Tapping the Geoscience Two-Year College Student Reservoir: Factors that Influence Student Transfer Intent and Physical Science Degree Aspirations

By

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Abstract

Colleges and universities are facing greater accountability to identify and implement practices that increase the number of two-year college (2YC) students who transfer to four-year institutions (4YC) and complete baccalaureate degrees. This is particularly true for physical science and geoscience disciplines, which have the lowest STEM degree completion rates of students transferring from 2YCs (Wilson, 2014a). A better understanding of how academic engagement experiences contribute to increased 2YC student interest in these disciplines and student intent to transfer is critical in strengthening the transfer pathway for the physical sciences and geosciences.

The purpose of this study was to gain understanding of the influence that background characteristics, mathematics preparation, academic experiences (e.g. faculty-student interaction, undergraduate research experiences, and field experiences), and academic advisor engagement have on 2YC student intentions to transfer to a four-year institution (4YC) with physical science or geoscience degree aspirations. Incorporating the conceptual frameworks of student engagement and transfer student capital (Laanan et al., 2010), this study used Astin's (1993; 1999) input-environment-outcomes (I-E-O) model to investigate what factors predict 2YC students' intent to transfer to a 4YC and pursue physical science or geoscience degrees.

This study used a quantitative research approach with data collected from 751 student respondents from 24 2YCs. Results from three sequential multiple regression models revealed advisor interaction, speaking with a transfer advisor, and visiting the intended 4YC were significant in increased 2YC student transfer intent. Student-faculty interaction and faculty and academic advisors discussing career opportunities in the physical sciences were significant in leading to increased 2YC student intent to pursue physical science degrees or geoscience degrees. The results also substantiated the significant role that field-based experiences have in increasing student intent in pursuing geoscience related majors. Surprisingly, developmental math placement was not found to be a significant predictor of transfer intent nor intent to pursue physical science or geoscience degrees. These findings reveal that developing practices focused on transfer student capital acquisition can strengthen the pipeline of physical science and geoscience degrees and supports the suggestion that 2YCs can serve as an intervention point to broaden participation in STEM related degrees.

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Table of Contents

List of Figures

List of Tables

Chapter1: Introduction

Two-year colleges (2YCs) play an important role in postsecondary education in the U.S., with nearly half of undergraduate college students enrolled in 2YCs and 45% of first time freshman using 2YCs as an entry point to a four-year degree (American Association of Community Colleges [AACC], 2015). Ease of access and low tuition have contributed to significant numbers of students who begin their postsecondary education career at 2YCs (Bailey & Alfonso, 2005; Hoachlander, Sikora, & Horn, 2003; Monaghan & Attewell, 2014; Mooney & Foley, 2011; Mullin, 2012a; Roman, 2007). It is for these reasons that President Obama recently proposed the America's College Promise to make two years of community college free for graduating high school seniors across the U.S., letting students earn the first two years of a bachelor's degree at no cost (The White House, 2015). However, these factors also contribute to higher numbers of enrolled students from lower socioeconomic status (SES) and students from underrepresented groups, who are often unprepared for college and in need of developmental and remedial education (AACC, 2015; Bailey, Jenkins, & Leinbach, 2005; Wild & Ebbers, 2002) and often fail to persist and attain baccalaureate degrees (Alfonso, 2006; Leigh & Gill, 2004; Pascarella & Terenzini, 2005).

Two-year colleges also serve a critical role in facilitating student access to higher education, particularly in the education and training of science, technology, engineering and mathematics (STEM) fields (Boggs, 2010; Hagedorn & Purnamasari, 2012; Packard, Gagnon, and Senas, 2012; Starobin & Lanaan, 2010; Tsapogas, 2004). For example, 44% of those earning a degree in science and engineering (bachelor's and master's) report that they had attended a 2YC (Tsapogas, 2004) and half of bachelor's degree graduates majoring in the physical and related sciences report having attended a 2YC (Wilson, 2014a). However, the geosciences lag far behind the other sciences in baccalaureate and graduate degree completion rates of students transferring from 2YCs (O'Connell & Holmes, 2011; Wilson, 2014b). Recognition of this disparity has driven conversations to strengthen the pipeline of geoscience students beginning at 2YCs (Mosher et al., 2014), and to serve as an intervention point to broaden participation in the geoscience workforce (Londré & Wolfe, 2011; Mosher et al., 2014; Wilson, 2014b).

Encouragingly, recent trends indicate that the geoscience pipeline may be strengthening, as percentages of geoscience graduates who report attending a 2YC for at least a semester are increasing (Wilson, 2014a). If the goal is to expand the number of geoscience graduates, grow the geoscience workforce, and facilitate greater numbers of 2YC transfer students to continue on to pursue geoscience graduate degrees, it is critical to identify factors at the 2YC that predict student intent to transfer to a four-year institution and intended physical science and geoscience degree pursuit. However, researchers have not paid enough attention to the pre-transfer academic experiences of 2YC transfer students and what influences their educational attainment (Wang, 2009). This study sought to gain an understanding of the influence, if any, of pre-transfer academic experiences of 2YC students enrolled in introductory physical science courses on 2YC students' intentions to transfer to a four-year institution with physical science or geoscience degree aspirations.

Statement of the Problem

Working to improve the efficiency and effectiveness of the 2YC transfer pathway leading to students pursuing baccalaureate degrees in STEM disciplines can have numerous returns for the nation's STEM workforce (Packard et al., 2012). Labor outlooks suggest increased job demand in STEM fields and a projected shortfall of individuals qualified for these positions (National Research Council, 2013). The geosciences, in particular, are positioned to bear the brunt of this shortfall. Large numbers of geoscientists are projected to retire in the next 10 years, and the number of geoscience-related jobs is predicted to increase over the same time frame (Wilson, 2014b). In 2012, there were approximately 340,000 geoscientists employed in the United States and over the next decade, 48% of the workforce will be at or near retirement including a predicted shortage of around 150,000 geoscientists (Wilson, 2014b). Although geoscience workforce placement and starting incomes are among the highest for all sciences, even at the baccalaureate level, there remains a significant shortage of students in the geoscience pipeline (Wilson, 2014b).

Strengthening the pipeline for students pursuing degrees who begin at a 2YC is a complicated and multifaceted process. The transfer pathway for 2YC students can be a complex and challenging adjustment including navigating new academic expectations and institutional cultures (Cejda, 1997; Diaz, 1992; Townsend, 2008; Townsend & Wilson, 2006). A number of pre-transfer factors, including the academic engagement experiences of students at the 2YC, contribute to successful transition from a 2YC to a four-year institution (Laanan, Starobin, & Eggleston, 2010). A better understanding of how of academic engagement experiences may contribute to increased 2YC student interested in physical science and geoscience degrees and strengthening their intent to transfer from 2YCs to four-year institutions is critical in developing effective policies and support mechanisms for students to successfully navigate the transfer pathway (Mosher et al., 2014).

An additional hurdle influencing the intent of students transferring, particularly in physical science and geoscience related fields, is students who use a 2YC as their entry point into higher education are more likely to be underprepared academically for college-level courses than similar students entering four-year schools; at least two thirds of 2YC students test into developmental (remedial) courses, particularly in mathematics, reading, and writing (Bailey, 2009; Bailey et al., 2005; Monaghan & Attewell, 2014). Research concerning the influence developmental classes may have on physical science and geoscience degree pursuit as well as the transfer intent of students who attended a 2YC is not well defined (Mongahan & Attewell, 2014). As physical science and geoscience degrees are disciplines requiring a strong foundation of mathematics and science courses, more research is needed to investigate the impact of developmental courses on 2YC student intent to transfer to a four-year institution and their intent to pursue physical science and geoscience degrees.

Purpose of the Study

The purpose of this study was twofold: (1) to gain understanding of the influence, if any, of student engagement on 2YC students' intentions to transfer to a four-year institution with physical science or geoscience degree aspirations and (2) to add to the current body of literature on student engagement as it pertains to specifically to 2YC student outcomes in the physical sciences and geosciences. This study hypothesized that the background characteristics of the student, the mathematics preparation prior to and at the 2YC, the student academic experiences (such as faculty-student interaction, undergraduate research experiences, and field-based learning opportunities), and academic advising interactions at the 2YC positively lead to intent to transfer to a four-year institution and intent in physical science degree aspiration, more specifically a geoscience major. To test this hypothesis, this study used a quantitative research approach analyzing data collected from a pre-transfer survey instrument measuring the academic experiences and pre-transfer behaviors of 2YC students enrolled in introductory physical science courses. The survey instrument questions were developed based on constructs identified through a review of the literature and focused on four key sections: academic preparedness, transfer preparedness, student academic engagement experiences (including student-faculty interaction, undergraduate research experiences, and field-study experiences), and background characteristics. The instrument was administered to students enrolled in 2YC introductory physical science classes at 24 institutions.

Research Questions

This study examined how the background characteristics and the academic engagement of students enrolled in a 2YC introductory physical science class predict intent to transfer to a four-year institution and pursuit of a degree in a physical science related field, or more specifically a degree in the geosciences. The following quantitative research questions guided this study:

1. Of students who attend a 2YC and are enrolled in an introductory physical science class (such as geoscience, physics, or chemistry), what background characteristics, such as gender, race, ethnicity, age, parental education, income, highest level of math taken at the high school, and science courses taken at the high school predict intended transfer to a four-year institution with the identified goal of pursuing a physical science or geoscience degree?
2. Of students who attend a 2YC and are enrolled in a 2YC introductory physical science class, what entry-level mathematics placement at the 2YC (developmental/remedial mathematics placement versus college-algebra or higher mathematics placement) predict intended transfer to a four-year institution with the identified goal of pursuing a physical science or geoscience degree?
3. Of the 2YC students taking an introductory physical science course, what academic experiences (such as faculty-student interaction, undergraduate research experiences, or

field-study experiences) at the 2YC predict intended transfer to a four-year institution with pursuit of a physical science or geoscience related degree?

4. Of the 2YC students taking an introductory physical science course, what academic advising experiences and pre-transfer advising activities (such as transfer campus visit or transfer orientation participation) while at the 2YC predict intended transfer to a four-year institution with pursuit of a physical science or geoscience related degree?

