Research Proposal:

Effects of Discourse and Experience on Student Choice of Biology STEM Majors in

Higher Education

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A National Science Board (2004) report suggests decreasing enrollments in higher education STEM majors, with other works indicating that the United States is not generating sufficient STEM graduates to meet its national needs (Atkin et al., 2002; Herrera & Hurtado, 2011). Referred to as a narrowing STEM pipeline, candidates are progressively *leaking* out of STEM as they progress toward and through college, (Cannady et al., 2014). The General Accounting Office (2005) has called for active recruitment of students into STEM programs, and encouraging secondary-school graduates to select higher education STEM majors is considered an important step (Atkin et al., 2002; Fouad, 2007; Herrera & Hurtado, 2011).

More than half of all students entering STEM majors in higher education ultimately exit STEM (Lomax, 2015), with first year students highly likely to switch to non-STEM majors (Piper & Krehbiel, 2015), often citing a loss of interest and motivation to pursue STEM (Hunter, 2019). Students switching primarily felt under-informed about their selected STEM major (Thiry & Weston, 2019) and subsequently identified aptitudes in non-STEM alternatives (Hunter, 2019).

Much research targets stimulation of pre-college STEM interests, and persistence in higher education STEM programs (Atkin et al., 2002; Fouad, 2007; Herrera & Hurtado, 2011), with little focus on how high school graduates make their STEM choices for high education (Moakler & Kim, 2014). STEM recruitment efforts often cite how female students are less likely to pursue STEM majors in higher education (Moakler & Kim, 2014), however the biology field exhibits a female student majority while maintaining a rigorous reputation (Sax et al., 2018).

With biology as a potential model for other STEM fields (Sax et al., 2018), the use of advanced preparation STEM curriculum in pre-college education as a means to promote engagement and persistence in higher education STEM programs may yield more long term results than reliance on traditional college STEM outreach and engagement programs (Lomax, 2015). Outreach programs, while effectively improving student interest in and access to college STEM majors, may fail to result in completion of STEM degrees by students selecting STEM majors or pursuit of STEM careers by STEM graduates (Lomax, 2015).

STEM Choice

Much of the existing research on recruiting students to STEM is linked to means of encouraging pursuit and engagement in STEM programs (Atkin et al., 2002; Fouad, 2007; Herrera & Hurtado, 2011). More recent works favor examining how and why students form relationships with STEM as a potential career field. Vincent-Ruz and Schunn (2019) describe interactions between student STEM and non-STEM identities, suggesting that STEM identities are malleable, subject to modification through experience, and may decline when in competition with those outside of STEM.

Wang (2013) suggests a key contributor to students choosing a STEM major in higher education is the development of the intent to pursue STEM, and this intent may be subject to external influencer such as family expectations, cultural norms, and economic limitations (Holmegaard, 2015). Godec (2018) adds that while students may individually overcome specific external expectations their decisions are still subject to social acceptance, limiting their realization of personal STEM identities. When faced with such conflicts, students often conformed to social expectations (Rowan & Lynch, 2011), thus suggesting that choice of a major in higher education is far from under student control alone (Holmegaard, 2015).

A Post-Structural Lens

Post-structuralism aids in the exploration of student generated narratives and shared discourses about the individual processes of identity formation, providing additional insight into how choices of higher education major are realized through examination the individual truths of each student (Landry & MacLean, 1996) and "embrac[ing] the wisdom of a multiplicity of positions acknowledging the contradictions implicit in them and accommodating ambiguity" (Hutchinson & Wilson, 1994, p. 302).

As students struggle to identify with their academic field, achieve a sense of belonging, and gain social acceptance, they must examine their life experiences, both as they see them and as seen by others. In so doing, they engage in various forms of discourse to negotiate these alternate views and question the validity of their associated meanings in an attempt to discover the true nature of themselves (Mann, 1994; Slembrouck, 2004). Discourse then is a complex interworking and exchange of concepts and ideas between individuals and environments, each impacting the other to some degree. The collective meaning derived from these discourses is socially constructed between each party and heavily influenced through the context in which it was delivered (Olsson, 2007).

Potential Costs

When considering the choices students make to select STEM majors in higher education, a post-structural approach affords researchers a glimpse into how such decisions are simultaneously individual and socially negotiated resolutions of potentially ambiguous and conflicting ideas. These same affordances also suggest means by which student choices may be influenced to enhance selection of STEM majors.

As (Holmegaard, 2015) describes, students may exhibit varying degrees of interest in STEM subjects, but this interest does not necessarily correlate with an interest to pursue STEM as a career. Following an uncertain career choice may or may not work to students' favor (e.g., see Hunter, 2019; Lomax, 2015; Piper & Krehbiel, 2015; Thiry & Weston, 2019), however deciding to change out of a selected STEM major into another field (or through attrition) has costs. Foraker (2012) examines the effects of changing majors and highlights the potential negative impacts on student grades and graduation rates as well as the likelihood of delayed matriculation, and Sullivan (2010) raises potential financial impacts.

