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Project Description I

Title:

Choosing a STEM Major in College: Family Socioeconomic Status, Individual, and Institutional Factors

Statement of the research problem and national importance:

Educating a strong workforce in science, technology, engineering, and math (STEM) fields has long been recognized as crucial to United States's leading position in a science and technology dominated global economy (Committee on Equal Opportunities in Science and Engineering, 2004). Promoting enrollment and success in STEM fields in postsecondary education has been a perennial research topic over the last decade. Research emphasis has been placed on the recruitment of student subpopulations, including women and underrepresented minorities, as well as the retention of STEM students (Griffith, 2010; Malcom, 2010; Rask, 2010). While these studies focus on gender and racial factors that influence STEM enrollment and on how to improve student persistence, they often neglect one important piece of the STEM pipeline, namely how in general college students choose to enter or avoid STEM fields.

The process of choosing college major is "seemingly voluntary" (Correll, 2001, p. 1692); however, it is influenced by numerous factors ranging from role models (Hackett, 1989) to students' values (Mitchell, 2008). This implies that the major choice process is beyond making a decision based solely on personal interests or socialized group identities. Besides gender and racial patterns, are there other factors systematically associated with students' decision of STEM enrollment? If so, what are these factors and how are they associated with students' choices?

Little attention has been paid to such concerns in the existing higher education literature. This study attempts to address these questions by focusing on one often-neglected dimension, namely students' family socioeconomic status (SES). It is generally agreed that family SES exerts significant influences on higher education outcomes both directly and indirectly (Kahlenberg, 2004; Kincheloe & Steinberg, 2007). Empirical studies have found that family SES is related to college major choice in that students from varied SES backgrounds tend to have different preferences for college majors based on types of rewards, with some value financial rewards while others value cultural rewards (Ma, 2009). STEM majors distinguish themselves from other undergraduate majors in that generally, they provide higher financial rewards and better job security upon graduation (Economics and Statistics Administration, 2011). Combining the two characteristics, it is plausible that family SES is systematically associated with college students' decision regarding STEM majors. Since current findings contradict each other about the direction of the association between family SES and major choice pattern (Ma, 2009; Ware & Lee, 1988), this study will explore whether such association exists on the national level and if yes, what the direction of the association is.

From the perspective of family SES, this study will examine a series of individual and institutional factors that might be associated with STEM major choice. These include individual characteristics such as pre-college academic achievements, educational aspirations, parental support, and financial constraints. Recognizing that college education decisions are not only related to personal traits, but also constrained by college characteristics and college experiences (Mau & Jepsen, 1992), this study will examine factors including college type, STEM major offering, and the type and amount of financial aid students receive. The association between family SES and STEM major decision will be examined for students who differ on the above-mentioned characteristics in order to reveal possible varying STEM enrollment patterns.

The proposed study will contribute to the higher education literature in several ways. First, it focuses on a piece of STEM pipeline that has been largely missing from the existing literature, namely students' decision of STEM enrollment. Knowing what factors are related to students'

STEM major decision will enable researchers and educators to find out students' concerns about STEM majors and the obstacles they may later face in completing STEM programs. Such information in turn will enable improving both STEM enrollment and retention. In a time when the retention rate in STEM fields is still relatively low (National Science Foundation, 2011), the findings of this study will be of practical value. Second, the study will examine the major choice process by going beyond gender and racial perspectives and examining the dimension of family SES. By doing so, this study aims to reveal general mechanism of college major choice in STEM fields across gender and racial groups. Third, this study's focus on family SES and the economic value of STEM majors for individuals is timely given the current national concern about the affordability of higher education (Alexander, Harnisch, Hurley, & Moran, 2010). The overall research question that guides this study is: Do the enrollment patterns in STEM majors vary for students with different financial means in a time of rising cost of college?