Theoretical and Conceptual Framework

This study is guided by two of Bahr, Toth, Thirolf, & Massé (2013) student transfer core frameworks: (1) Student engagement (which Bahr et al. included alongside what they termed involvement), specifically academic engagement practices such as faculty-student interaction, undergraduate research experiences, and field study experiences; and (2) capital in the form of transfer student capital (TSC) (Laanan et al., 2010). This study incorporated these two constructs within an overarching framework of Astin’s (1993; 1999) input-environment-outcomes (I-E-O) model to investigate what background characteristics and 2YC academic engagement factors predict 2YC students enrolled in an introductory physical science intent to transfer to a four-year institution pursuing physical science or geoscience degrees. In the I-E-O model (see Figure 1), pre-college and 2YC student background characteristics serve as inputs into the model that 2YC students brought with them upon entry to the 2YC. While at the 2YC, the academic engagement experiences and pre-transfer academic advising interaction of 2YC students served as the environment in the model. The outputs of the model were defined as student intent to transfer and student intent to pursue a physical science or geoscience degree.

Student engagement. Research has shown the time and effort that students spend on educationally effective activities, or amount of student engagement, is the best predictor of their learning and personal development (Astin, 1993; Kuh, 2009a; Kuh, Kinzie, & Buckley, 2007; Kuh, Kinzie, Schuh, Whitt, 2010; Pascarella & Terenzini, 2005). Further, student engagement in educationally purposeful activities and practices, including purposeful student–faculty contact, is positively related to both grades and persistence, and therefore is necessary for student success (Kuh et al., 2007; Kuh, 2009b). Kuh (2003) defines student engagement as “the time and energy students devote to educationally sound activities inside and outside of the classroom, and the policies and practices that institutions use to induce students to take part in these activities” (p. 25). The concept of student engagement represents two key components: (1) the time and effort students devote to educational activities that are linked to desired outcomes of student success and (2) what institutions do to encourage students to participate in these activities (Kuh, 2003, 2009a).

The conceptual framework of student engagement is especially relevant as this study sought to examine the academic engagement experiences of students at a 2YC and the influence those have on students’ intentions to transfer to a four-year institution pursuing physical science and geoscience degrees. Specifically, this study hypothesized that students who engage in purposeful academic engagement experiences, such as undergraduate research opportunities and field study experiences, and meaningful interactions with physical science and geoscience faculty members at the 2YC predict important outcomes for 2YC student transfers, including greater intent to pursue physical science and geoscience related degrees.

Transfer student capital. Although capital theories have been used widely in research literature on 2YC students, Bahr et al. (2013) notes few researchers have applied these theories to 2YC students’ transfer experiences. Capital theories provide a useful framework for understanding how students’ background characteristics combine with their pre-transfer

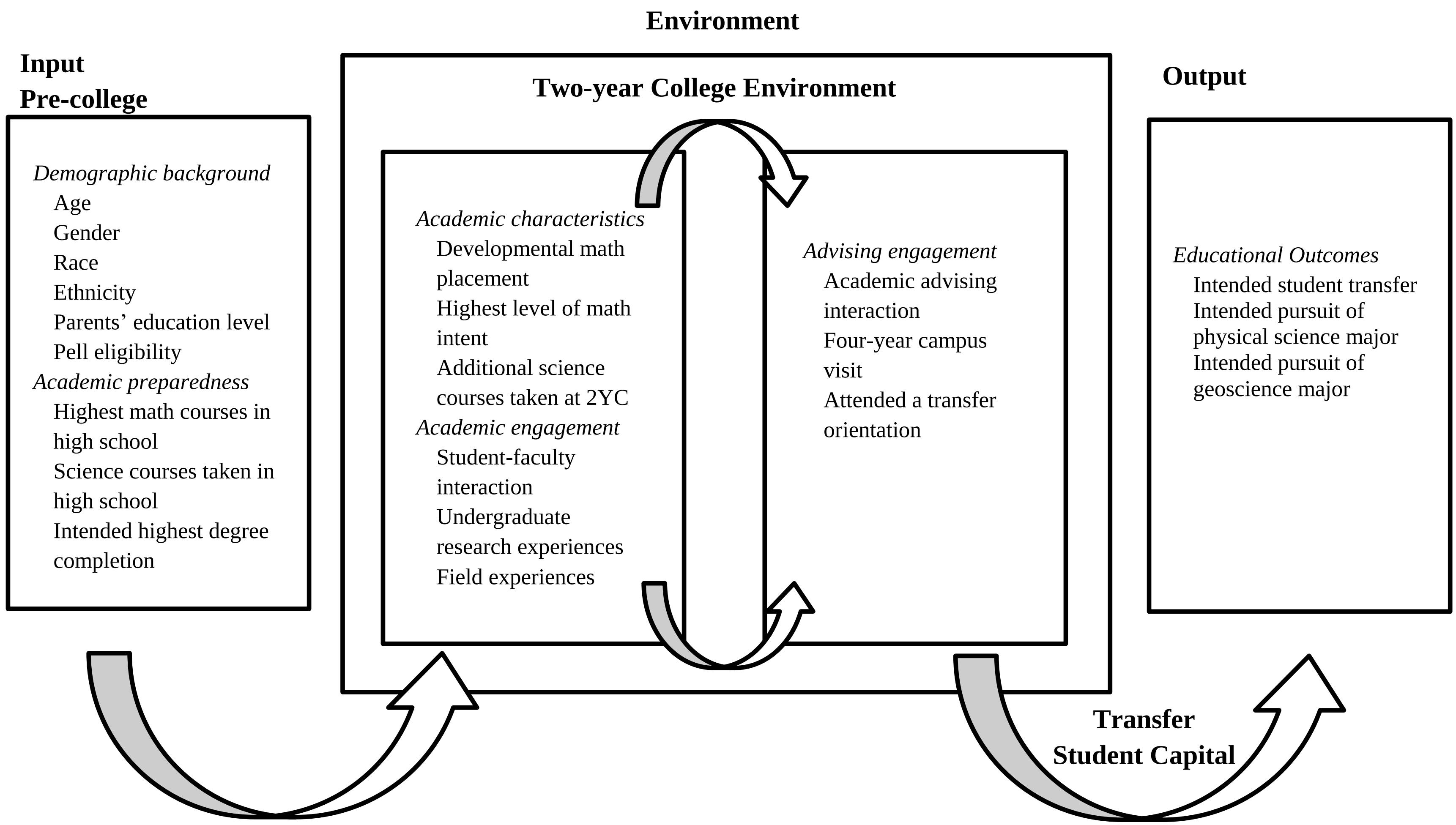

Figure 1. Conceptual model guiding the study. Inputs are defined by background characteristics and high school academic preparedness. These characteristics are what the student brings upon entry to the environment or 2YC. The environment includes the 2YC academic coursework, academic engagement activities, and pre-transfer academic advising engagement of the student. This transfer capital is carried by the student influencing outcomes of transfer intent and STEM and geoscience degree pursuit.

socialization experiences at the 2YC to influence their academic and social experiences in the receiving four-year institution (Bahr et al., 2013). This study applied the framework of transfer student capital (Laanan et al., 2010), which refers to the accumulated knowledge and experiences of 2YC students while at their 2YC who then transfer to four-year institutions. More specifically, transfer student capital indicates how 2YC students "accumulate knowledge in order to negotiate the transfer process, such as understanding credit transfer agreements between colleges, grade requirements for admission into a desired major, and course prerequisites" (Laanan et al., 2010, p. 177). Laanan et al. (2010) defined transfer student capital using four constructs: (a) academic advising experiences; (b) perceptions of transfer process; (c) experiences with faculty at the 2YC; and (d) learning and study skills acquired at the community college. They hypothesized that the more transfer capital a student acquired, the easier the transition to the four-year institution. Moser (2012; 2013) found that additional forms of transfer student capital, such as formal collaboration with faculty members at the 2YC, financial knowledge, and motivation and self-efficacy, promote the development of capital as transfer students move into the receiving four-year institution. Through such interactions, students gain knowledge in transfer credit articulation, admission requirements, and available resources at their target institution (Moser, 2013).

For the purposes of this study, the framework of transfer student capital was applied to understand the factors of faculty-student interaction, advisor-student interaction, and pre-transfer advising activities that affect 2YC student transfer intent and intended physical science or geoscience degree pursuit. It was hypothesized for this study that for 2YC students enrolled in introductory physical science courses, acquiring greater amounts of transfer student capital, in the form of advisor interaction, speaking with at transfer advisor, visiting the intended-four year institution, or attending a transfer orientation at the four-year institution promoted increased motivation and greater confidence in intended transfer to a four-year institution with intent to pursue a physical science or geoscience related degree.

Significance of the Study

While extensive literature focuses on the general student transfer experience from 2YCs to four-year institutions, less research has focused on transfer pathways and outcomes for students in specific majors and professional programs (Bahr et al., 2013). Although some studies have examined the 2YC pathway to engineering careers (Mattis & Sislin, 2005) and health related professional programs (Cameron, 2005), little research has focused on transfer experiences of 2YC students with the intention of seeking a degree in STEM related fields (Starobin & Laanan, 2010). Moreover, research on the student transfer processes is primarily through single-institution studies and recommendations of how to structure services that support students through the transfer pathway are primarily institution specific (Bahr et al., 2013). Students in 2YCs are a diverse population with varying SES status and wide ranges of age, racial, ethnic, and cultural identities (AACC, 2015; Mullin, 2012b) and these diverse characteristics have implications for 2YC students' intent to transfer and their interest in physical science and geoscience related degrees. However, the existing research on student transfer generally homogenizes 2YC transfer students and little attention has been paid to the transfer process of subpopulations of 2YC transfer students (Bahr et al., 2013). To address this gap, Bahr et al. (2013) called for future studies to examine differences in student transfer "across differing programs of study" (p. 502). This study contributes to the growing body of research on 2YC student transfer intent and 2YC students' STEM degree aspirations. It also examines the gap in research on the pre-transfer experience within particular subpopulations of 2YC students, specifically in the physical sciences and geosciences.

The timeliness of this study is important as the effort to strengthen and facilitate transfer from 2YCs to four-year institutions has come under greater scrutiny by policymakers (Mongahan & Attewell, 2014), particularly for those pursuing STEM related baccalaureate degrees (Mooney & Foley, 2011, Mosher et al., 2014). Many have suggested that a possible source for increasing students, including underrepresented students, in STEM is from 2YCs (e.g., Hagedorn & Purnamasari, 2012; President’s Council of Advisors on Science and Technology, 2012; Mooney & Foley, 2011; National Research Council and National Academy of Engineering, 2012; Reyes, 2011). This is particularly true for the geosciences which historically have overlooked the 2YC pipeline of potential geoscience majors (Mosher et al., 2014; Wilson, 2014a; Wolfe, van der Hoeven Kraft, & Wilson, 2015; Wolfe, Wilson, & van der Hoeven Kraft, 2014). Starobin and Laanan (2010) suggest a better understanding of students intending to transfer with majors in STEM disciplines can enhance the understandings of STEM majors’ educational pathways, allowing development of institutional policies and resources to assist students in their social, psychological, and academic adjustment process. This study also addresses a call by the American Geoscience Institute (AGI) for greater understanding of factors that influence 2YC students transferring into four-year institutions to obtain geoscience degrees (Wilson, 2014a).

