Formal Program Support and STEM Outcomes in a Research Opportunity Intervention: A Theory-Driven Study of Differential Benefits from Exemplary Pipeline Interventions

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Abstract

For more than 30 years now, the higher education literature has documented the obstacles and difficulties experienced by historically underrepresented minority (URM) undergraduate students in science, technology, engineering, and mathematic (STEM) majors at predominately White institutions (PWI). While it is important to identify these barriers, it is also important to better understand and inform supportive program interventions that ***promote success*** among URM undergraduate students in STEM ***despite barriers***. There is a growing interest by the National Science Foundation, the National Institutes for Health, and other organizations in ***theory-driven research*** that provides a better understanding of how ***exemplary intervention programs*** combine with ***other mechanisms*** (e.g., informal and formal program supports) to facilitate success among URM students in STEM fields.

Over the years, PWI have developed a range of exemplary student support programs (e.g., undergraduate research experiences) to promote success among students in STEM fields (especially URM) in the form of research opportunities. However, the mechanisms underlying the positive impact of student support programs on successful student outcomes are not well explicated. Drawing on the framework of the strength-based model with a role strain and adaptation approach, this research presents preliminary findings regarding the differential influence of formal program supports and informal program supports of an exemplary pipeline intervention – the Summer Research Opportunity Program (SROP) on participant's STEM outcomes (GPA, Ph.D. plans, research career plans, faculty career plans) compared to non-participants' STEM outcomes. The anticipated findings will contribute to program intervention literature and research on exemplary interventions by explicating the differential engagement and explanatory factors of various formal program components that suggests benefit for participants.

Background and Significance

Building on preliminary evaluation findings, this poster highlights an ongoing study that focuses on how differential engagement of formal program components can help to explain which participants benefit the most from exemplary interventions. Guided by a strength-based role strain and adaptation model, this study seeks to further clarify how participants' positive engagement of formal program components can further promote successful STEM outcomes in exemplary pipeline interventions.

This study focuses on the Summer Research Opportunity Program (SROP) – nationally recognized pipeline intervention. SROP is coordinated by the Committee for Institutional Cooperation (CIC), which is an academic consortium of 12 major research universities in the Big 10 Conference. CIC institutions confer more than 15% of all Ph.D. degrees awarded nationally and more than 20% in some Science, Technology, Engineering, and Mathematic (STEM) fields. SROP promotes graduate studies among underrepresented students as a bridge to faculty research careers. Since 1986, SROP has provided over 11,819 research experiences for talented students with over 3,000 who have pursued graduate studies. This exemplary intervention provides formal hands-on research experience supervised by a faculty mentor, regularly scheduled workshops, research presentations, and other structured activities to promote academic excellence, graduate studies, and research career socialization.

Specific Aims

Guided by a strengths-based approach, Figure 1 presents a conceptual model to clarify the influence of formal and informal support on successful outcomes in educational pipeline interventions (Bowman, 2006). This study is organized around five specific aims:

(1) to ***assess*** SROP participants' engagement of ***formal program components*** – financial award, research/academic, graduate study planning, faculty career planning, and social/personal network;

(2) to ***examine*** the ***relative predictive power*** of formal program engagement and informal program support on successful STEM outcomes;

(3) to ***investigate*** if formal program engagement ***moderates*** the relationship between informal support and successful STEM outcomes;

(4) ***explore*** if the relationship between formal program engagement and successful STEM outcomes is ***mediated*** by informal support and self efficacy; and

(5) to ***compare*** if the impact of formal engagement and informal support on successful outcomes is stronger under high ***student role strain***.

Conceptual Framework

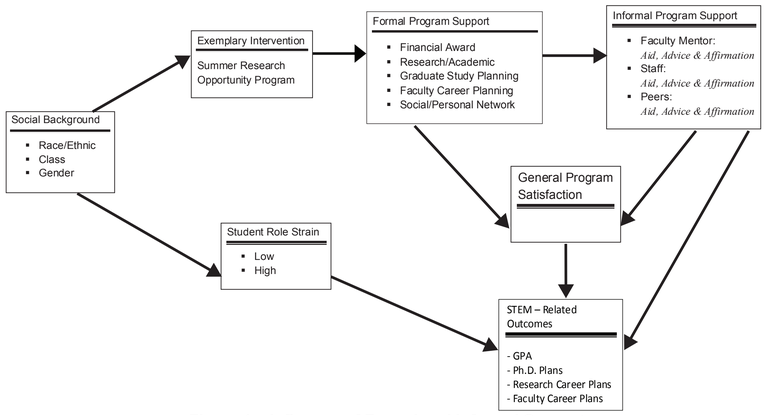

Figure 1 – Influence of Formal and Informal Support on STEM-Related Outcomes in an Exemplary Intervention Program