Discourse and Language

Discourse is the primary means by which students may negotiate the meaning and value of differing ideas between themselves and others (Mann, 1994; Slembrouck, 2004), using language to facilitate the assembly of statements (Graham, 2005) conceptualizing the communication of perceptions and experience (Trifonas, 2009). Information transfer is not exact however and Bakhtin (1981) posits that since all language and speakers are infused with their own values, something is always gained or lost in the process of transfer, through even the most basic statements.

Experience through Action as Text

Experience plays an important role in choice and student decisions toward STEM majors (e.g., see Bottia et al., 2015; Bøe, 2012; Vincent-Ruz & Schunn, 2019). Students' everyday experiences serve to support their own ideas, catalyze change in their own and others' ideas, and promote change in their and their peers' conceptions of science (Na & Song, 2014).

Meaning must be interpreted from experience, with actions and experience considered as a form of text (Scott-Baumann, 2011), and thus a discourse that must be analyzed from the point

of view of the recipient of the action (Foucault, 1972). Discursive statements through actions bear similarity to acts of oral discourse, and both relay some form of meaning to the individual (Ricoeur, 1971), though there may be disagreement between the motivation and intent of the authors of actions and the interpreted understanding of the recipients (Scott-Baumann, 2011). Ricoeur (1976) further suggests that direct transfer of an experience from author to recipient is not possible without an intervening alteration of the intended meaning, influenced by the lived-experiences and interpretations of the target.

Context

Since context is highly relevant to interpretation, authors of experiences may supplement the available contexts in an attempt to improve the fidelity of their intended message (Shen, 2013). A primary purpose of discourse is to exert influence (Clarke, 2015) and ideas represented through discourse need not be grounded in reality (Lanas & Brunila, 2019). Discourse constructs rather than represents reality (Pinar et al., 1995). Its goal is to evoke action more than to simply inform (Clarke, 2015).

Shen (2013) adds that since individuals exhibit such variety in their lives and experiences, they may draw from any number contextual references when attempting to interpret discourse. Relating this to the principle of relevance, Shen suggests the most likely interpretation is the first to have sufficient contextual backing, to make adequate sense of what was just experienced.

This point is critical for those who desire to communicate a precise message through discourse. While an individual may have a multitude of experiential contexts from which to draw, contexts recently constructed through carefully coordinated discursive exchanges that adequately support the original intent are the most likely to support that interpretation. This

application and manipulation of context to influence discourse interpretation parallels the use of language to organize and deliver discursive statements intended to convey specific meanings.

Effects on Student Choice

Paul (1986) suggests that choice is a *messy* problem, one that requires evaluation of a multitude of experiences and competing perspectives, all interpreted through the individual contexts available to the students (Reznitskaya & Sternberg, 2012). Choice of academic path for students involves not only personal negotiation of interests and identity but also integration of influences and expectations from external sources (Godec, 2018; Holmegaard, 2015). Students must balance their decisions while considering what values are represented, but Reznitskaya and Sternberg (2012) question who decides which values are more *right* and thus should weigh more heavily in decisions.

Reznitskaya and Sternberg (2012) suggest wise students will primarily base decisions upon a union of their own knowledge and values along with a consideration of any external inputs or expectations over the short and long term. Student knowledge and values are, to a large degree, developed through the discourses encountered throughout their academic careers, but as Clarke (2015) and Lanas and Brunila (2019) suggest, discourse may serve more to exert influence than convey factual information, constructing a perceived reality that does not necessarily exist outside of the discourse.

Throughout primary and secondary education, ample opportunities exist to establish supportive and perpetuating discourses involving action as experience. If STEM outreach or engagement experiences include meaningful actions, such as those promoting a sense of identity, belonging, or purpose in students, those experiences may be interpreted by students as part of an ongoing discourse that was designed to convey a specific sense of their personal STEM reality.

As students undoubtedly exhibit a diverse array of lived experiences, the contexts students use for interpretation may vary significantly. Thus, appropriate contexts for the discourse author's intent could be embedded directly into the experiences or built up over time through student interactions with previous discourses, sufficiently supporting the intent of the authors with immediately apparent and accessible contexts, potentially outcompeting alternatives from within the student's life experiences.

A process such as this may work to offset disparity between a student's interest in pursuing STEM and a nationally declared need for students to pursue STEM. Thus, while STEM identity may be enhanced through the perceived reality a discourse of active engagement creates, implementing STEM outreach or engagement programs to entice students into pursuing STEM in higher education may place the (biased) needs of society over the individual needs of the student.