Studying the factors that lead to increased 2YC student transfer intent and greater physical science and geoscience degree aspiration may lead to increased recruitment of students, particularly those from underrepresented groups, in choosing to pursue a physical science or geoscience related major. Further, it has been suggested that 2YCs can serve as an intervention point to broaden participation in the STEM workforce (Starobin & Laanan, 2010; Londré &

Wolfe, 2011; Mosher et al., 2014; Wilson, 2014a). However, a significant gap exists for minority population participation in science and mathematics fields (National Science Board, 2014; Wilson, 2014b). Even more discouraging, the geosciences lag behind all other sciences in terms of minority and first generation college-student participation with 18% of geoscience associate's degrees awarded to minorities, lower than for any other science discipline (Wilson, 2014b). With Hispanics alone making up 21% of the enrollments at 2YCs (AACC, 2015), the low percentage of awarded associate's degrees in the geosciences for underrepresented groups reinforces the need for a stronger pipeline for geoscience majors among minority populations who often start at 2YCs (Moser et al., 2014; Wilson, 2014a, 2014b). Although this study focuses on the general student population taking an introductory physical science course at 2YCs, the wide diversity of students from 2YCs including racial, ethnic, cultural identity, socioeconomic background, and age, may reveal possible insights in how academic engagement experiences influence transfer and STEM degree intent for underrepresented populations, and result in increasing overall diversity of the geoscience workforce.

Chapter 2: Literature Review

Nationally, two-year colleges (2YCs) have come under greater scrutiny of completion of baccalaureate degrees by 2YC transfer students (Dougherty et al., 2014; Tandberg, Hillman, & Barakat, 2014; Townsend & Wilson, 2006). Coupled with the rising costs of tuition and competition for reduced resources, greater attention by state governments is being paid to college performance outcomes including accountability of student transfer performance for 2YCs and receiving four-year institutions (Anderson, Alfonso, & Sun, 2006; Dougherty et al., 2014; Dougherty, Natow, Bork, Jones, & Vega, 2013; Tandberg, et al., 2014). Eggleston and Laanan (2001) stress that "understanding the elements that hinder or enhance academic performance, persistence, and graduation rates among transfer students can advance the knowledge currently available regarding the performance and success of community college transfer students at senior institutions" (p. 87). Similarly, Shapiro et al. (2013) argues in a time of greater postsecondary educational accountability based on certificate or degree completion rates as a measure of institutional effectiveness, it is critical for higher education policymakers to determine the practices of 2YCs that increase the number of students who transfer and graduate with bachelor's degrees. Therefore, a greater understanding of the pathways and completion outcomes of students who transfer from 2YCs to four-year institutions is needed.

Of particular importance is the science, technology, engineering and mathematics (STEM) student transfer pipeline (Mooney & Foley, 2011, Mosher et al., 2014). Two-year colleges (2YCs) serve a critical role in the education and training of STEM fields (Boggs, 2010; Hagedorn & Purnamasari, 2012; Packard, et al., 2012; Starobin & Lanaan, 2010; Tsapogas, 2004). Specific to the geosciences, 28% of baccalaureate graduates report having attended a 2YC for at least one semester and 26% of master's degree recipients report having attended a 2YC

(Wilson, 2014b). However, among the STEM disciplines the geosciences lag far behind the other sciences in baccalaureate and graduate degree completion rates of students transferring from 2YCs (Wilson, 2014b). Recognition of this disparity and a desire to increase the number of geoscience graduates has driven conversations to strengthen the pipeline of geoscience transfer student beginning at 2YCs (Mosher et al., 2014; Wolfe et al., 2015; Wolfe, et al., 2014). However, challenges remain in increasing the numbers of 2YC students successfully completing a 2YC program then transferring to and completing four-year STEM baccalaureate programs (Boggs, 2010). Starobin and Laanan (2010) suggest a better understanding of transfer students majoring in STEM disciplines can enhance the understandings of STEM majors' educational pathways, allowing development of institutional policies and resources to assist students in their social, psychological, and academic adjustment process.

A considerable body of literature exists examining 2YC student transfer to four-year institutions. This chapter examines this research, first exploring the population of students who attend 2YCs followed by a review of previous research findings related to the student transfer process. This includes examining the influence of students' background and demographic characteristics, pre-college and 2YC academic preparation and achievement, and institutional factors such as transfer preparedness and academic advising. This chapter also explores the influence of two key conceptual frameworks on student transfer: (1) student engagement (Kuh, 2003), in the form of student-faculty interaction, undergraduate research experiences, and field based experiences; and (2) capital theories, including transfer student capital (Laanan et al., 2010). Merging these two concepts, this chapter also presents a conceptual model of 2YC student transfer and intent to pursue physical science and geoscience related degrees.

Two-Year College Students

This study sought to understand what influences, if any, student academic engagement experiences have on 2YC students' intentions to transfer and on 2YC students' physical science or geoscience degree aspirations. In focusing on 2YC students, it is necessary to discuss the current state of 2YCs in the United States and their demographic makeup nationwide. Two-year colleges serve as an access point for students to higher education through their open access admission policies, location, and lower tuition costs (Bailey & Alfonso, 2005; Hoachlander, et al., 2003; Monaghan & Attewell, 2014; Mullin, 2012a; Roman, 2007). More importantly, the transfer function of 2YCs makes it possible for many students, particularly nontraditional students, to access higher education and continue pursuing their degree at a four-year institution (Eggelston & Laanan, 2001; Laanan, 2001; Starobin & Laanan, 2010). Currently 1,132 public and private 2YCs in the U. S. enroll 12.4 million students annually, including approximately 46% of all U.S. undergraduates and 41% of first time freshman (AACC, 2015).

The student population of 2YCs are often more demographically diverse than of four-year institutions as women, minority students, and students from lower socioeconomic status (SES) are more likely use 2YCs as their entry point to higher education (Cohen & Brawer, 2008; Reyes, 2011; Wild & Ebbers, 2002). Nationally, 2YCs enroll 61% of Native American, 57% of Hispanic, 52% of African American, and 43% Asian/Pacific Islander undergraduate students (AACC, 2015). Thirty-six percent of first-generation college students begin at 2YCs, where the average student is older (Starobin & Laanan, 2010), more likely to be female (57%), attending college part time (61%), and working full or part time (73%) while attending school (AACC, 2015). Two-year college students are more likely to be receiving some type of financial aid (58%) including 33% of students receiving Pell grants (AACC, 2015). Most 2YCs are commuter campuses and the constraints of 2YC students, such as job and family responsibilities, often results in less engagement on campus by students who typically go to campus only when they need to attend classes (Astin, 1993, Cohen, 1990; McArthur, 2005; Zhang & Ozuna, 2015). Additionally, 2YC students are more likely to interrupt enrollment and delay enrollment (Alfonso, 2006; Mullin, 2012b).

The demographics of 2YC students has important implications to this study as they may impact the ability for students to actively engage both academically and socially while attending a 2YC; working part-time or full-time jobs, family obligations or responsibilities, lack of available funding, and poor academic preparation can act as challenges and barriers to student engagement (Kuh et al., 2007). More so, the demographic characteristics, such as gender, age, and race and ethnicity of 2YC students can have significant implications for STEM degree pursuit (Laanan et al., 2010; Myers, Starobin, Chen, Baul, & Kollasch, 2015).

Cooling Out versus Heating Up Function of Two-Year Colleges

This study examines the pre-transfer engagement experiences of 2YC college students with physical science and geoscience degree aspirations and how those experiences influence their transfer intent behaviors. It is important therefore to examine the current literature regarding the impact of entering higher education through a 2YC has on student retention and subsequent successful student transfer. Many students begin at the 2YC with aspirations of transferring to a baccalaureate-granting institution (Berkner, Horn, & Clune, 2000; Hoachlander, et al., 2003; Horn, & Skomsvold, 2012; Laanan, 2003, 2004; Laanan, et al., 2010; Mullin, 2012a). It is for these reasons that 2YCs have been praised for democratization of higher education by enhancing access to postsecondary education (Leigh & Gill, 2004; Rouse, 1995). Conversely, 2YCs have been criticized for lowering educational attainment by diverting students from four-year institutions (Brint & Karabel, 1989; Rouse, 1995) and serve as a holding pattern where students fail to persist and attain baccalaureate degrees (Alfonso, 2006; Bahr, 2008a; Brint & Karabel, 1989; Clark, 1960, 1980). This claim is supported by a significant number of students who enter 2YCs and fail to complete a formal credential (Berkner et al., 2000) or manage to transfer to a four-year institution (Alfonso, 2006). For example, Alfonso (2006) after controlling for SES, academic preparation, and educational expectations reported students attending a 2YC have between a 21 and 33% lower baccalaureate completion rate than their four-year counterparts. Similarly, Reynolds (2012) reported estimates of about a 25% baccalaureate disadvantage for men and about 32%-point difference for women who start at a 2YC than those that begin at a four-year institution. In their study, Long and Kurlaender (2009) found 2YC students were 43% less likely to complete bachelor's degrees than students who began at selective four-year colleges, had a significantly smaller likelihood of degree receipt, earned fewer total credits, and had an increased likelihood of stopping out without a degree.

Clark (1960, 1980) first advanced an explanation for the large number of 2YCs students who depart from the institution or fail to go on and complete a baccalaureate degree, which he termed "the cooling out function" of community colleges. With their open admission policies, many 2YCs admit all students, regardless of their high school academic record or academic preparedness. Clark argued that this results in many students lowering their educational expectations during their time spent at the 2YC. Specifically, he suggested that 2YCs develop ways through academic advising to lower students' expectations and reorient student goals based on the deficiencies in a student's academic record such that students accept "a substitute that has lower status in both the college and society in general" (1960, p. 572). Bahr (2008b), contradicting Clark in finding that academic advising does benefits students, instead stressed other institutional practices may be a contributing factor to the cooling out process pointing to low success rates of students in developmental math programs.

Brint and Karabel (1989) took the “cooling out function” a step further in advancing the premise that leaders of elite universities promote 2YCs to redirect student demand for access to four-year institutions. They further argue that 2YCs serve as a means by which student ambitions are lowered to fit with the opportunities actually available in the labor market, channeling students into short-term and vocational programs. Similarly, in his review of several studies comparing the effects of 2YCs and other postsecondary institutions on educational attainment, Dougherty (1987) claimed 2YCs’ concern with vocational education resulted in shifting resources and attention to developing vocational programs ultimately not encouraging students to consider transfer to a four-year institution. He concluded baccalaureate seeking students who enter a 2YC secure significantly fewer bachelor's degrees, obtained fewer years of education, and ultimately secured less prestigious jobs, than similar students who start at a four-year institution.

