Factors Influencing Selection of a Science, Technology, Engineering or Math Major

Curtis M. Kularski

University of North Carolina at Charlotte

Departments of Sociology and Philosophy

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Students select a major field of study (a major) as part of their higher educational experience (Ma 2009:211). This paper will investigate the literature regarding choice of college major to determine if the research regarding students choosing to major in science, technology, engineering and math (STEM) fields is applicable to non-STEM fields as well. What factors drive the decision to select one major over another? Gender has historically been one of the more visible social factors for students selecting a major, but other factors of stratification such as race and socioeconomic status also contribute to the way a student conceives of their academic (and career) identity.

What causes students to be driven from one major or attracted to another? Is it a function of the cultural background of the student or is it an attribute of the major? Up to eighty-percent of students do not stay in their initially declared major (Gordon 2007:88). What does this mean for social determination arguments that place the factors of major selection as being ascribed before college admission?

The selection of major is important to how students approach the college experience and ultimately how they approach selecting a career. Some occupations require specialized training, which is acquired through the training received through the bachelor's degree, whereas other occupations require other 'soft' skills acquired as part of the process of earning a degree, but is not necessarily linked to the specific degree program or major field of study.

Stratification in specific majors limits the variety of perspectives available to those programs. In the STEM category of disciplines this means that certain populations, such as women, are discouraged from entering the fields which in turn limits the pool of talent available to fill STEM vacancies. For humanities, social sciences and arts the lack of diversity challenges the existence of the fields. As long as those fields are viewed as being primarily for women or other marginalized individuals, then they are in danger as they are not granted the same degree of social and political legitimacy as that granted to STEM fields. Academic disciplines, and as a result occupational fields, that are relatively homogeneous only develop from the perspective of their majority composition and thus the advancement of knowledge is restricted to only that perspective.

Relationship between Major and Career

Throughout this paper I will refer to a student's choice of academic major. In most cases this will also refer to a student's choice of post-graduation career. This is a social creation that has been developed as a result of industrialization and now the post-industrial move to a neoliberal economy. Capitalist contributes to higher education have helped to solidify the relationship between academic major and the occupations that students pursue (Slaughter and Rhoades 2011:433-434). The implications of this assumption for the future of academia and for the diversity of specialized knowledge in the workforce are outside the scope of this particular paper, but the assumption itself is an underlying theme upon which many of the sociological phenomena in this paper are able to function.

Review of Literature

Existing studies regarding selection of major have been based on social attributes such as gender, race and economic status (Ma 2009:211). Some research also relates a student's choice of major to the types of role models they were exposed to in high school (Bottia et al. 2015). Many studies into the issue of major choice are quantitative studies that consider the demographics of the students enrolled into various majors or categories of majors and draw conclusions based on that data (Turner and Bowen 1999). Other research relies upon interviews with students to locate the criteria used for major selection (Montgomery 2004). Some research on major selection raises a critique of the institutional structures present in particular fields to seek possible attributes that may attract or repel a student (Seymour and Hewitt 1997).

Every student is unique in their social history and the distinct collection of cultural capital that they take with them into their career in higher education. These assets combined with the student's personal academic aptitudes provide them with a background to make a choice of major. Some of the information in the student's background may be biased based on cultural expectations or perceptions that have been developed as a result of social training. Some of those biased include gender appropriate careers and behaviors, socially desirable career choices and what is viewed as a serious or worthy major to pursue. Significant challenges to those expectations may be required to negate their influence on the student's selection of major. Laura Montgomery argues that students may also be hindered in their selection of major based on ignorance of their own cultural conditioning. Montgomery conducted interviews with students regarding their selection of major. Many of those students asserted that their selection of major was a personal choice that was reflective of their own interests and capabilities. Despite the assertions of

an autonomous choice reflective of individuality, Montgomery found that many students selected majors that were consistent with gender expectations and reflective of socially defined roles (Montgomery 2004:788).

