Spencer Small Grant Proposal:

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

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(APA 7th)

Proposal Summary

Growing STEM industries require ever increasing numbers of qualified graduates to fulfill their needs. Interest in STEM is frequently promoted through STEM outreach and engagement programs, fostering students to envision themselves fulfilling roles within STEM. Such efforts, often rich in interesting information and entertaining experiences, constitute a discourse relating the potential futures students could have if they choose to follow STEM.

Establishing enough interest to enroll in STEM is not necessarily the same as maintaining that interest moving forward, however. Attrition from STEM programs is high, with students often feeling underinformed about their selected field, suggesting that student needs may be misunderstood and highlighting a disparity between fulfilling the *need for* students in STEM and the *needs of* students in STEM. The choices of college major students make have consequences and changes to these decisions may negatively impact learning and performance, prolong enrollment, and increase financial burdens.

This study examines how discourse and experience influence the decisions of students in selecting college STEM majors, using a framework rooted in post-structuralism and critical discourse analysis, and the qualitative method of phenomenology which leverages students' rich narrative descriptions their lived experiences, drawing meaning from the essences of their stories. (Proposal Summary: 197 words)

Project and Budget

Project Information

Institution: Purdue University, West Lafayette, IN

Principal Investigator: Nathanial C. Hilliard

Project Title: Effects of Discourse and Experience on Student Choice of Biology STEM Majors in Higher Education

Grant Period: January 1, 2021 to December 31, 2021

Budget Information

- Salaries (1 fiscal year)
  - Principal Investigator $18,538 (12 months, 0.5 FTE)
- Benefits
  - Tuition & Fees $9,992 (two semesters)
- Travel $1,500 (conference fees, transport, lodging)
- Equipment and Software $1,000 (HQ audio recorder/mic, analysis software)
- Project Expenses
  - Supplies $500 (office supplies, notebooks, digital storage)
  - Transcription $3,600 (approx. 20 x 2 hour at $1.50 per minute)
  - Participant Gift Cards $500 (approx. 20 at $20 to $25)
  - Miscellaneous $500 (reference materials, copies, PPE materials)
- **Total Projected Costs $35,230**

Project Proposal Narrative

Purpose

The purpose of this study is to explore the individual experiences leading students to major in the college STEM discipline of biology yet also find themselves feeling discontented with their selected field of study. STEM outreach and engagement programs are often utilized as a means to promote interest and enrollment in college STEM programs, using elements of discourse and experience to encourage the development of positive STEM identities with

prospective students. These efforts may appear effective at STEM recruitment, but they may not clearly and accurately represent STEM to students, which is required in order to make informed decisions regarding their potential futures. Improperly informed decisions may result in unplanned corrections and impose negative long-lasting academic and financial consequences. The goal of this study is to highlight how discourse and experience impacts students' decisions to pursue STEM majors and to better inform STEM recruiting practices.

Significance

With the pervasiveness of STEM in our social and economic lives, the need to adequately supply STEM fields with qualified working individuals has become increasingly critical. The effort to encourage STEM interests in pre-college students has extended throughout all grade levels, inundating students with STEM oriented programs designed to promote the engaging and enjoyable aspects of working in STEM while improving students ability to identify with STEM fields of study. STEM outreach and engagement programs, with the primary goal of increasing STEM exposure and positively portraying work in STEM fields, frequently succeed at improving student interest in STEM and willingness to pursue STEM as a college major. This increased interest does not appear to persist among STEM students in higher education however, with many exiting STEM often feeling as if they did not understand the true nature of their selected fields. This disparity between the effective pre-college promotion of STEM and the persistent contentedness of college STEM students suggests a misunderstanding of how students evaluate and express their academic needs and interests, requiring further investigation to ensure that resources allocated to fulfilling the need for STEM students better aligns with the needs of the students themselves.

This study initiates this investigation with an examination of how students, discontented with their STEM majors, decided to major in STEM and how their interaction with STEM related discourses and experiences influenced these decisions. An improved understanding how this impacts immediate and longer-term student decision-making regarding STEM majors may inform further efforts to effectively engage persistent student interest in STEM without the unfortunate consequences of excessive STEM attrition in college programs.