More recently, other researchers have found the “cooling out” function of 2YCs may be overstated (Alexander, Bozick, & Entwisle, 2008; Leigh & Gill, 2004; Monaghan & Attewell, 2014; Mullin, 2012a; Romano, 2004). Alexander et al. (2008) found 2YC students actually increased their degree expectations as they spent more time there, in a process termed “heating up.” Leigh and Gill (2004) found that degree aspirations measured at end of high school and again in the 2YC or four-year institution “heated up” more than cooled. They found in 2YCs, students increased their educational aspirations by almost 38%, while only 23% cooled, and are similar to rates of heating up (35%) and cooling (20%) reported by students at four-year institutions. Romano (2004), in his study of student educational intentions through analyses of student survey data collected in the 1970s, 80s, and 90s at a single institution, found 33% of students' aspirations were heated up and only 2.5% were cooled-out. Roksa (2006) concluded that when community colleges offer vocational training in degree-granting programs, it does not hinder students' educational attainment finding that students attending vocationally focused 2YCs did not have lower educational attainment than those directly enrolling in a four-year institution. Further, 2YC students who transfer to four-year institutions are just as likely to complete a baccalaureate as similar students who initially enrolled at four-year institutions (Melguizo, Kienzl, & Alfonso, 2011; Monaghan & Attewell, 2014; Mullin, 2012a).

The cooling off versus heating up function of 2YC is meaningfully connected to this study. Specifically, this study sought to examine what influences academic preparedness, 2YC academic experiences, and pre-transfer advising activities have on the cooling off versus heating up of transfer intent and degree aspirations in physical science and geoscience for students starting at a 2YC. Although this study proposed to focus on the pre-transfer experiences of 2YC students and did not examine longitudinally the completion of baccalaureate degrees post-transfer, it did examine if these pre-transfer experiences resulted in a "heating up" measured by student transfer intent and intent to pursue a physical science or geoscience major.

Student Transfer

This study examined the transfer intent of students enrolled in physical science courses at the 2YC. As such, a greater understanding of the types of student transfer pathways between institutions of higher education is necessary. Student transfer is defined as "a transition between postsecondary institutions in which the second institution (the destination or receiving institution) typically grants the student credit for coursework taken at the first institution (the origin or sending institution)" (McCormick, 1997, p. 1). This transition commonly is either "horizontal" between institutions at the same level (e.g. between four-year institutions) or “vertical” such as upward transfer from a 2YC to a four-year institution (McCormick, 1997). Less common patterns of transfer behavior include “reverse” transfers where students move to a lower-level degree granting institution (e.g., moving from a four-year institution to a 2YC) (McCormick, 1997) and “swirling” which describes back and forth patterns of enrollment between two institutions such as between a 2YC and four-year institution (Borden, 2004; McCormick, 2003). Some students also “double-dip” in attending two different institutions at the same time (de los Santos and Wright, 1990). Although some students who swirl and/or double-dip transfer, for others the credit for course work completed at the other institution is awarded by the original home institution (McCormick, 2003).

Preparing students for vertical transfer to four-year colleges and universities has been a primary function of 2YCs since they began (Cohen, 1990; Cohen and Brawer 2003). The National Student Clearinghouse Research Center (2012) reports that 45% of all bachelor’s degrees are awarded to students who have transferred from a 2YC. They also found that among all transfers from 2YCs to four-year institutions, 60% obtain a baccalaureate degree within four years of transfer. For those who completed an associate’s degree or a certificate prior to transfer, the baccalaureate graduation rate is 72% (Shapiro et al., 2013).

Within the geosciences, the percentages of geoscience graduates who report attending a 2YC for at least a semester have been increasing, including an increase of reported 2YC attendance for graduate degree recipients (Wilson, 2014b). Currently, 27% of students graduating with a bachelor’s degree in the geosciences report spending at least a semester at a 2YC before transferring to a four-year institution (Wilson, 2014b). For students who continue on to post-baccalaureate degrees, 12% of doctoral graduates and 16% of master’s graduates report transfer from a 2YC during their education (Wilson, 2014b). However, Wilson (2014b) did not report whether respondents to her survey transferred vertically or were engaged in swirling or double-dipping behaviors. It is also important to note that there is significant regional variation in the numbers of 2YC student transfers in the geosciences, which is often tied to regions with greater economic focus on the extraction of natural resources. For example, in 2012, 69% of the 7,445 geoscience majors at 26 Texas public universities, a state with significant economic development in oil and natural gas resources, had transferred from one of 67 Texas 2YCs (Gonzalez, 2013). Although there is a larger variation in the types of 2YC student transfer, this study focused on the vertical transfer intent of 2YC students with physical science or geoscience degree pursuit. Therefore, it was necessary for the research design of the study to include a means of identifying student transfer type so as to account for students who are swirling and double dipping.

Transfer Student Background Characteristics

Typically studies on college student transfer use quantitative measures of student background demographic variables, such as gender, ethnic origin, parents' formal education, and SES on academic performance (e.g. Bailey et al, 2005; Dougherty & Kienzl 2006; Freeman, Conley, & Brooks, 2006; Melguizo & Dowd, 2009; Porchea, Allen, Robbins, & Phelps, 2010; Wang, 2009; 2012). Others examine relationship between college student transfer and high school academic preparation and performance (e.g. Cabrera, Burkum, La Nasa, and Bibo, 2012; Hoachlander, et al, 2003; Lee & Frank, 1990; Porchea et al., 2010) and academic performance at the two-year college (e.g. Bauer & Bauer, 1994; Friedl, Pittenger, & Sherman, 2012; Glass & Harrington, 2002; Wang, 2012). As this study examined the influence of background characteristics on transfer intent within physical science and geoscience disciplines, the existing literature on background characteristics relationship to general student transfer was examined.

Gender, race/ethnicity, age, and socioeconomic status (SES) differences are commonly identified as determinants of postsecondary outcomes and it has been documented that student background characteristics are related to transfer (Pascarella & Terenzini, 2005). Studies have suggested that certain socio-demographic groups are less likely to succeed academically and persist at 2YCs (Bailey et al., 2005; Cabrera, et al., 2012; Freeman, et al., 2006; Wang, 2009; Zamani, 2001). For example, Lee and Frank (1990) found in their study of 2,500 students attending a 2YC that those students who successfully transferred to four-year institutions were of higher SES, less likely to be from a minority group, and less likely to be female. They found the SES of 2YC student transfers closely resembled the average SES of native four-year students, or those students who originally enrolled in four-year institutions. Dougherty and Kienzl (2006) found the SES of the parents of students was strongly and significantly associated with whether those students transferred to four-year institutions, reporting transfer rates of approximately 55% among the most affluent students compared with only a 10% transfer rate among those in the lowest income.

Others have found student SES has little or no effect on transfer success (Melguizo & Dowd, 2009; Wang, 2009). Melguizo and Dowd (2009) found in their study comparing baccalaureate attainment rates of two-year college transfer students with those of rising juniors at a four-year college, that after controlling for differences in SES, the negative effect of being a transfer student substantially diminishes. More so, when comparing completion rates of low-SES transfer and low-SES rising junior students they found no statistically significant differences. In analyzing college readiness in relation to SES, Wang (2009) found that although lower SES negatively affects transfer and degree attainment, rigorous high school academics could offset negative effects of lower SES. In light of this discrepancy and to determine what, if any, influence SES has on student transfer intent and physical science or geoscience degree pursuit, this study measured student Pell eligibility as an independent variable.

Race is a factor in the length of time required for transfer where minority students take longer to graduate (Glass & Bunn, 1998) and have lower GPAs than their white counterparts (Wang, 2012). African American and Hispanic students who enroll in 2YCs are less likely to transfer and complete bachelor's degrees than their Caucasian counterparts (Bailey et al., 2005; Wang, 2009; Zamani, 2001). Likewise, gender has been identified as a factor that impacts a student's ability to adjust to the university environment (Glass & Bunn, 1998; Lee & Frank, 1990; Suerette, 2001; Wang, 2009, 2012) and first-generation 2YC students are much more likely, relative to students with a parent holding a bachelor's degree, to drop out without having obtained a degree or transferring (Ishitani, 2006; Porchea et al, 2010). Some studies suggest that older 2YC students are less likely to transfer, stopping out after obtaining an associate's degree versus younger students who are more likely to transfer to a four-year institution without first obtaining an associate's degree (Porchea et al., 2010). This study gathered student gender, race, and ethnicity as independent variables to measure their influence on student transfer in physical science and geoscience disciplines. However, the low percentages of underrepresented populations participating in STEM disciplines, with geosciences being at the bottom (Wilson, 2014a), the diversity of the sample of students enrolled in an introductory physical science course at the 2YC might not be reflective of the general population of 2YC students.

Some researchers use demographic characteristics of student populations at 2YCs to see if there is a relationship to "risk factors" of transfer and subsequent baccalaureate degree, associate's degree, and/or certificate attainment (Freeman et al., 2006). These risk factors include delayed enrollment, attending part-time, no high school diploma, being financially independent, having a dependent other than a spouse, being a single parent, and/or working full time (Freeman et al., 2006). Many argue these risk factors negatively affect successful student transfer including time to degree completion (Alfonso, 2006; Dougherty & Kienzl, 2006; Freeman et al., 2006; Glass & Bunn, 1998). For example, Alfonso (2006) found that non-traditional enrollment pathways, such as attending part-time and delaying enrollment, result in a probability of attaining a baccalaureate degree almost a third lower than students with similar enrollment pathways who attend a four-year institution. Porchea et al., (2010) suggests younger students may be more mobile, while the number of factors unique to older students, such as dependents, lower-educational aspirations, a vocational major, and being enrolled part-time may prevent them from transferring. Given the importance of these variables in the general 2YC student transfer literature, this study will also use these variable in answering research question one in determining what background characteristics predict intended transfer with the identified goal of pursuing a physical science or geoscience degree.

Transfer Student Academic Preparedness

The academic preparedness of 2YC students is an important predictor of student success outcomes (Baily & Alfonso, 2005; Calcagno, Crosta, Bailey, & Jenkins, 2007; Dougherty & Kienzl, 2006; Lee & Frank, 1990; Roksa, 2006; Surette, 2001). As physical science and geoscience disciplines require higher level math and science courses for baccalaureate degree completion, it is necessary to gain an understanding of existing research on academic preparedness as a predictor for successful student transfer. For example, Cabrera et al. (2012) report of students with poor levels of academic preparation for college who enter higher education through 2YCs, only 2.3% achieved a bachelor's degree, compared with 30% of highly resourced students initially attending a 2YC. Likewise, numerous others have reported students with more rigorous high school preparation, higher achievement test scores, and higher high school grade point averages (GPAs) are more likely to transfer to four-year institutions and are more likely to persist through degree attainment (Hagedorn Cypers & Lester, 2008; Hoachlander et al., 2003; Lee & Frank, 1990; Porchea et al., 2010). In order to measure the high school academic preparedness' influence on student transfer intent and STEM degree pursuit, this study will ask students to record the highest level of math and science courses completed while at the high school.