Some institutions of higher education provide students with instruments such as the Strong Interest Inventory or Myers Briggs Type Inventory to assist them with making a selection of major. These instruments are based on personality research and have historically been used to pair a student with a career path. These instruments highlight what skills and attitudes a student has accumulated, but essentially can only interpret the traits that have been instilled in the individual in their past and do not point to what types of fields of study or future careers to which the student may be well suited, if their cultural biases were not present (Toker and Ackerman 2012:525). Responses to the Strong Interest Inventory in particular show a correlation to gender or race, depending upon the assessment item. Females are more likely to respond positively to nurturing task examples than males, whereas African-Americans show stronger responses to religious activities than other ethnic groups (Fouad and Walker 2005:120-121). Students who are undecided about their major are often pointed to these instruments as a way to narrow their options and guide them into majors that fit their personality interests, but the instruments themselves could be biased toward reinforcing the embedded cultural norms that the student has adopted, rather than revealing the cultural-independent interests that a student may have.

Strategies regarding major selection vary per institution, but most prefer students to declare early in their career to maximize the number of credits that apply toward their degree program and reduce the time to degree. While these goals seem to be in the best interest of the student and the school, for most students it is encouraging young adults

who have only known independence for a few months to make a decision that can shape their academic future as well as their career path. Instruments such as the Strong Interest Inventory may make students more aware of career options that are in line with the beliefs and values with which they enter higher education, but it does not encourage investigating the source of those values (Fouad and Walker 2005:105). The Strong Interest Inventory and the Myers-Briggs Type Inventory, referred to as self-assessments, must be interpreted for the student by a counselor who is has been trained by the respective organizations to interpret the assessments (Toker and Ackerman 2012:525). Beyond this type of service and consultation with academic advisors from within academic departments students are left to navigate to majors on their own (Seymour and Hewitt 1997:72).

Students select a major based on the intersectionality of their social attributes, cultural capital, personal interests, personal academic capabilities, influences from others and perceptions of the purpose of higher education (Steidl 2012:28). The number of factors that contribute to major selection should make analysis of how students select their major a very complicated issue, but instead the majority of major selections can be traced to contributions made by social attributes or by institutional factors.

Impact of General Attributes of Major Fields

In *Talking About Leaving: Why Undergraduates Leave the Sciences* Seymour and Hewitt discuss a broad problem regarding the composition of certain fields in higher education. In the past several decades STEM fields have experienced a loss of students or a failure to grow their departments as a result of lack of student interest. Mainstream cultural practices and gender norms only account for some of the leavers and avoiders. Some other factors identified are the difficulty of the course material, a lack of support

structures for the curriculum and an excessively competitive environment (Seymour and Hewitt 1997). Seymour and Hewitt conducted qualitative interviews with students who were qualified to be STEM students to determine their reasons for the major selection they eventually made, whether it was to avoid STEM or to complete a STEM degree (1997).

Difficulty of course content, which is identified as a reason why students leave STEM, is not a problem that can be corrected. This problem does suggest that part of the issue with attracting students to STEM is the amount of preparation that students receive. Marginal preparation may be adequate to allow students to enter STEM fields of study, but it would be a more difficult process than if the student had a more advanced understanding or familiarity with the concepts required. Lack of preparation may also cause a lack of confidence on the part of the student (Seymour and Hewitt 1997).

Students interviewed by Seymour and Hewitt identified a lack of available social and academic support to be a key problem that encouraged their departure from STEM fields. Students sought academic and career advice, but could not identify resources available to help them navigate through their program. Other students identified that there was no one available in their academic department that took a personal interest in their progress or success. These large gaps in support structures, which are common in technology and engineering programs, discourage students who are not self-motivated and resourceful from staying in a STEM major (Seymour and Hewitt 1997:133-135).

STEM majors are often more competitive and less collaborative than their liberal arts counterparts. This is paired with a history of being selective and "weeding out" students who do not immediately perform well. Some faculty were reported to limit the number of passing grades they assigned to create the appearance of rigor in their classes,

preventing all but the top students from being successful in their classes. Creating a competitive environment discourages collaboration, which eliminates a potential source of support for students who may find themselves not as familiar with the coursework as their peers (Seymour and Hewitt 1997:115-125).

Students who experience the problems of STEM are not isolated and can discuss it with their friends who may also be considering a STEM major. STEM majors present a culture that may deter students who desire a nurturing and supporting educational environment where their individual interests are as important as how well they can compete with their peers.

Gender in Major Selection

One of the strongest and most studied social attributes that has historically been shown to impact choice of major is gender. This attribute has been analyzed for many years in parallel with STEM education. Historically masculine-identifying students have been drawn to STEM majors and feminine-identifying students have been drawn to non-STEM fields (Stone and McKee 2000; Turner and Bowen 1999; Montgomery 2004). The difference in gender between types of majors can be explained by future family considerations, expectations of status variance in career outcomes, and the perceptions of gender-based hostility in traditionally single-gender fields.