Literature

Despite increased recruitment of students into college STEM programs (General Accounting Office, 2005) to fulfill national needs (Atkin et al., 2002), more than half of those enrolled exit STEM programs (Lomax, 2015), often switching to non-STEM alternatives (Piper & Krehbiel, 2015). Students often report a loss of interest or motivation (Hunter, 2019) and feeling under-informed about their chosen STEM major (Thiry & Weston, 2019). Much research focuses on stimulating pre-college STEM interests (Herrera & Hurtado, 2011) rather than how students make STEM choices (Moakler & Kim, 2014). Some college STEM biology programs have demonstrated improved enrollment and maintenance of rigor through the use of advanced curriculum preparation, suggesting that the pure outreach and engagement efforts typically employed to improve student interest and promote enrollment in STEM majors may not best address the long term success of recruiting in STEM fields (Lomax, 2015; Sax et al., 2018).

STEM outreach and engagement programs are essentially an exchange of information between program hosts and students with the goal of improving the future selection of STEM related majors. This exchange constitutes a discourse and as such, its primary intent is to exert an influence (Clarke, 2015) through construction of a perceived reality (Lanas & Brunila, 2019; Pinar et al., 1995) that evokes a desired action (Clarke, 2015). Students regularly engage in

discourse as they negotiate the meaning and value of ideas between themselves and others (Slembrouck, 2004), conceptualizing their perceptions and experiences through language (Trifonas, 2009). Such information transfer is imperfect however, as language becomes infused with one's own values and adds to or subtracts from the intended meaning (Bakhtin, 1981).

Similarly, experience, a key aspect in STEM outreach and engagement programs, is also discursive in nature (Ricoeur, 1971; Scott-Baumann, 2011) and important in student decisions toward STEM majors (Bottia et al., 2015; Vincent-Ruz & Schunn, 2019), serving to catalyze changes in their ideas and conceptions of science (Na & Song, 2014). The meaning of an experience, however, must be interpreted from the student's point of view (Foucault, 1972), and may be altered from its original intent by the available interpretive contexts (Ricoeur, 1976). Available contexts may vary widely between individuals, and those most proximal which adequately support a meaningful interpretation tend to become the most relevant (Shen, 2013). In response, specific contexts may be supplied which improve the fidelity of the intended message (i.e., increasing STEM interest) (Shen, 2013), increasing the apparent effectiveness of outreach and engagement activities.

Wise students base their decisions on an assimilation of knowledge and values, from both themselves and others (Reznitskaya & Sternberg, 2012), and negotiate the derived meanings to mediate discovery of their own realities (Mann, 1994; Slembrouck, 2004). Efforts to influence the formation of these realities (Pinar et al., 1995), encouraging the selection of STEM majors, ultimately may diminish the control students have over their decisions (Holmegaard, 2015). Decisions that address immediately perceived interests but lack persistence when considering long term personal needs may incur unexpected costs, including negative impacts on student

grades, graduation rates, matriculation delays, and increased financial burdens (Foraker, 2012; Sullivan, 2010).

Research Questions

This study explores the pre-college experiences of students who feel discontented in their selection of biology as a college major, examining how these experiences impacted their decisions to pursue this STEM major. The research questions are:

RQ1: How did specific pre-college STEM-related experiences impact students' decisions to pursue a university biology degree?

RQ2: What impact did pre-college STEM-related discourse have on students' decisions to pursue a university biology degree?

Theoretical Framework

This study is rooted in post-structuralism and critical discourse analysis. 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 of the individual truths of each student (Landry & MacLean, 1996). Critical discourse analysis represents how information is assembled by an author (the described object of discourse), how it is presented and transferred to a recipient (the process and interpretation of discourse), and the social context which influenced the creation of the discourse (Fairclough, 2013; Janks, 1997). As students struggle to identify with their academic field and achieve a sense of belonging, 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 alternate views and question their associated meanings in an attempt to discover the true nature of themselves (Mann, 1994; Slembrouck, 2004). Discourse 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 and heavily influenced by the context in which it was delivered (Olsson, 2007).