The open admission policies of 2YCs mean that many students enter college underprepared academically for college work and have limited knowledge of what is required to be successful in achieving their higher education goals. As a result, 2YCs typically serve less academically prepared students than four-year institutions including students who are less likely to have taken gateway courses such as English composition and college level mathematics during high school (Adelman, 2005; Porchea et al., 2010) and therefore, many 2YC students need developmental courses to prepare for college-level work (Adelman, 2005; Attewell, Lavin, Domina, & Levey, 2006; Bailey, Jeong, & Cho, 2010). Developmental education (also known as remedial, compensatory, preparatory, or basic skills studies) are the courses required for students that enter college below the college level coursework and in most cases does not transfer to four-year institutions as college credit (Cohen & Brawer, 2008; Hagedorn & DuBray, 2010). Nearly all 2YCs provide some form of developmental education (Parsad, Lewis & Greene, 2003). Fifty-nine percent of 2YC students enroll in at least one developmental education course (Bailey, 2009) and nearly 80% of first-time freshmen who enroll in non-vocational math enroll specifically in developmental math (Bahr, 2008b). Since large percentages of 2YC students enroll or have taken at least one developmental course, this study measured academic preparedness by asking students if their college entry placement test directed them into a developmental math course.

Crisp and Delgato (2014) suggest that developmental coursework, which they found typically are over-represented with female, minority, and first-generation students, may serve to decrease students' odds of transfer. In their study, they found only 35% of developmental students transferred indicating developmental education substantially increases the risk of 2YC students leaving the institution prior to achieving their educational goals. Likewise, Wang (2012) found having taken developmental courses in math was negatively related to the academic performance of 2YC transfers. Melguizo, Bos, & Prather, (2008) report transfer students requiring developmental education courses spend three additional years enrolled full-time at the receiving four-year institution, a total of eight years of schooling, to complete their baccalaureate degree and subsequently delaying post baccalaureate degree pursuit.

Math is a major hurdle for underprepared 2YC students interested in entering STEM related majors. Student success rates in developmental math sequences is typically only about 30% (Attewell et al., 2006; Bahr, 2008b). For some students, it can take four or more semesters of successfully passing each developmental math course in the sequence to get to the math courses that are transferrable to a four-year institution and counted toward a STEM degree (Hagedorn & DuBray, 2010). This is particularly problematic for STEM majors which often require higher levels of math coursework such as trigonometry and calculus. As a result, developmental courses in mathematics by default become "gatekeeper" courses to necessary science and higher-level math courses and has significant influences on student transfer and science degree completion (Hagedorn & DuBray, 2010). Some scholars have noted that passing these gatekeeper classes, including other initial college-level courses, can substantially increase the probability of earning educational credentials (Adelman, 2006; Bailey & Alfonso, 2005). However, of the large numbers of students that take developmental mathematic courses at 2YCs, very few continue on to the college transfer based courses – such as college algebra, trigonometry, and calculus (Hagedorn & DuBray, 2010). In light of the impact developmental math coursework has on general student progression through the math sequence and the potential impact on interest in STEM degrees which require higher level math courses, this study will ask participants to report highest level of math intent at the 2YC. This will address research question two of the study in examining the influence developmental coursework has on 2YC student transfer intent and what effect, if any, on physical science and geoscience degree pursuit.

Understanding the role of this academic course-work taken at the 2YC as it relates to eventual student transfer to the four-year institution and intended pursuit of physical science and geoscience degrees is important. Lee and Frank (1990) found students' academic behaviors in 2YCs had the strongest direct effects on transfer and the probability of transfer. They state that, "although accruing more credit-hours and being a full-time student facilitate transferring, it is credits in mathematics and science that make the biggest difference" (p. 186). They conclude that completed course work in these fields seems to matter in predicting probability of transfer. Similarly, Cabrera et al. (2012) found that students who took one college math course increased their degree completion by 27%, and those that enrolled in three or more math courses were 42% more likely to earn a four-year degree than peers who took no college math courses. Additionally, they found students who took a college science course increased their degree completion by 21%.

It is important to note that other researchers have found that academic performance has no effect on educational attainment between two-year and four-year college students. Melguizo, Bos, and Prather (2011) report 2YC transfer students earn equivalent numbers of non-remedial credits and attain baccalaureate degrees at similar rates as four-year rising juniors. However, their study did not address why only a small percentage of 2YC students manage to transfer to four-year institutions. Glass and Bunn (1998) also found that students who transfer from 2YCs were academically prepared for the four-year institution and graduate given sufficient time to complete degree requirements. Further, they found 55% of students graduated within four years of enrolling at the four-year institution. Others found that "gatekeeper" courses have very little influence on students majoring in STEM and that other demographic and personal factors derail students from completing degrees (Anderson & Kim, 2006).

Similarly, some researchers, controlling for entering academic preparedness and other demographic characteristics, advance that developmental students in 2YCs do as well academically as students who did not place in developmental courses (Attewell, et al., 2006). Bettinger and Long (2005) in analyzing first-time degree seeking 2YC students who were traditional college age and whom had taken the ACT assessment test found those students who were placed in developmental math courses were 15% more likely to transfer to a four-year institution, and take approximately ten more credit hours than similar students not placed in developmental coursework. Attewell et al. (2006) found no differences in the likelihood of graduation between underprepared students who successfully complete a developmental course sequence and college-prepared students, and that students who successfully complete developmental course sequences in English experience an increased likelihood of graduation. Similarly, Bahr (2008b) found students who are successful in developmental math sequences achieve degree attainment that is comparable to that of students without the need for math remediation. Noting the disagreement between researchers regarding the impacts of developmental courses on 2YC student outcomes, this study seeks to add to the current body of developmental math literature in examining developmental placement and highest math level intent at the 2YC influence on student transfer and physical science or geoscience degree pursuit.

Academic Advising and Student Transfer

Just as background characteristics and academic preparedness influences student transfer outcomes, pre-transfer academic advising and counseling has significant impacts on student transfer success (Hagedorn et al., 2008; Packard, et al., 2012). More specific, a lack of information regarding transfer requirements, scheduling problems, and generally poor academic advising can act as barriers to successful student transfer (Glass & Bunn, 1998; Hagedorn et al., 2008; Packard et al., 2012). This study seeks to determine what academic advising pre-transfer experiences 2YC students enrolled in an introductory physical science course have engaged in and what, if any, influence those experiences have on transfer intent and STEM degree pursuit. It is therefore necessary to review the literature regarding academic advising's role in subsequent 2YC student transfer.

Packard, Gagnon, & Senas (2012), identified three 2YC institutional delay experiences for transfer STEM majors: (1) institutional setbacks such as poor or passive advising, (2) imperfect program alignment with four-year institutions such as lack of course transferability and changing prerequisites, and (3) two-year college resource limitations including scheduling issues and poor experiences with financial aid. Similarly, Hagedorn, et al. (2008) suggest that student transfer is influenced by institutional factors, such as academic advising. Townsend (2008) found that the most frequent frustration for 2YC transfer students to a large, public, research university involved the transfer of course credits taken at the 2YC including the uncertainty of the number of prior credits would count toward the desired major as opposed to electives and general education courses.

However, students who receive early transfer information provided in discipline-specific advising can avoid delays that often impede STEM persistence (Packard, Gagnon, LaBelle, Jeffers, and Lynn, 2011; Packard et al., 2012) and can position students toward transfer in STEM majors (Packard et al, 2011). For example, Jackson & Laanan (2011) found 2YC female students who transferred to a four-year institution and majored in a STEM related discipline identified academic advising as an important factor in their educational choices and that more than 75% of female students in their study who transferred to a four-year institution indicated that they met with their counselors or advisors about their intention to transfer. Similarly, Packard, Tuladhar, and Lee (2013) examined how embedding transfer advising support into STEM courses class time supported students in their transfer goals. They reported a range of actions that supported transfer of students including sharing personal experience from being at a four-year school, discussing material students will need for advanced studies, discussing the difference between 2YC and four-year institutions, identifying strategies for adjusting to a new institution, and discussing which schools are best and what programs are available.

Theoretical and Conceptual Frameworks

In their review and critique of the literature on 2YC student' post transfer transition process and outcomes, Bahr et al. (2013) identified a framework of five core concepts encompassing the post-transfer transition process and called for future research to utilize greater operationalization of these core concepts: (a) integration into the four-year institution; (b) student involvement (including engagement alongside involvement); (c) environmental pull factors working against student integration and involvement; (d) the capital that students possess at entry to the four-year institution; and (e) the transfer receptivity of the four-year institution. Although their review focused on student post-transfer transition and outcomes, two of these core frameworks are critical components of the pre-transfer process at the 2YC: (1) student engagement (which Bahr et al. included alongside what they termed involvement) and (2) capital in the form of transfer student capital.

This study, guided by the two core frameworks of student engagement and transfer student capital, employed Astin's (1993; 1999) input-environment-outcomes (I-E-O) model, shown in Figure 1, as an overarching framework to investigate what academic engagement factors predict intent to transfer and pursuit of physical science or geoscience degrees of 2YC students enrolled in an introductory physical science course. In the I-E-O model, inputs are defined as pre-college student background demographic characteristics and high school academic preparedness. These background characteristics are the input characteristics student bring with them as they enter the environment, or 2YC, in the model. The environment refers to the various coursework, pre-transfer academic advising, faculty interaction, and educational experiences including undergraduate research experiences and field based experiences, to which the student is exposed. This environment influences the amount of student engagement and transfer student capital the student obtains and in turn influences the outputs defined as student intent to transfer and student intent to pursue a physical science or geoscience degree (see Chapter 1, Figure 1). The literature map guiding this study, including the literature that supports the proposed constructs, can be found in Figure 2.