Preliminary Studies

The majority of the quantitative studies on formal support in pipeline programs on the effects of either financial aid or academic preparation on educational outcomes (i.e., Ishitani & DesJardins, 2002; Perna, 2005; Ramos, 2011; St. John, 1991). More comprehensive pipeline interventions have combined financial aid, academic preparation, educational planning and social/personal development to promote educational success (i.e., Trent & St. John, 2008). However, quantitative studies have yet to clarify how such formal program components combine with informal support to promote successful educational outcomes. While a growing number of qualitative studies on research opportunity programs suggest that formal program activities combine with informal support from faculty mentors on positive program experiences and success.

Formal Program Support (i.e., program experiences and success)

- **Financial Award** (Anderson & Kim, 2006; Cabrera, Nora, & Castaneda, 1992; Fenske, Porter, & DuBrock, 2000; Georges, 1999; Murdock, 1987; St. John, Kirshstein, & Noell, 1991; U.S. Department of Education, 2000)
- **Research/Academic** (Bauer & Bennett, 2003; Bonous-Hammarth, 2000; Davis, 2006; Eatman, 2002; Gafney, 2005; Gregerman, 1999; Hackett, Croissant, & Schneider, 1992; Hunter, Laursen, & Seymour, 2006; Koch & Johnson, 2000; Nnadozie, Ishiyama, & Chon, 2001; Solórzano, 1993)
- **Graduate Study Planning** (Davis, 2006; Powers, 1987; Solórzano, 1993; Swinton & Powers, 1983)
- **Faculty Career Planning** (Davis, 2006; Gafney, 2005; Gloria & Hird, 1999; Lent, Brown, & Larkin, 1986; Luzzo, 1993; Murry & Mosidi, 1993; Wyer, 2001)
- **Social/Personal Network** (Davis, 2006; Eatman, 2002; Schambach & Kephart, 1997; Seymour, Hunter, Laursen, & Deantoni, 2004; Vance, 1993)

Informal Program Support (i.e., program experiences and success)

- **Faculty Mentor** (Eimers, 2000; Hackett, Croissant, & Schneider, 1992; Highsmith, Denes, & Pierre, 1998; Hilton, Hsia, Solórzano, & Benton, 1989; Ishiyama, 2002; Pascarella & Terenzini, 1991; Terenzini, Springer, Yaeger, Pascarella, & Nora, 1996)
  Aid, Advice & Affirmation
- **Staff** (Baron & Kenny, 1986; Ebreo, 1998; Highsmith, Denes, & Pierre, 1998; Penick & Morning, 1983; Reyes, 2002; Seymour & Hewitt, 1997; Velez, 2000)
  Aid, Advice & Affirmation
- **Peers** (Baron & Kenny, 1986; Ebreo, 1998; Good, Halpin, & Halpin, 1998; Mabrouk & Peters, 2000; Reyes, 2002)
  Aid, Advice & Affirmation

Formal and Informal Program Support (i.e., program experiences and success)

- Building Engineering & Science Talent, 2004; Clewell & Ficklen, 1987; Collea, 1990; Fries-Britt, 1998; Fullilove & Treisman, 1990; Good, Halpin, & Halpin, 2002; Hrabowski & Maton, 1995; Johnson, 2005; Landis, 1988; Matyas, 1991; May & Chubin, 2003; Morrison & Williams, 1993; Ohland & Zhang, 2002; Summers & Hrabowski, 2006)

Research Design and Methods

Participants

Participants include undergraduates, both US and non-US, in the SROP which is based in 11 major research universities in the Midwest that are part of the CIC: University of Illinois, Indiana University, University of Iowa, University of Michigan, Michigan State University, University of Minnesota, Ohio State University, Pennsylvania State University, Purdue University, and the University of Wisconsin. The quasi-experimental design also includes a control group of non-SROP students who applied but did not participate in SROP for some reason.

Data Collection Procedures

This study employs data from a quasi-experimental survey study of SROP participants and a comparison group of applicants who did not participate. SROP program outcomes include students' improved academic performance, educational and career plans in STEM, and educational and career outcomes in STEM. Students' improved academic performance refers to measurements of GPA - 1st semester GPA in postsecondary education, Prior term of GPA before SROP, 1st semester GPA after SROP, and 2nd semester GPA after SROP. Educational and career plans in STEM refer to Ph.D. aspirations and faculty career aspirations. Educational and career outcomes in STEM include Ph.D. attainment and faculty career.