Review the literature and establish a theoretical grounding for the research:

It has been long pointed out that while the hierarchy of institutions' differing prestige forms an external stratification in higher education, varying power and prestige attached to major fields form an internal stratification of no less significance (Thomas, 1985). Much of the power difference among study fields stems from their different perspective economic return, making college majors like engineering and business more prestigious and desirable (Davies & Guppy, 1997; Rumberger & Thomas, 1993). The choice of college major is thus recognized as an important educational decision, which is both an outcome of accumulative educational experiences and a determinant of future educational and career outcomes (Turner & Bowen, 1999). In the literature investigating college major choice, factors including self-assessment of major field competence (Correll, 2001; Trusty & Ng, 2000), influences of role models (Hackett, 1989), and perception of the profession (Worthington & Higgs, 2003) have been identified to be associated with students' major decision.

While most of these studies are based on the framework of gender or racial/ethnic differences, only a few studies have paid attention to the influence of family SES. Goyette and Mullen (2006) found that students from lower SES background were more likely to choose vocational majors and seek full-time employment upon graduation, while those of higher family SES were more inclined to major in arts and sciences before enrolling in graduate school. Their findings imply that when choosing college major, low SES students value immediate economic return more than their affluent peers do. Cebula and Lopes (1982) found that expected future earning was associated with college students' choice of major field through their preference for majors of high financial return. Their findings are corroborated by empirical studies by Davies and Guppy (1997) and Ma (2009), who found that low SES students tended to view college education as an instrument for economic return. As a result, low SES students prefer lucrative majors such as life/health science, engineering, and business over humanities and social sciences/education majors more than their affluent peers do, controlling for academic achievement factors (Davies & Guppy, 1997; Ma, 2009). On the other hand, as SES increases, students become more likely to major in humanities and social sciences and less likely to choose health majors (Leppel, Williams, & Waldauer, 2001). In sum, these findings suggest that family SES might influence what students want to gain from a college education and subsequently influence their major choice pattern.

Although the aforementioned studies reveal the plausible correlation between family SES and college major choice, none has focused on major choice in STEM fields. Studies that have focused on students' decision about STEM majors have largely neglected the perspective of family SES and economic return of college education and have been mainly dominated by two perspectives, gender or racial/ethnic differences and academic achievement. The former examines the role socialized gender identity and/or racial/ethnic group membership plays in students' college major and career decision making (for example, Dickson, 2010; Maple & Stage, 1991; Riegel-Crumb & King, 2010). Empirical evidence shows that Asian American students tend to select study fields of technical and science nature partly due to their lack of cultural capital in the American society (Xie & Goyette, 2003). Women's negative perception of engineering professions discourages them from choosing engineering majors in college

(Frehill, 1997).

The latter perspective focuses on STEM majors' demanding requirements of academic preparation and examines the influence of academic factors on STEM enrollment. Pre-college academic preparation level has been found to be positively related to choice of STEM majors, including high school course-taking pattern (Li, Alfeld, Kennedy, & Putallaz, 2009; Trusty, 2002), high school academic achievement (Crisp, Nora, & Taggart, 2009; Smyth and McArdle, 2004; Turner & Bowen, 1999), and math self-efficacy (Betz & Hackett, 1983; Hackett, 1985). These studies are also frequently organized along the gender and racial/ethnic dimensions, resulting in findings pertaining to one gender or racial/ethnic group with limited generalizability across the entire college student population.

As important as these results are, there is still a lack of empirical research that combines the perspective of family SES and college major choice in STEM fields. As discussed above, research suggests a correlation between family SES and college choice pattern through students' pursuit of different types of reward. Given STEM majors' strong advantage in economic return, it is worth exploring the enrollment pattern along the dimension of family SES. In addition, going beyond the axes of gender and racial/ethnic groups will yield enrollment patterns generalizable to the entire college student population. The proposed study will address this research gap using the theory of human capital as theoretical guide. According to human capital theory, human capital is a means of production, meaning that additional investment could yield additional output, or productivity (Becker, 1993). Human capital theory argues that education is an important activity of human investment that increases human capacities by improving the qualitative dimension of human resources; therefore, additional education explains rise in individuals' income (Schultz, 1961).

Built on the framework of investment-output, human capital theory emphasizes the relation between education cost (investment) and economic return of education (output). Since education is seen as a form of investment in individual's skills and productivity, the monetary cost of receiving education, besides time and efforts, becomes part of the investment students make in themselves. Such investment is expected to yield financial return, among other forms of benefits in the long run (Leslie & Brinkman, 1988).