The factors of gender in higher education are generally important from two perspectives. The primary perspective for major selection is how the student incorporates the social concepts associated with their gender into their sense of self. The secondary characteristic is the systematic (and systemic) treatment of a gender category inside a

discipline or set of disciplines. These characteristics shape the gendered experience that a student has in coursework and major selection.

As discussed in the previous section, qualitative research performed by Seymour and Hewitt revealed that there were factors of the courses and faculty of STEM majors themselves that pushed some students out. In the quantitative analysis of those qualitative responses it was revealed that females were the students primarily being pushed out of STEM fields (Seymour and Hewitt 1997). Seymour and Hewitt found that the most frequently stated reasons for women leaving STEM majors were the presence of a competitive environment or the lack of a supportive/cooperative environment. Female engineering majors and leavers noted that they disliked competing with classmates for grades and that the instructors were unapproachable with regard to questions. Interviews with male engineering students revealed similar complaints, but for males it was not a cause for leaving the major (Seymour and Hewitt 1997:261-262). The difference in reaction is likely due to the different emphasis placed on competition for each gender in western culture. Masculine culture incorporates competition into the male identity such that not competing or failing in competition results in a degraded gender identity. In general young men are socially taught and encouraged to compete (Kimmel 2008). Competition is a central component of the ranking and prestige system used by men (Seymour and Hewitt 1997:263). The result of this gender difference is that men subject themselves to competition even if they are uncomfortable with it, whereas women are not socially conditioned to compete in the same way. The masculine ranking system impacts women in STEM majors in another way as well. Women that are able to adapt to the competitive atmosphere and find methods of support for themselves are viewed as a threat to the male-dominated culture of engineering and are often treated disrespectfully by both male peers and instructors (Seymour and Hewitt 1997:264-266). The culture of

masculinity is a problem in society in general with regard to the exclusion of women. In academia the gendering of disciplines is a threat to the overall mission of diversity in higher education.

Family expectations are a factor of gender that can influence major selection. Women often construct their identities based on how they perceive their future family life. This is a result of social conditioning and media portrayals of women (Damaske 2011:411). The importance of femininity and traditional female roles has decreased among female college students since 1972, but family is still an important consideration for many students when selecting a major (England and Li 2006:659). Men typically will make a choice of major purely based on career prospects and the anticipated outcome with regard to their ability to support a family, whereas women are more likely to select a major primarily based on personal interests and the ability to have a career that will not interfere with their ability to raise a family (Montgomery 2004:789). Engineering and technology occupations have the hazard of potentially requiring more time and travel commitments than other occupations, which would result in less time with family or maintaining other social ties, which may be unpalatable to women wishing to raise a family (Seymour and Hewitt 1997).

One of the key factors that influence the choice of masculine-identified students to select STEM fields is because of the career possibilities at graduation. STEM fields offer numerous opportunities which have high economic rewards and high social status. The supply of STEM-trained individuals is considerably less than the demand for those individuals (Byers-Winston et al. 2010:205). Persistence in a STEM field for men is often the perception that the degree will enable them to function as economic providers for their future family (Jome and Tokar 1998:121). STEM fields have been traditionally cast as

masculine due to their practical basis, competitive culture and the view that they are culturally valued more than other majors. Overall STEM fields have experienced a decrease in male enrollment due to the changing social attitudes toward other fields, such as economics and business, which have recently experienced an increase in social power (Jome and Tokar 1998:121-123).

Between 1971 and 1986 the gender discrepancy in STEM fields was decreasing rapidly. From 1986 to 2002 there was still a decrease, but at a reduced rate from the preceding period. The decrease in the gender gap was due to an increase in groups of women choosing to enter male dominated fields of study. There was no similar move by men toward traditionally female dominated fields. This difference is due to what England and Li refer to as the "devaluation perspective", which indicates that those fields are treated as feminine and therefore viewed as inferior and devalued relative to male-dominated fields. There is not data to suggest why the strong trend of women entering male-dominated fields has slowed, but it is suggested that the expectation of employer discrimination for future job prospects may be one possible explanation (England and Li 2006).