Student engagement theory. Student engagement is a predictor of learning and personal development and is linked positively to desirable learning outcomes such as critical thinking and grades (Carini, Kuh, & Klein, 2006; Kuh et al., 2007). Student engagement represents two

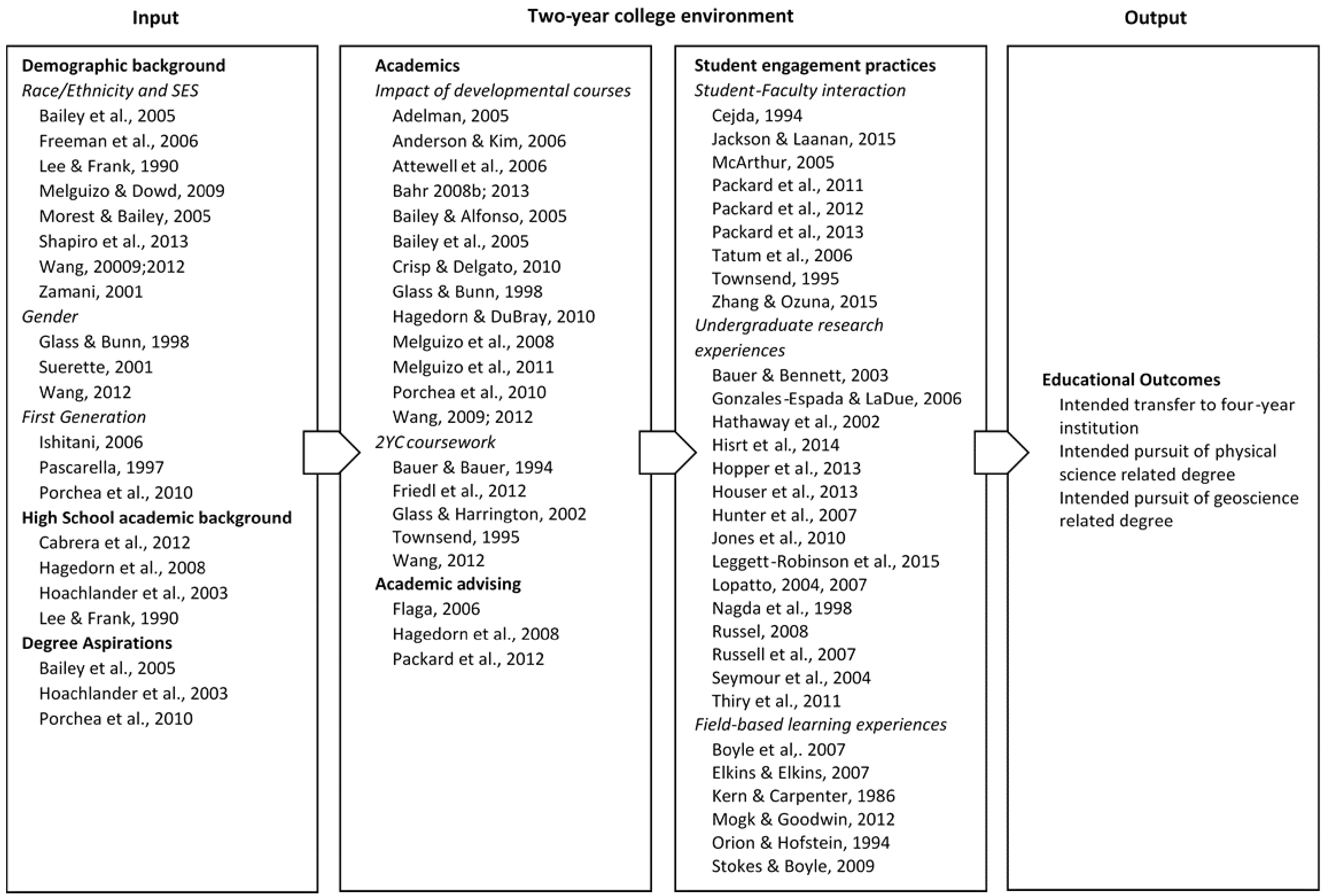

Figure 2. Literature map for this study.

critical features; the amount of time and effort students put into their studies and educationally purposeful activities (Kuh, 2003). These two features are critical factors in student persistence and retention (Kuh et al., 2007) as students who are involved in educationally purposeful activities are building ongoing capacity for academic and personal development (Carini et al., 2006).

Student engagement is used to represent constructs of quality of effort and involvement in productive learning activities (Kuh, 2009a) and is grounded in three key concepts; (1) the indicators of Chickering and Gamson (1987) seven principles for good practice in undergraduate education, (2) involvement theory (Astin, 1993, 1999), and (3) Pace's (1980) quality of effort measures. Given the conceptual overlap of student engagement and involvement, the terms are often used interchangeably (Wolf-Wendel, Ward, & Kinzie, 2009). However, student engagement differs from involvement in that it links more directly to desired educational processes and outcomes and emphasizes action that the institution can take to increase student engagement (Wolf-Wendel et al., 2009).

Student engagement also conceptualizes how the institution deploys its resources and organizes the curriculum, other learning opportunities, and support services to induce students to participate in activities that lead to the experiences and desired outcomes such as persistence, satisfaction, learning, and graduation (Kuh, 2001). Research has shown certain institutional academic practices are known to lead to high levels of student engagement (Chickering & Reisser, 1993; Pascarella & Terenzini, 2005). First described by Chickering and Gamson (1987), these practices include those that (1) encourages student-faculty contact, (2) encourages cooperation among students, (3) encourages active learning, (4) gives prompt feedback, (5) emphasizes time on task, (6) communicates high expectations, and (7) respects diverse talents and ways of learning. More so, student engagement represents the time and effort students devote to good educational practices that are linked to desired outcomes of college and what institutions do to encourage students to participate in these activities (Kuh, 2001, 2003, 2009b; Wolf-Wendel, et al., 2009).

This study seeks to examine 2YC student engagement experiences as they relate to student-faculty contact, undergraduate research experiences, and field-based learning experiences of 2YC students enrolled in introductory physical science courses and the influence those experiences may have on student intent to transfer to a four-year institution pursuing physical science or geoscience degrees. Student engagement theory suggests students who engage in these three common purposeful academic experiences for science related disciplines predict important outcomes for 2YC student transfers, including strengthening intent to transfer and greater confidence in physical science and geoscience degree pursuit. In order to contextualize the role of student-faculty interaction, undergraduate research experiences, and field-based learning experiences as it relates to this study, the following examines the literature on these three engagement practices and resulting student outcomes.

***Student-faculty interaction*.** High levels of purposeful student-faculty contact are related to student satisfaction, persistence, educational attainment, learning, and development (Astin, 1993, 1999; Chickering and Gamson, 1987; Kuh et al., 2007; Pascarella and Terenzini, 2005). Some have argued frequent student-faculty contact in and out of classes is the most important factor in student motivation and involvement (Astin, 1993; Pascarella & Terenzini, 2005). Building a relationship with faculty members can help students strengthen their motivations, develop and take ownership of their own educational goals, and persevere through difficulties and challenges encountered on the path to degree attainment (Chickering & Gamson, 1987).

Astin (1993) found that “student–faculty interaction has significant positive correlations with every academic attainment outcome: college GPA, degree attainment, graduating with honors, and enrollment in graduate or professional school” (Astin, 1993, p. 383). He also found faculty-student interaction also has a positive correlation with raising students’ aspirations. Additionally, significant outcomes of faculty-student collaboration include the reduction of the amount of transfer shock experienced by transfer students (Cejda, 1994), serves as an avenue for students seeking career advice (Zhang & Ozuna, 2015), and plays an important role in students’ decisions to attend graduate school (Astin, 1993; Houser, Lemmons, & Cahill, 2013; Pascarella & Terenzini, 2005).

Student perception of effective advising is much greater when faculty advising is discipline specific. For example, McArthur’s (2005) study of the effects of arts and humanities faculty advising outreach at a single 2YC reported positive impact on student retention in the arts and humanities than for the general student population. He found that students receiving targeted discipline advising reported greater positive interactions with faculty and felt their faculty advisor was more knowledgeable about academic and career options (McArthur, 2005).

Undergraduate research experiences. Undergraduate research experiences (UREs) are associated with increased persistence in pursuit of an undergraduate degree (Nagda, Gregeerman, Jonides, von Hipple & Lerner, 1998) particularly in STEM disciplines (Jones, Barlow, & Villarejo, 2010; Lopatto, 2004; 2007) and increased levels of pursuit of graduate education (Gonzales-Espada and LaDue, 2006; Hathaway, Nagda, & Gregerman, 2002; Hunter, Laursen, & Seymour, 2007; Russell, Hancock, & McCullough, 2007; Seymou, Hunter, Laursen, & DeAntoni, 2004). More than half (53%) of all STEM undergraduates participate in UREs (Russell, 2008). The positive influences associated with UREs has been well demonstrated including increases in graduate school and science related career aspirations (Hathaway et al., 2002; Hunter et al., 2007; Leggett-Robinson, Mooring, & Villa, 2015; Russell, 2008; Russell et al., 2007; Seymour et al, 2004; Thiry, Laursen, & Hunter, 2011), increases in student confidence (Bauer & Bennett, 2003; Hunter et al., 2007; Hunter et al., 2008), greater student understanding of the nature of science (Leggett-Robinson et al., 2015; Thiry et al., 2011), enhancement of students' understanding of the process of scientific research (Bauer & Bennett, 2003; Leggett-Robinson et al., 2015; Lopatto, 2004; Thiry et al., 2011), and gains in basic workforce skills (such as research processes, communication, technical skills, teamwork, and working independently) (Bauer & Bennett, 2003; Hunter et al., 2007; Lopatto, 2004; Thiry et al., 2011). Jones et al. (2010) reported in their study of undergraduate students majoring in biology that UREs are positively associated with odds of obtaining a baccalaureate degree, persisting in biology, and performing well in biology. Students who are involved in UREs are more likely to pursue graduate education, pursue post-undergraduate research activity, and use faculty for job recommendations than student who do not participate in undergraduate research (Hathaway et al., 2002). For example, Bauer and Bennett (2003) reported that University of Delaware alumni who had participated in an URE were significantly more likely to pursue graduate education and were twice as likely to complete doctoral studies compared with alumni with no URE. Similarly, Thiry et al. (2011) found students clarify, confirm, or refine their career and educational goals, including gaining knowledge about graduate school and career options, and increased their confidence about their readiness for graduate school. Gonzalez-Espada and LaDue (2006) found students who participated in a geoscience specific discipline (meteorology) URE leave the program with a more certain idea about attending graduate school.

It is argued that undergraduate research experiences (URE) are a significant means to establish and strengthen student-faculty relationships (Hopper, Schumacher, & Stachnik, 2013; Houser, et al., 2013). Undergraduate research experiences and student-faculty interaction may involve students in smaller communities, may offer students closer contact with faculty not easily accessible at larger four-year institutions (Hathaway et al., 2002), and may make 2YC students feel more connected to the receiving institution and decreased apprehension of the transfer process (Leggett-Robinson et al., 2015).