Based on human capital theory, to increase earnings, students would want to invest more in their education in order to improve their productivity and eventually earn high income. However, they must also consider how much cost is involved and whether such cost is affordable. Balance between investment and affordability and between investment and return must be achieved. Students from different SES background can afford different level of higher education investment and may have different understanding and expectation of the return of college education, be it financial, cultural, or personal. These concerns may be systematically associated with their choice of study field.

Describe the research method that will be used:

This study will address the following research questions:

Research question 1: In general, is students' family SES related to their decision of whether to enroll in a STEM major in college?

From the perspective of financial return of higher education for individuals, STEM majors distinguish themselves from other undergraduate majors in several ways. First, the rise of high technology and new development in sciences has become one of the strongest powers of the economic growth of the US and has largely expanded the job market for STEM graduates (Department of Labor, 2007). As a result, STEM fields in general provide better economic return through job security and higher earnings than fields as humanities and social sciences (Rampell, 2011). Second, the time and monetary investment in STEM fields is less than those in lucrative professional education such as law and medicine (Frehill, 1997). These facts lead to the hypothesis that low SES students are more likely to enroll in STEM fields, controlling for academic qualifications.

Research question 2: Does the enrollment pattern in STEM fields vary for students with different college investment level?

The goal of this research question is to explore the relationship between the monetary investment students and their families make in college education and their decision of whether to enroll in STEM majors. College investment level is defined in this study as the ratio of net cost paid for college education to students' total family income from all sources. It measures the difficulty of paying for college. Net cost paid for college education is defined as the difference between the total attendance cost of the institution a student is enrolled in and the amount of grant the student receives. The higher the investment level, the more "precious" the college education is for students in an economic sense and based on the main hypothesis discussed above, the more likely students will take the economic return into consideration when they choose major. This research question will examine whether this is the case.

Research question 3: Does the enrollment pattern in STEM fields vary at institutions with different STEM major offerings?

Besides individual factors, it is possible that students' choice of college major also depends on the program offerings at the institutions they enroll in. This research question aims at finding out whether the level and scale of STEM major offerings are related to students' decision. If a STEM program is large in scale, and/or offers graduate degrees, does it exert stronger influence on students who are seeking for a suitable major? In other words, do STEM program scale and quality matter in recruiting students? Recognizing that some students choose an institution because of certain program(s) they want to enroll in rather than choosing major after enrolling in an institution, the analysis of this question will be limited to students who didn't choose their institution for program.

Dependent variable. The outcome of interest in this proposed study is whether students enroll in a STEM major. The dependent variable is a dummy variable to be created by using the major variable in the *ELS:2002* second follow-up data. This study will adopt the narrow definition of STEM used by the National Center for Education Statistics (NCES) in its *2009 Statistics in Brief* (Chen & Weko, 2009) and define STEM as mathematics, natural sciences (including physical sciences and biological/agricultural sciences), engineering, and computer/information sciences.

Independent and control variables. The most important independent variable is students' family SES. The composite variable in *ELS:2002* (BYSES1) will be used as measure of family SES. As discussed above, college investment level and STEM program scale/level are important independent variables. The variable of college investment level will be constructed by using *IPEDS* variables of institution price of attendance and *ELS:2002* variables of family income and received aid amount. STEM program scale will be measured by *IPEDS* variables of number of conferred STEM undergraduate degree/certificate, and STEM program level will be measured by *Survey of Graduate Students and Postdoctorates in Science and Engineering* variables of graduate level enrollment. Other independent variables including student aspiration and parents' educational expectation of their children will be included in the model. A series of variables of demographics, high school, and college factors will be included in the model to control for personal background, academic preparation, and institutional influences.