Jome and Tokar measured males in traditionally masculine majors and males in majors that were not traditionally considered masculine on multiple scales of masculinity to determine if there was a difference in the masculine ideology score of men between the two groups. They found that the level of masculine ideology was significantly different between the groups. In addition they found that gender-appropriate behavior was considered important to the traditional group, whereas the non-traditional group did not place any particular preference for gender-appropriate behavior (Jome and Tokar 1998:130).

One possible way to counter internalized gender bias for women to accept STEM as part of their gender identity is through the presence of same-gender role-models teaching in STEM fields their high school. In one study of North Carolina public university students a positive correlation was found between a high percentage of female representation among STEM high school faculty and the chances a female student would major in STEM at the university level (Bottia et al. 2015:25). This effect indicates that having same-gender role models in STEM can encourage female students to consider a STEM major. This is likely due to negation of gender stereotypes that the student may have previously been exposed to. There was no effect for male students (Bottia et al. 2015:21).

Impact of Race on Major Selection

A lot is known of the impact that gender has on the selection of college major, but it is by no means the only social factor that influences student major choice. In considering research on higher education it is difficult to isolate race as a factor alone as its effects are often combined with or complicated by the effects of gender in ways that cannot be cancelled purely by statistically controlling for gender (Dickson 2010:109).

The research on the impact of race on major selection varies greatly. Some research claims that enrollment in STEM majors by African-Americans and Hispanics is comparable to that of whites and Asian-Americans, whereas other research shows an advantage for Asian-Americans and other research shows that African-Americans and Hispanics are under-represented (Dickson 2010; Seymour and Hewitt 1997; Steidl 2012). Despite these disagreements, it is generally accepted that African-American and Hispanics have much lower degree completion rates than their white and Asian-American

counterparts (Steidl 2012:24). Some of the inequality in degree completion may be due to a lack of adequate preparation for the coursework from high school (Steidl 2012:30). Another possible cause of the lack of degree completion is the lack of social support systems in science and engineering programs which limits the social cohesion between non-white students in STEM majors (Seymour and Hewitt 1997:320-321; Reay et al. 2001).

One problem that was noted by Seymour and Hewitt from the majority of the non-white/non-Asian leavers they interviewed could be potentially problematic for STEM recruitment. Students left as a result of feeling that they had made an inappropriate choice to select a STEM major. Further inquiry into that response revealed that it was the "active influence of others", including programs that targeted their race to engage them in STEM. A few African-American leaver students interviewed directly cited being recruited with scholarship offers by engineering schools (Seymour and Hewitt 1997:324-325). Directly recruiting or influencing the major choice of minority students may cause more harm to the student and their academic goals if they do not have an interest in the major.

Perceptions of Higher Education for Career Placement

Changes in the structure of the labor force and the overall change in the way that the global economy is structured has placed in increased emphasis on the relationship between the field of study in higher education and the occupational selection after graduation. This has an impact on the areas in which students choose to major. Students select majors that are specific to a career path, rather than one that may offer them broader career choices (Reay et al. 2001:857).

Recent Data

The available research for student selection of and persistence in a STEM major spans from the 1980s to present and while the general themes that affect how a student selects a major are still present, recent data suggests that the composition of some fields has changed over time. As noted by Bottia et al, the gender discrepancy in biology and biological sciences has narrowed to be almost non-existent (2015:14). In 2010, women earned 62% of the baccalaureate degrees conferred in the United States. Of the 86,400 degrees conferred in biological sciences women earned 50,535 of them, about 58%. Similarly women account for 40% of the 23,379 degrees in physical sciences that were conferred. In contrast, women only represent 18% of the degrees earned in engineering and 18% of the degrees earned in computer science related fields (U.S. Department of Education, National Center for Education Statistics 2011). The data does not provide insight as to what factors have changed the involvement of women in biological and physical sciences, but perhaps a change in the perception of gender in those disciplines as well as more visible female role models could contribute.

Limitations of Available Research

General research regarding the selection of college major is rather limited. There are few studies that interrogate the exact process or social factors that are considered by a student when they are preparing to declare a major. A majority of the existing research is focused on STEM fields as a whole or on identifying groups that avoid specific STEM majors, such as computer science or engineering. This reinforces the privileged position of STEM fields over other disciplines.