Research Design and Methods (continued)

Table 1. Model I: Outcome: Academic Performance measured by GPA
(Pretest-Posttest Nonequivalent Control Groups; Interrupted Time-Series Design)
(O = GPA; X = SROP Intervention)

NR	Time 1 1st Semester GPA	Time 2 Prior Term GPA	SROP Intervention	Time 3 1st Semester After GPA	Time 4 2nd Semester After GPA	
CIC SROP: Selected Participants	O_1	O_2	X	O_3	O_4	Participants
CIC SROP: Not-Selected	O_5	O_6		O_7	O_8	Comparison Group

Table 2. Short-Term Model II: Educational and Career Plans
(Pretest-Posttest Nonequivalent Control Groups; Interrupted Time-Series Design)
(O = Ph.D. Plans/ Faculty Career Plans in STEM; X = SROP Intervention)

NR	Time 1 Prior Term Before	SROP Intervention	Time 2 1st Semester After	
CIC SROP: Selected Participants	O_1	X	O_2	Participants
CIC SROP: Not-Selected	O_3		O_4	Comparison Group

Table 3. Long-Term Model III: Educational and Career Outcome
(Pretest-Posttest Nonequivalent Control Groups; Interrupted Time-Series Design)
(O = Ph.D. Attainment/ Faculty Career in STEM; X = SROP Intervention)

NR	Time 1 Ph.D./ Faculty Career Plans	SROP Intervention	Time 2 Ph.D./ Faculty Career Plans	Time 3 Applied to Ph.D. Program	Time 4 Enrolled in Ph.D. Program	Time 5 Completed Ph.D. Program/ Faculty Career Attained	
CIC SROP: Selected Participants	O_1	X	O_2	O_3	O_4	O_5	Participants
CIC SROP: Not-Selected	O_6		O_7	O_8	O_9	O_{10}	Comparison Group

Measures: Operational Definitions

Dependent Variable: STEM Outcomes	
	GPA
	Ph.D. Plans
	Research Career Plans
	Faculty Career Plans
Independent Variable: Formal Program Supports	
	Research Mentor
	Program Staff
	Program Peers
Independent Variable: Informal Program Supports	
	Aid
	Advice
	Affirmation

Components: Formal Program Support

Financial Award
1. Financial support including your SROP stipend and travel expenses
2. Campus resources including your housing and facilities

Research/Academic
3. Research project with faculty mentor
4. Regular meetings with faculty mentor
5. Scheduled meetings with SROP advisors/staff
6. Scheduled meetings with SROP peer mentors
7. Sessions or presentations on research project writing

Graduate Study Planning
8. GRE exam preparation course
9. Sessions on applying to graduate school
10. Sessions on funding for graduate studies
11. Sessions on life as a graduate student
12. Opportunities for oral and written research project presentations
13. Overall CIC SROP Conference

Faculty Career Planning
14. Opportunity to observe faculty as role model
15. Opportunities to interact with graduate student
16. Presentations on how to talk about my research

Social/Personal Network
17. Formal opportunity for personal development
18. Formal opportunity for social networking
19. Overall, how satisfied are you with your experience as an SROP student last summer?

Data Analysis Approach

Multivariate statistical analyses include:

(Aim 1) factor analysis to reveal that each of the formal program support (engagement) components – financial award, research/academic, educational study planning, faculty career planning, and social/personal network – emerge as separate factors;

(Aim 2) hierarchical multiple regression to show that both formal program support (engagement) and informal program support both add to the prediction of successful STEM outcomes;
(1) $Y = \beta 0 + \beta 1\ Int + \varepsilon$
(2) $Y = \beta 0 + \beta 1\ Int + \beta 2\ FPS + \varepsilon$
(3) $Y = \beta 0 + \beta 1\ Int + \beta 2\ FPS + \beta 3\ IPS + \varepsilon$

(Aim 3) moderated regression analysis to show that formal program support (engagement) moderates the relationship between informal program support and successful STEM outcomes;

(Aim 4) structural equation model (SEM) analysis to show how the relationship between formal program support (engagement) and successful STEM outcomes is mediated by informal program support and general program satisfaction; and

(Aim 5) moderated-mediation analysis will replicate SEM analysis for high and low student role strain conditions to show that the impact of formal program support (engagement) and informal support on successful STEM outcomes is stronger when role strain is high.

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