Statistical model. Due to the nature of the dependent variable (dummy variable), logistic regression will be used to estimate the relation between variables of interest. The statistical model is as follows:

$$\text{Logit}(p_i) = \beta_0 + \beta_1 SES_i + \beta_2 IL_i + \beta_3 P_{ij} + \beta_4 E_i + \beta_5 D_i + \beta_6 A_i + \beta_7 C_{ij} + \beta_8 I + \mu_i$$

where SES_i represents student *i*'s family SES, IL_i represents student *i*'s college investment level, and P_{ij} represents the STEM offering scale and level at the institution *j* that student *i* attends. E_i represents student and parent educational expectations. D_i represents demographic characteristics including gender, race, and nativity. A_i represent academic achievements in high school and college. C_{ij} represents characteristics of the institution *j* that student *i* attends, including control and level of institution. Finally, *I* represents interaction terms of selected independent and control variables.

Previous research has pointed out that when relating family SES and college major choice, STEM majors and business majors are often

preferred by students in similar ways possibly because of their similar promise for economic return (Davies & Guppy, 1997; Ma, 2009). In order to find out whether students prefer STEM and business majors differently, a multinomial logistic regression will be estimated for a categorical dependent variable with four categories of major fields: STEM, business, social sciences/education/humanities/arts, and "other fields". This model will include the same independent and control variables as in the logistic regression except for the program scale/level variables. The goal of this model is to compare the direction and magnitude of the relation between the independent variables and the choice of STEM or business majors in order to find out which one attracts more students with similar financial concerns.

Uploaded Appendix Document(s):

Project Description II

Will you use NCES target dataset? Yes

Please check all NCES datasets that apply
- Educational Longitudinal Study of 2002 (ELS: 2002)
- IPEDS Institutional Characteristics (IC)

Explain why each dataset best serves this research. Include a variable list for each dataset used.

This project will use two NCES databases.

1. Education Longitudinal Study of 2002 (ELS:2002): This dataset is suitable for this study first because it is a nationally representative sample. The results of the study will be generalizable to the national student population. Second, this data set follows high school students through their high school career into higher education. The currently available data provide information on students' family background, pre-college academic preparation, and college career including college major choice. Such information is necessary for building a comprehensive model. Third, it is a multilevel study and collects data from several respondent populations that represent the students. Information from these sources will help to control for students' family background, individual characteristics, and institutional characteristics of high schools.

Variable list of *ELS:2002*:

F2B23A

F2B24

F2B22

F2B26R

F2B28R

F2B30

F2B13A

F2B13C

F2B15

F2B17A

F2B17B

F2B20A

F2B25A

F2B25B

F2RESZIP

F1SES1R

F2B25C

F2B25F

F2B27

BYS56

BYS57

BYS62D

BYS65A

BYS65B

BYS67

BYSES1

PLAMTP1

F1RAGP

F1RAGP12

F1RAGP11

F1RAGP10

F1S42

F1S43A

F1S43B

F1S52A

F1S52B

F1S52C

F1S52F

F1S52G

F1S52I

F1S52J

F1S52K

F1S52M

2. IPEDS Institutional Characteristics: This dataset provides data of total price of attendance for different types of students. Using such data and data of family income and grant aid from the *ELS:2002* dataset, it will be possible to construct a variable of students' college investment level, which will be an important independent variable in this study.

Variable list of IPEDS Institutional Characteristics:

CINSON

COTSON

CINSOFF

COTSOFF

CINSFAM

COTSFAM

Will you use NSF target dataset? Yes

Please check all NSF datasets that apply
- Survey of Graduate Students and Postdoctorates in Science and Engineering (GSS)

Explain why each dataset best serves this research. Include a variable list for each dataset used.

Survey of Graduate Students and Postdoctorates in Science and Engineering: This data set provides data of institution's STEM program level and scale through variables of graduate student enrollment and postdoctoral appointees in STEM fields. These data will act as measures of both level and scale of STEM offerings in colleges and universities. Level of STEM offering will be measured by the highest degree in STEM offered at the institution. Scale of STEM programs will be measured by the total graduate enrollment and the total number of postdoctoral appointees in STEM majors. This database is suitable for the proposed project first because it focuses on STEM program offerings, which is compatible with this project's research questions. Second, the GSS dataset provides data of STEM programs on the graduate level, which indicate the academic influence of STEM programs and will be used in the investigation of the third question of this study.

