with peer mentoring compared with those of capitalization suggest that universities should focus on these informal relationships in particular, encouraging socialization among students and highlighting the importance of peer relationships to foster mentoring relationships and generate positive outcomes among their students. These findings identify informal peer mentoring as a relatively low-cost avenue for aiding in the retention of capable and talented individuals in STEM fields that universities and the country as a whole need to cultivate. Such efforts should be especially targeted at underrepresented students who are most at risk for leaving STEM majors because they may feel unwelcome or out of place, as demonstrated by our findings that minority students reported lower levels of satisfaction with and commitment to their major. Encouraging these students to be comfortable learning from friends and classmates and to turn to those peers for guidance will build and maintain a network of students who help one another thrive as STEM students.

Although student relationships are the focus of this study, the burden falls on universities to support their students and to help them forge such important developmental relationships. Faculty members, career counselors, and other university officials could host events such as group study sessions aimed at these students to provide a setting for establishing these relationships. Professors could incorporate collaborative assignments and even encourage high-performing students to act as mentors to their classmates, with the goal of building professional relationships that will extend beyond individual courses. Results also suggest that these efforts will be self-perpetuating; active encouragement of mentoring will likely result in future generations of students who are willing to serve as peer mentors. This is indeed important if mentor relationships are to thrive outside of a structured program.

Limitations and Future Research Directions

Many of the observed effect sizes, particularly those involving capitalization, were small, which may be because students were asked to consider their capitalization activities from only one semester. Additionally, the use of a single time point prevents the interpretation of causal links. Future research should gather data across multiple time points to strengthen these findings.

Researchers could expand on these findings by focusing on different kinds of capitalization activities. Perhaps more social or group-oriented activities (e.g., joining a student organization) will have different relationships with mentoring and student outcomes than more individual capitalization activities (e.g., independently practicing a new skill outside of class). Future work is also warranted with respect to the role of multiple mentors as opposed to a single influential peer, further connecting mentoring research to the developmental network literature (Higgins & Thomas, 2001). Finally, researchers should seek to replicate these findings in other fields of study. Although other fields may not have the retention issues that threaten STEM fields, the use of informal peer mentoring and capitalization to anchor students to their majors is still of value to them.

Conclusion

This study provides educators and career guidance specialists with several avenues for encouraging professional identity development in undergraduate students, while also identifying several paths for future research. Professional identity development via extracurricular mechanisms may be particularly salient for STEM students because of the challenging and potentially intimidating nature of their majors, and researchers would do well to build on these findings to further address the retention issue in STEM fields.

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