Existing studies of URE programs come primarily from STEM fields other than the geosciences (Gonzales-Espada and LaDue, 2006) and fewer studies have focused on UREs for 2YC students (Hirst, Bolduc, Liotta, & Packard, 2014; Leggett-Robinson et al., 2015). Recent data has shown the percentage of geoscience bachelor's graduates participating in at least one research activity while working towards their degree appears to be increasing; 56% of geoscience bachelor's student graduates report participating in faculty-directed research (Wilson, 2014b). Additionally, in a national survey of geoscience graduates, research experiences were rated "very important" by 83% of respondents (Wilson, 2014b) to their academic and professional development, suggesting the need to gain a better understanding of the factors of UREs in 2YC student transfer and geoscience degree intent. Although it has been shown UREs build confidence and research skills (Leggett-Robinson et al., 2015; Lopatto, 2004; Thiry et al., 2011), greater knowledge of and confidence to transfer to a four-year institution, and the development of an aspiration for STEM related degrees, a number factors unique to 2YC students, such as not living on campus and outside time commitments can limit their full participation in UREs (Hirst et al., 2014; Leggett-Robinson et al., 2015).

***Undergraduate field-based educational experiences*.** In addition to UREs, many geoscience undergraduate students participate in field-based educational experiences which provide them with a better understanding of scientific careers, principles, and processes. More so, field-based educational experiences provide students an opportunity to interact with other geoscience majors and faculty and are a factor associated with recruitment and retention that appear to be geoscience-specific (Levine, González, Cole, Fuhrman, & Le Floch, 2007). This prevalence and importance of field trips in geoscience education distinguishes the geosciences from other STEM fields (Levine et al., 2007), are often incorporated into the geoscience curriculum (e.g. Knapp, Greer, Connors, & Harbor, 2006), and are often component for geoscience bachelor degrees (Drummond & Markin, 2008).

The effectiveness of field study courses in improved student learning and comprehension is well-documented (Kern & Carpenter, 1986; Elkins & Elkins, 2007; Boyle et al., 2007; Stokes & Boyle, 2009; Mogk & Goodwin, 2012). It has been shown that field study courses can have positive effects on students' values, interest, and attitudes (Kern & Carpenter, 1984; Boyle et al., 2007; Stokes & Boyle, 2009). Field studies provide learning experiences that positively affect student motivation, attitudes, perceptions, and values (Mogk & Goodwin, 2012; Wolfe & Martin, 2013). Field studies also provide a social learning environment and shared experiences that build strong social and professional networks between students and faculty and student to student (Boyle, et al., 2007; Mogk & Goodwin, 2012; Wolfe & Martin, 2013). Similar to UREs, field-based educational experiences can help break down student-faculty barriers and build student-faculty relationships (Boyle et al., 2007; Fuller, Edmondson, France, Higgitt, & Ratinen, 2006). Stokes & Boyle (2009) found students increased their confidence in interacting with faculty members during fieldwork activities. Although the effectiveness of field-study courses has been studied at four-year institutions (Knapp et al., 2006; LaSage, Jones, & Edwards, 2006) and on upper level students majoring in science disciplines (Ambers, 2005; Feig, 2010), the effects of field-study courses have been less frequently reported at 2YCs (Wolfe & Martin, 2013).

Transfer student capital. The conceptual framework of capital has been employed in research on the college transfer process (e.g. Kruse, Starobin, Chen, Baul & Laanan, 2015; Melguizo & Dowd, 2009; Packard et al., 2011). Historically, capital has been used to examine factors such as the influence of college choice (Perna, 2000), access to higher education (Horvat, 2001), the college transition process (Crisp & Nora, 2010; Walpole, 2003), and participation in the sciences, specifically the geosciences (Callahan, Libarkin, McCallum, & Atchison, 2015). For the purposes of this study, Laanan’s transfer student capital is useful in understanding the disparities in 2YC student transfer, particularly as they relate to student engagement at the 2YC.

After transferring to a four-year institution, 2YC students may experience difficult adjustments to new academic, social, and institutional environments (Ishitani & McKitrick, 2010; Townsend & Wilson, 2006). Transfer students are socialized differently at the 2YC including smaller class sizes and one-on-one formal and informal interaction with faculty (Bailey et al., 2005; Jackson & Laanan, 2011; Rhine, Milligan, & Nelson, 2000). Upon transferring to the four-year environment, their experiences can be new, different, and unfamiliar and students can undergo many levels of academic and social adjustments. Students are introduced to larger classrooms, more limited interaction with faculty, and they expectations to perform academically at a level comparable to the native students at the four-year institution (Jackson & Laanan, 2015). Additionally, some 2YC transfer students may have preconceived perceptions of the four-year institution environment, which Laanan (2007) found could negatively impact their academic adjustment to the university.

Historically, the majority of the literature examining the academic and social adjustments faced by student transfers has dealt with ‘‘transfer shock’’ (first described by Hills, 1965), which is defined as a temporary drop in grade point average at the new four-year institution (Cejda, 1997; Hills, 1965). The evidence of first semester GPA declines for 2YC transfer students exceeding GPA declines of native students at the four-year institution in corresponding semesters is often offered as proof of transfer shock (Cedja, 1997). Flaga (2006) argued that although academic performance is an important part of students' experiences, "transfer shock literature does not tell the full story of transfer student transition" and that "grades are the result of a complex set of processes that occur throughout the semester" (p. 4). As a result, others have expanded the definition to include "other academic and social factors that can result in student attrition and ultimate failure to achieve a bachelor's degree" (Rhine et al., 2000, p. 443). Once transfer students survive transfer shock and adjust to their new institution, according to Hills (1965), they tend to adjust to their new institution.

Some researchers have noted that transfer shock varies significantly by discipline (Carlan & Byxbe, 2000; Cejda, 1997). Transfer students majoring in education, fine arts, humanities, and social science majors have been shown to experience very little to no transfer shock by increasing their grades during their first semester after transfer, while transfer students majoring in STEM fields experience declines (Cejda, 1997). Student transfers in science related majors have been shown to earn substantially lower GPAs in upper division course work than native four-year students and experience the most transfer shock in their first semester at the receiving institution (Carlan & Byxbe, 2000). Some argue the toughest part of the transition is in the natural and physical science fields especially for students who do not complete freshman and sophomore level prerequisite courses in mathematics, physics, chemistry, and biology prior to transfer to the four-year institution and therefore must essentially start over upon entry (Handel, 2011).

More recently, research on transfer students has moved beyond the concept of “transfer shock” to account for the more complex nature of transfer students, the multidimensional process of student transfer and the differing social organization of educational institutions (Laanan et al., 2010). Laanan et al. (2010) have posited that the student transfer process would be better understood through the lens of what they termed “transfer student capital”, which refers to the accumulated knowledge and experiences of students in order to navigate transfer to a four-year institution. This includes knowledge acquisition of credit transfer agreements between colleges, grade requirements for admission into a desired major, and course prerequisites (Laanan et al., 2010).

The transfer student capital framework of Laanan et al. (2010) is grounded in the concepts of student learning and cognitive development by Pascarella (1985); human capital theory (Becker, 1993; Sweetland, 1996); and the notion of transfer as student retention in postsecondary education (Hagedorn & Cepeda, 2004; Hagedorn, Moon, Cypers, Maxwell, & Lester, 2006; Hagedorn et al., 2008). In their study, Laanan et al. (2010) hypothesized that the more transfer capital a student acquired, the easier the transition adjustment to the four-year institution. They developed a predictive model where TSC was defined using four constructs: academic advising experiences; perceptions of the transfer process; experiences with faculty; and learning and study skills. Moser (2012; 2013) in building on the original concept of TSC, found formal collaboration with faculty members at the 2YC, financial knowledge, motivation and self-efficacy are additional forms of TSC that can be acquired as transfer students move to the receiving four-year institution.

In their study, Laanan et al., (2010) found that increased levels of transfer student capital yielded a positive influence in academic performance and adjustment once they moved to the four-year institution. These results build on Hagedorn et al., (2008) findings that transfer readiness, in the form of transfer related academic goals, is the best predictor of successful student transfer. In their findings, students who successfully transferred had completed and successfully passed more transfer courses and were more engaged in their academic pursuits. Based on these findings, an inference can be made that academic engagement of students at the 2YC can lead to an accumulation of TSC pre-transfer and in turn increases student intent to transfer and the likelihood of them moving through the transfer process successfully.

For the purposes of this study, transfer student capital was applied to understand the pre-transfer advising engagement factors that predict 2YC student intent to transfer to a four-year institution and pursuit of physical science or geoscience degrees. This includes measuring 2YC student interaction with academic advisors and faculty about the transfer process, speaking with a transfer advisor, visiting the intended four-year institution, and participation in transfer orientation pre-transfer. Additionally, academic coursework including highest math and science courses taken while at the 2YC were measured. It is hypothesized for this study that for 2YC students, acquiring greater amounts of transfer student capital promotes greater student transfer intent, and increased physical science or geoscience degree aspiration.

Summary

This chapter detailed the extensive literature that exists regarding 2YC student transfer and highlighted strategies and policies proposed by researchers to increase the number of students successfully transitioning from the 2YC to their receiving four-year institution. The chapter also detailed a number of studies that have focused on transfer for students with STEM aspirations, and pointed to a gap in research focused on 2YC student transfer in the geoscience fields. This lack of research on the influence of engagement and pre-transfer experiences within a particular subpopulation of 2YC students' intentions to transfer and their physical science degree aspirations calls for further study on this topic. By incorporating the constructs of student engagement and transfer student capital into Astin's I-E-O model, this chapter presents an overarching conceptual model of 2YC student transfer intent and physical science and geoscience degree aspiration. The next chapter will explain the methodology, data source, and data analysis plan for this study.

Chapter 3: Methodology

This study investigated factors that influence the intent of two-year college (2YC) students enrolled in entry level physical science courses (such as geoscience, physics, and chemistry) to transfer to a four-year institution and pursue STEM related degrees, more specifically physical science or geoscience degrees. The purpose of this study is twofold: (1) to gain understanding of the influence, if any, of student engagement on 2YC students' intentions to transfer to a four-year institution with physical science or geoscience degree aspirations and (2) to add to the current body of literature on student engagement as it pertains to 2YC students in specific STEM disciplines. This study hypothesized that the background characteristics of the student, the mathematics preparation prior to and at the 2YC, the student academic experiences (such as faculty-student interaction, undergraduate research experiences, and field-based learning opportunities), and engagement with academic advisors at the 2YC positively lead to student intent to transfer to a four-year institution and pursuit of a physical science or geoscience. To test this hypothesis, this study used a quantitative research approach with data collected from a pre-transfer survey instrument administered to 2YC students enrolled in introductory physical science courses.