Promotion of STEM as a viable career is both valuable and necessary to overcome inequities however, manipulating discourse and context to ensure increased enrollment in outreach and engagement programs at the cost of student autonomy may not be the best solution.

Purpose

The purpose of this study is to identify current students pursuing an undergraduate program in biology at Purdue University who feel discontented with their selected STEM major and examine the in- and out-of-school STEM outreach or engagement experiences most influential in leading students to the decision to pursue a biology degree.

Research Questions

RQ 1: How did specific pre-college STEM-related experiences impact the student's decisions to pursue a university biology degree?

RQ 2: What impact did pre-college STEM-related discourse have on the student's decisions to pursue a university biology degree?

Methods

Research Design

Since I am interested in examining what experiences were most influential in leading multiple students to choose a STEM major (in this study, biological sciences), I will use a phenomenological approach. Phenomenology bears similarities with constructivism (Chiari & Nuzzo, 1996) in regard to how experiences are interpreted by individuals and phenomenological research examines the essences of experience through interpretation of the participants' original descriptions (Moustakas, 1994). Phenomenology, as a methodology, is appropriate for drawing out meaning from the uniqueness of personal lived experiences (van Manen & Adams, 2010)

Theoretical Framework

This study is rooted in post-structuralism and critical discourse analysis. Post-Structuralism embraces a sense of multiplicity, ambiguity, and contradiction in interpretation and focuses emphasis on the receivers rather than the authors of discourse, while still allowing for external influence on individual interpretations (Hutchinson & Wilson, 1994). Critical discourse analysis represents how information is assembled by an author (the object of discourse), how it is presented and transferred to a recipient (the process of discourse), and how it is interpreted by the recipient (the meaning of discourse) (Janks, 1997).

Participants

This study will focus on two groups. Group one consists of college undergraduates enrolled in in a Bachelor of Science biology degree program at a large Midwestern public university. Group two consists of college undergraduates who were enrolled in in a Bachelor of

Science biology degree program but have since completed a change of major to another non-STEM major (e.g., not science, technology, or engineering) at the same large Midwestern public university. Both groups are limited to those of legal age, matriculating directly from high school, and with no intervening gap-years in their education progress. Interview participants will be added until data saturation occurs, approximately 5 to 10 expected per group (Moser & Korstjens, 2018).

Context

This study will take place at a large state university predominantly known for its engineering and agricultural programs. The undergraduate program makeup is of predominantly white, domestic students, with 55% female. The biology program mentioned in this study is housed with the other hard sciences (e.g., chemistry, math, and physics) under the College of Science. The College of Science is approximately 81% domestic, 38% female, and 7.4% underrepresented minority (URM) students. The Department of Biology is approximately 94% domestic, 68% female, and 12% URM students. Source: Purdue University (2020).

Procedures

Group one will solicit undergraduate students within the Department of Biology through both physical flyers and email distribution lists. Group two will be similarly identified either in academic areas known as transfer targets, or through mailing lists derived from university Registrar program transfer records. The solicitation will request participants who meet the base criteria (e.g., Group one: enrolled in a biology major, undergraduate classification, and exhibiting some degree of discontent with their choice of major; Group two: current non-STEM major, previously enrolled as biology major, undergraduate classification, and expressing discontent with their previous STEM major), with a small value gift card advertised as an

enticement for those who qualify for the study. Respondents will complete a further screening questionnaire to ensure all specified qualifications are met (i.e., legal age, direct from high school, no gap year) and further confirmation of their discontent in their current (group one) or previous (group two) choice of STEM major.

After suitable participants are identified, mutual arrangements will be made for an in-person or virtual interview. The intent to record the interview for later transcription will be disclosed to the participants. The interviewer will begin with general prompts for the participant to briefly describe their STEM major and to elaborate upon their feelings of discontent. Further inquiry will address the two research questions, inquiring as to what pre-college STEM-related experiences most impacted their decision to choose to major in biology, followed by response specific probes for additional details on their experiences and any STEM-specific discursive exchanges they may have participated in.

Data Sources

The study will use primary data obtained from direct interviews with participants. The interviews will be audio recorded and transcribed into textual form for further analysis. Both will be stored in secured electronic formats.

Data Analysis

Data analysis will be concurrent with collection to help determine when saturation occurs. Once transcribed, the data will be verified against the original source material for accuracy. The narratives describing the participant's experiences will be analyzed for themes related to the study research questions (thematic narrative analysis) (Kim, 2016). Similarities and differences between participant narratives will be examined to identify how various experiences influenced students' identification with and decisions regarding STEM majors. Analysis of

additional narratives will further refine this analysis until no new themes are identified. The final

analysis will result in a restorying of the participants' narratives, describing how the experiences

act to influence students' choices to major in STEM programs.

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