This study will examine students' self-described experiences as they relate to their influence on the choice to pursue a college STEM major. Particular attention will be given to the influences on students' ability to identify with their selected field. These findings will be related to how the students' experiences and any supporting discourses were encountered and received, and the perceptions of STEM that resulted from the interactions.

Methods

Research Design

This study will employ a phenomenological approach to examine what experiences were most influential in leading students to choose a STEM major (in this study, biological sciences). 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)

Participants

This study will focus on two groups at a large public Midwestern research-intensive university. The Biology group will consist of college undergraduates enrolled in a Bachelor of Science biology degree program. The Transfer group will consist of college undergraduates who were enrolled in a Bachelor of Science biology degree program but have since completed a change of major to another non-STEM major. Inclusion criteria for both groups are

undergraduate students 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.

Context

The study site university's overall undergraduate program (all majors) consists of predominantly white, domestic students, with 55% female. The College of Science, which includes biology and the other *hard* sciences, is as a whole 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

Participants for the Biology group will be solicited from undergraduate students within the Department of Biology, through both physical flyers and email distribution lists. Participants for the Transfer group will be similarly identified in academic areas known as transfer targets, and through mailing lists derived from the university registrar's program transfer records. The solicitation will request participants who meet the inclusion criteria for each group, with a small-value gift card advertised as an incentive for those who qualify for the study. Respondents will complete a further screening questionnaire to ensure all specified inclusion criteria are met and further confirm their feelings of discontent in their current (Biology) or previous (Transfer) choice of STEM major.

Data Sources

The study will utilize data obtained through direct interviews with participants. The interviews will be audio recorded and transcribed verbatim for further analysis. Both forms will be stored in secured electronic formats.

Data Analysis

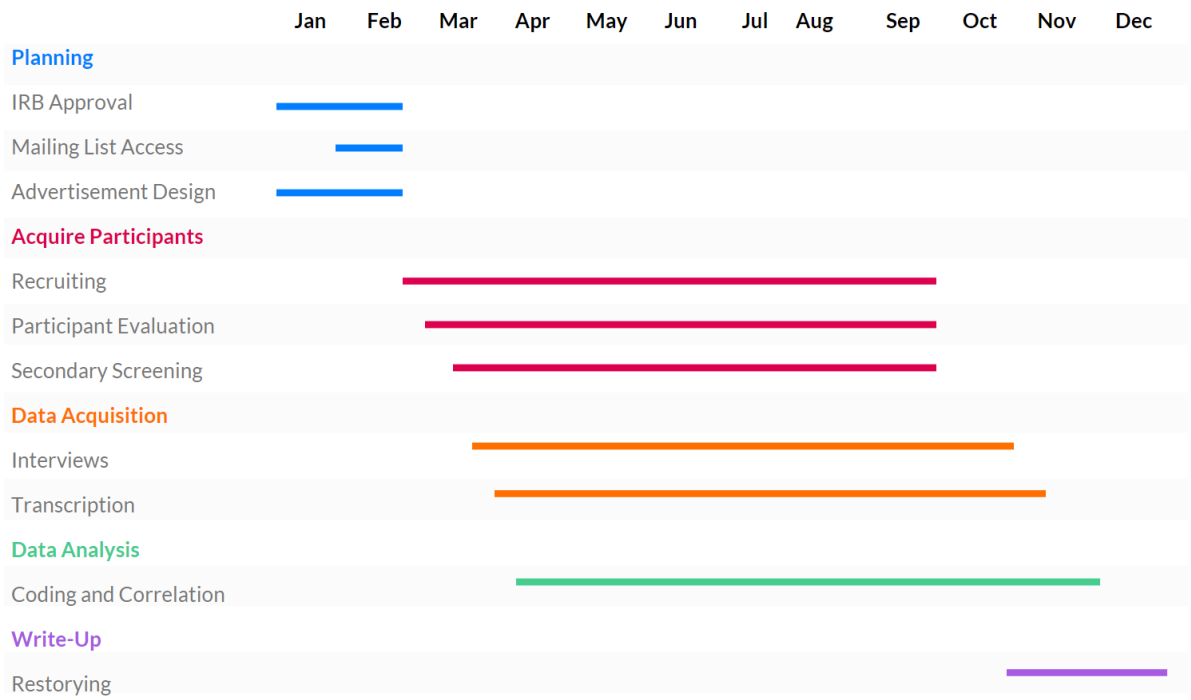
Data analysis will be concurrent with collection to help determine the saturation point within each study group. The transcribed interview data will be verified against the original audio for accuracy. The narratives describing the participant's experiences will be analyzed for themes related to the 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 selection of STEM majors. Additional narratives will be analyzed to further refine the findings until no new themes are identified within either study group. The final analysis will result in a restorying of the participants' narratives, describing how their experiences acted to influence their choices to major in STEM programs. (Project Proposal Narrative:1796 words)