The majority of research on major selection produced to date classifies majors into two binary categories: STEM and non-STEM. This binary classification distorts the selection of majors and undermines efforts made by some disciplines to attract a more diverse group of students. Each discipline at each institution likely attracts a different population and it is overly reductive to classify all humanities, social science, arts and business disciplines as "non-STEM".

Much of the research on major selection is confined to either a single institution or to a small group of schools that are selected to be representative of higher education in the United States generally, but it fails to account for individual school variations. It is usually assumed that studies are conducted in co-educational institutions and not single-gender schools. A female-only engineering program would have a very different climate than an engineering program at a co-educational institution.

There is a bias in the tone of the literature. Some literature presents as sexist and other literature presents a tone of superiority toward STEM fields over non-STEM fields. One article describes the entrance of females into traditionally male occupations as potentially having the effect of "forcing men to consider female-dominated occupations" (Jome and Tokar 1998:125).

The research on gender in relation to major choice treats gender and biological sex as interchangeable and does not consider gender identification or a non-binary gender matrix. Sexual orientation is also neglected as a possible attribute that may have some bearing on the social factors involved in the selection of a major. Jome and Tokar address sexual orientation and its relation to gender identity in a limited basis (1998). The study was conducted in 1998 and may no longer reflect current cultural values toward heterosexism as they relate to the masculine identity used to select majors and careers that

are in gender conforming. It may be of value to perform their study again in an updated format to determine if the changes in cultural values are in line with changes in STEM enrollment or for enrollment in fields that have gained masculine status. The Jome and Tokar study was also limited because it analyzed a male-only sample and did not attempt to replicate its findings for female-traditional and female-non-traditional cases.

In general there is very little research on major selection that does not focus on or otherwise privilege STEM. Some of the research is also biased toward an assumption that the major selection process is undertaken with a career goal in mind. Most of the available literature could be improved by being more inclusive to non-STEM fields. The problems of being focused on a limited set of privileged and in demand academic disciplines negates the importance of other fields or the impact that lack of diversity may have on the future of higher education through those fields.

Importance of Major Selection Research

Major selection is an important research area because major is often correlated to the selection of occupation after graduation, lack of diversity of major fields of study hinders the growth of the fields and understanding the factors of a successful selection of major may reduce drop-out rates and increase lifetime career satisfaction.

The STEM labor force is primarily composed of white males (Bottia et al. 2015:2). This is directly related to the composition of students in STEM majors. STEM careers typically are socially and financially valued; therefore the rewards for pursuing such a career are significant (Seymour and Hewitt 1997:182). This factor would allow women and minorities participating in STEM to have an opportunity for improving their

socioeconomic status. Financially this is important because it allows women and other minorities to become more independent. Socially this is important because it will continue a pattern of change toward a more diverse workforce in STEM, which would decrease the stigma of women in STEM. Greater social justice requires diversity of representation in all aspects of social life, including the academic disciplines and their related career fields.

Inverting the Research

This paper focuses on student choice to select or avoid a STEM field due to the abundance of research available on the topic. Can that research be applied to other majors? Perhaps, if traits regarding major selection are stable and predictable. Academic programs have gender and ethic expectations due to their majority make up and the composition of the workforce that represents the major in industry, so it should therefore be possible to utilize similar social characteristics to analyze the selection of non-STEM majors.

Conclusion

The existing research indicates that there are many factors that can influence a student's selection of major. Students may select majors based on their compatibility with their gender identity, based on high school role models, perceived culture of the major or a variety of factors of personal goals and perceived capabilities.

Major selection reflects the social factors that influence a student's self-identity and also replicates social stratification. STEM majors that are dominated by men can

develop an atmosphere of competition and non-cooperation that pushes women out. As a result of male domination in STEM and the historical association of females with nurturing fields the process of creating gender diversity across disciplines has been a slow. Similar to the diversion of females away from STEM through the gendering of STEM classes, males also have an aversion to nurturing fields such as nursing and education due to the perception of the fields as feminized.

The current climate of emphasis on STEM majors in higher education is due to the unmet demands for a diverse STEM workforce (Bottia et al. 2015:14). An emphasis on STEM as valued over other academic fields endangers other academic disciplines and they must compete with STEM for both students and funding. At the present time it does not seem as though there is risk of market saturation for the STEM workforce, but this is not to say that other fields are overflowing with unneeded workers. Encouraging STEM education for more students devalues liberal arts and humanities education, placing the academic tradition of cultural awareness and critical thinking at risk.

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