Variable list of GSS:

UNITID
orgunit_id
OrgUnit_Name
hdg_inst
toc_code
pt_tot_all_races_v
ft_tot_all_races_v
ft_tot_forgn_v
tot_postdoc_all_srces_v

Will you address the NPEC focus topic? No

If yes, please briefly describe:

Project Description III

Provide a timeline of key project activities:

Summer 2012: In-depth literature review; data cleaning; submit conference proposal to AERA; oral defense of proposal;

Fall 2012: Data analysis; writing of dissertation chapters; share preliminary findings at graduate student discussion sessions in college;

Spring 2013: Finish data analysis and dissertation writing; if possible, present findings at the AERA annual conference; prepare manuscripts to be submitted to peer-reviewed journals for publication; dissertation defense;

Summer 2013: Present findings at AIR Annual Forum; prepare and submit final report to AIR.

List deliverables such as research reports, books, and presentations that will be developed from this research initiative:

This project will lead to reports, conference presentations, and research study manuscripts to be submitted to peer-reviewed journals for publication.

I will develop mid-year report and final report to the AIR. Planned conference presentations include AERA 2013 and/or ASHE 2013 annual conferences. I also plan to submit one or two manuscripts developed from this project to *Research in Higher education* or *Journal of Higher Education*.

Describe how you will disseminate the results of this research:

I will present the findings of this study at the 2013 AIR Forum. In addition, I will submit proposals to the 2013 AERA annual conference and/or the 2013 ASHE annual conference. I plan to develop one to two research study manuscripts to be submitted to peer-reviewed journals in the fields of higher education and/or STEM education. In addition, I will take the chance to present my findings within my department and college through graduate student discussion sessions.

Provide a reference list of sources cited:

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IRB Statement

Statement of Institutional Review Board approval or exemption:

According to federal regulation 45 CFR 46.101(b), certain uses of existing data may be exempted from the IRB review requirement. As outlined on the University of Florida IRB website (http://irb.ufl.edu/irb02/irbrev.html):

Research involving the "collection or study of existing data, documents, records, pathological or diagnostic specimens, if these sources are publicly available or if the information is recorded by the researcher in such a manner that participants cannot be identified" [46.101(b)4)], may also be exempt from review.

I will contact the IRB office of University of Florida to confirm whether this applies to the proposed project and take steps as advised.

Statement of Use of Restricted Datasets

The proposed project will use the restricted dataset of *Education Longitudinal Study of 2002* (ELS:2002) from NCES. The restricted data of this dataset has been acquired from the IES Data Security Office by my advisor Dr. Behar-Horenstein under the license number #11080010 and I am an authorized user of the data.

Biographical Sketch

Lian Niu is a Research Assistant and doctoral student in the Higher Education Administration program at College of Education, University of Florida. She received her Master's degree of Education from Beijing Normal University, China. Her research interests include equity in higher

education, college student enrollment and persistence in STEM fields, and family influence on postsecondary education decisions.

Niu has completed doctoral level quantitative research methodology courses in areas of structural equation modeling, hierarchical linear modeling, quasi-experimental research design, propensity score analysis, educational program evaluation, and theory of measurement. She is involved in several research projects utilizing quantitative research methods, including meta-analysis studies of college teaching and faculty development survey instrument design study. The interest in this project is based on prior analysis of the *ELS:2002* data on enrollment in STEM fields. The finding that family SES interacts with pre-college academic achievement in predicting students' decision of STEM enrollment prompted the interest in examining the topic on a more comprehensive scale in order to explore the factors that influence enrollment in STEM fields. The quantitative trainings Niu has received and her experiences with the proposed national datasets build a solid basis for the completion of this proposed project.

Budget Requirements

Salary/Stipend: $17302.72
Tuition and fees: $1697.28
Travel: $500.00
Other travel related expenses: $500.00
Other research expenses: $0.00
Total Request: $20000.00

Funding History

I was a fellow of the AIR 2011 National Summer Data Policy Institute. This proposed project has not received any funding and is not submitted for any funding other than the AIR dissertation grant.

Letter of Support from Dissertation Faculty Advisor

- Letter of Support