Project Timeline

Figure 1 provides an approximate timeline describing the anticipated order and duration of key project events. Data collection will be concurrent with analysis to help determine saturation, therefore recruiting, data acquisition, and data analysis overlap and potentially span the bulk of the project duration.

Figure 1

Approximate Project 2021 Timeline



A Gantt chart showing the approximate 2021 timeline of key project milestones. Concurrent data collection and analysis result in overlapping activity windows.

Project Team

Principal Investigator: Nathanial C. Hilliard, graduate student.

Curriculum Vitae

1. **Personal data**

Nathanial C Hilliard, Graduate student

Learning Design and Technology, Purdue University, PFEN G076

715 W State Street,

West Lafayette, IN 47906

765-494-3569

Email: nhilliar@purdue.edu

2. Academic record

a. Degrees awarded

Institution	Degree	Completed
Purdue University	Bachelor of Science Major: Biology	May, 1993
Purdue University	Master of Science Environmental Engineering	May, 2016
Purdue University	Ph.D. Learning Design & Technology	August, 2023

3. Certifications

Project Wet & Wild Educator Workshop Certification, 2014

NAAEE Initial Preparation for Environmental Educators Certificate, 2014

A. DISCOVERY

1. Published work

** indicates primary author(s)*

a. Refereed journal articles

1. Dilmac, N.*, **Hilliard, N**., & Hockerman, G. H. (2003). Molecular determinants of Ca2+ potentiation of diltiazem block and Ca2+-dependent inactivation in the pore region of cav1. 2. *Molecular pharmacology*, *64*(2), 491-501.
2. Liu, G.*, Dilmac, N.*, **Hilliard, N**., & Hockerman, G. H. (2003). Cav1. 3 is

preferentially coupled to glucose-stimulated insulin secretion in the pancreatic β-cell line INS-1. *Journal of Pharmacology and Experimental Therapeutics*, *305*(1), 271-278.

3. Dilmac, N.*, **Hilliard, N**., & Hockerman, G. H. (2004). Molecular determinants of frequency dependence and Ca2+ potentiation of verapamil block in the pore region of Cav1. 2. *Molecular pharmacology*, *66*(5), 1236-1247.
4. Liu, G.*, **Hilliard, N**., & Hockerman, G. H. (2004). Cav1. 3 is preferentially coupled to glucose-induced [Ca2+] i oscillations in the pancreatic β cell line INS-1. *Molecular pharmacology*, *65*(5), 1269-1277.
5. Liu, G.*, Jacobo, S. M. P.*, **Hilliard, N**., & Hockerman, G. H. (2006). Differential modulation of Cav1. 2 and Cav1. 3-mediated glucose-stimulated insulin secretion by cAMP in INS-1 cells: distinct roles for exchange protein directly activated by cAMP 2 (Epac2) and protein kinase A. *Journal of Pharmacology and Experimental Therapeutics*, *318*(1), 152-160.
6. Walsh, K. B.*, Zhang, J.*, Fuseler, J. W., **Hilliard, N**., & Hockerman, G. H. (2007). Adenoviral-mediated expression of dihydropyridine-insensitive L-type calcium channels in cardiac ventricular myocytes and fibroblasts. European journal of pharmacology, 565(1-3), 7-16.

B. LEARNING

1. Courses taught in the last three years

a. FNR 353 - Forest Measurements (3 cr.). S11-20

2. Course and Curriculum Development

a. Significant redesign of FNR 353 field laboratory experiences to improve alignment with course topics and concept application
b. Re/Design of FNR 353 lecture topics to facilitate an active learning classroom

References

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