The results of this study provide information for assisting 2YCs and receiving four-year institutions regarding which academic experiences, such as undergraduate research experiences, student-faculty experiences, and field-study experiences, as well as academic advising and pre-transfer engagement activities predict 2YC student intent to transfer to a four-year institution and pursuit of a physical science or geoscience related major. This creates the potential for both programmatic and pedagogical adjustments that promote positive student experiences prior to transfer. This, in turn, may lead to increased recruitment of students in choosing to pursue a STEM related major.

This chapter further outlines the methodology employed in this study, including the study's research questions, research design, population and setting, theoretical framework, ethical considerations, variables in the study, data analysis, and limitations. The pre-transfer survey instrument is included in Appendix A.

Research Questions

This study examined how the background characteristics and the academic engagement of students enrolled in a 2YC introductory physical science class predict intent to transfer to a four-year institution and pursue a physical science or geoscience degree. The following research questions guided this study:

1. Of students who attend a 2YC and are enrolled in an introductory physical science class (such as geoscience, physics, or chemistry), what background characteristics, such as gender, race, ethnicity, age, parental education, income, highest level of math taken at the high school, and science courses taken at the high school predict intended transfer to a four-year institution with the identified goal of pursuing a physical science or geoscience degree?
2. Of students who attend a 2YC and are enrolled in a 2YC introductory physical science class, what entry-level mathematics placement at the 2YC (developmental/remedial mathematics placement versus college-algebra or higher mathematics placement) predict intended transfer to a four-year institution with the identified goal of pursuing a physical science or geoscience degree?

3. Of the 2YC students taking an introductory physical science course, what academic experiences (such as faculty-student interaction, undergraduate research experiences, or field-study experiences) at the 2YC predict intended transfer to a four-year institution with pursuit of a physical science or geoscience related degree?
4. Of the 2YC students taking an introductory physical science course, what academic advising experiences and pre-transfer advising activities (such as transfer campus visit or transfer orientation participation) while at the 2YC predict intended transfer to a four-year institution with pursuit of a physical science or geoscience related degree?

Research Design

This study used a quantitative research method design conducted in three phases. Phase 1 involved a review of the 2YC transfer student literature to inform constructs in the development of a pre-transfer survey instrument administered to students enrolled in 2YC introductory physical science classes. In phase 2, a pilot survey was administered in three 2YC introductory science courses (an introductory geology course, an introductory chemistry course, and an introductory physics course) in Fall 2015 to test the design and properties of the survey instrument. Phase 3 involved the administration of the revised survey instrument to a broader sample of 2YC students enrolled in introductory physical science classes across the country in Spring 2016.

Pre-transfer survey instrument. This study utilized an I-E-O model to examine the influence of several pre-college student background characteristics as inputs in the model, the students' academic experience in their educational environment at the 2YC, and the influence of these on the outputs defined as student intent to transfer and student intent to pursue a physical science or geoscience degree (see Chapter 1, Figure 1). During phase 1, the initial Pre-Transfer

Survey Instrument (Appendix A) was developed after an extensive review of the student transfer literature. The instrument focuses on four key sections: academic preparedness, transfer preparedness in the form of academic advisor interaction and pre-transfer activities, student academic engagement experiences (including student-faculty interaction, undergraduate research experiences, and field-study experiences), and demographics. The pre-transfer survey instrument questions were developed and based on the precepts put forth by the study model. The survey instrument questions were designed to focus on key constructs that emerged from the literature review; academic preparedness, student academic engagement, and transfer preparedness (in the form of transfer student capital precepts from Laanan et al., 2010).

The first section of the survey focused on the academic preparedness of the student and included self-reported answers to questions related to the student's pre-college academic experiences. These survey items focused on background variables of the student's highest level of math taken in high school, number of science courses taken in high school, and highest academic degree intent. This section also contained questions related to 2YC students' characteristics such as enrollment status upon entry to the 2YC, their current class level, their associate's degree intent, their intent to transfer, and their intent to pursue physical science or geoscience majors. Additional academic preparedness questions asked students to report if they tested into, or were advised to take, developmental or remedial math courses at the 2YC and the number of science courses they had completed at the 2YC beyond the current course in which they were enrolled.

The student academic engagement experiences at the 2YC section of the survey was broken into three subcategories and included questions focused on gauging the student's student-faculty interaction level, participation in any undergraduate research experiences (UREs), and participation in any field-study experiences. Questions in this section, which used Likert-type scale responses, measured the level of the student's engagement with 2YC faculty members including faculty advising. If the student had participated in either UREs or field study experiences while at the 2YC, additional questions measuring the level of the student's engagement with those experiences were presented. Responses to these questions were on a Likert-type scale.

The transfer preparedness portion of the survey instrument sought to better understand the level of the student's engagement with academic advising and pre-transfer interactions with their intended receiving four-year institution (such as campus visit or transfer orientation). This included a block of questions gauging level of student-academic advisor engagement, if the student had spoken with a transfer advisor at the receiving four-year institution, if the student had visited the four-year institution, and if the student had attended a transfer orientation at the receiving four-year institution. Responses to most questions in this portion were on a Likert-type scale.

The final section, student demographics, sought to gather basic demographic data about the respondents, including: gender, race/ethnicity, age, Pell eligibility, and parent's highest level of education. The responses to the demographic questions were mostly categorical.

Pilot study. To test the usability of the survey instrument and wording as well as measure the time impact of administrating the survey during a class period, a pilot study was conducted in November 2015. The pilot survey was administered to 24 students enrolled in an introduction to physical geology class, 28 students enrolled in an introductory chemistry class, and 20 student enrolled in an introductory to physics class at a suburban 2YC campus with approximately 2,500 total student enrollment located in a large Midwestern metropolitan city. Printed copies of the pre-transfer survey instrument and instructions were provided to the instructors who distributed the survey instrument at the beginning of a class period to students who voluntarily completed the pilot survey. Informed consent was obtained by students agreeing to a consent statement at the beginning of the pilot survey. Instructors provided feedback regarding the survey length and recorded the total time necessary for students to complete the survey. Fifty-two surveys were returned for a total response rate of 72%. The average completion time for survey administration was approximately seven minutes and instructor feedback noted the survey instrument caused minimal disruption to the class period. A total of 46 student respondents identified intent to transfer to a four-year institution with 24 students identifying intent to pursue a physical science related major. Three students identified as likely or very likely to pursue a geoscience related degree. Minor adjustments were made to the survey instrument based on feedback, including wording and ordering of the survey questions.

Data collection. After reviewing the pilot study for reliability and completing minor revisions to the survey instrument, the pre-transfer survey instrument was administered to students enrolled in introductory physical science courses at 2YCs across the United States. Two-year college faculty volunteers were recruited from the membership of the Geo2YC division of the National Association of Geoscience Teachers (NAGT). Geo2YC is the two-year college division of NAGT and has an established extensive network of geoscience educators at 2YCs across the country. Additionally, recruitment of science faculty occurred via the email listserv managed by the Supporting and Advancing Geoscience Education at Two-Year Colleges (SAGE 2YC) initiative housed at the Science Education Resource Center (SERC). The survey instrument (see Appendix A), along with a copy of the University of Kansas (KU) Institutional Review Board (IRB) approval (Appendix B) was sent to 2YC instructors who volunteered to participate in the research project. These instructors administered paper copies of the instrument to undergraduate 2YC students enrolled in introductory physical science courses at their respective 2YC during the spring of 2016. Instructors recorded the 2YC name, the class title the survey was administered in, and the number of survey instruments distributed. All surveys were collected and returned via US mail.

Population and setting. This study was conducted in introductory physical science courses (physics, chemistry, and geosciences) at 24 2YCs nation-wide in the spring semester of 2016. Thirty-nine faculty volunteers were recruited from the Geo2YC division membership and from a request for volunteers sent via the SAGE2YC listserv. The faculty volunteers were from a wide array of 2YCs representing multi-campus systems, urban, suburban, and rural institutions, as well as minority serving institutions from 24 different states. Recruited faculty volunteers administered the survey instrument to the undergraduate 2YC students enrolled in their introductory physical science courses at their respective 2YC. A total of 828 students responded to the pre-transfer survey. An initial analysis of the total sample revealed 19 current high school students, 26 current four-year college students, 22 four-year college graduates, and 10 international students enrolled in 2YC introductory physical science courses. These respondents were removed from the sample leaving 751 surveys completed for the final sample. The final sample included respondents who identified themselves as either enrolling in the 2YC less than one year after graduating high school, enrolling in the 2YC after more than one year after graduating from high school, attended another 2YC before attending their current 2YC, or attended a four-year college or university before attending their current 2YC.

Ethical Considerations

Prior to administering the pre-transfer survey instrument, approval from the KU IRB was sought (see Appendix B). Although the pre-transfer survey instrument was designed as a minimal risk survey, precautions were undertaken to ensure all responses to the study's survey remained confidential. Each respondent was issued a unique identifier, and the only personal data (name and e-mail address) collected was voluntarily provided by the student if they indicate their willingness to participate in a follow-up interview as needed. No subsequent follow-up interviews took place as part of this study and contact information supplied by these students was destroyed and not retained. All necessary protocols ensuring participant consent and confidentiality was followed as prescribed by the IRB.

Study Variables

The purpose of this study was to examine demographic characteristics, academic preparedness, transfer preparedness, and academic engagement including faculty-student interaction, undergraduate research experiences, and field study experiences on students' intentions to transfer and on physical science and geoscience degree aspirations. To identify and account for populations of reverse transfer, swirling, and double dipping students, question 5 on the survey instrument asked students to identify their enrollment patterns at the 2YC. Respondents identifying themselves as current high school students, current four-year college students, four-year college graduates, or international students enrolled in 2YC introductory physical science courses were removed from the sample.

Dependent variables. This study utilized three dependent variables. The first dependent variable, intention to transfer, sought to measure the students' intention to transfer from a 2YC to a four-year institution. This variable used student responses to question 6 on the pre-transfer survey instrument which asked students to record their likelihood of transferring to a four-year college or university. Students recorded their responses on a Likert scale of 1 = none to 6 = definitely.

The second dependent variable, physical science degree intent, measured students' intended pursuit of a degree or major in a physical science related field upon transfer. This variable used student responses to question 10 on the survey instrument. Students recorded their intentions to pursue a major in a physical science discipline, such as chemistry or physics, on a Likert scale of 1 = no to 6 = definitely.

The third dependent variable, geoscience degree intent, measured students' intended pursuit of a degree or major in the geosciences upon transfer. This variable used student responses to question 11 on the survey instrument. Students recorded their intentions to pursue a major in the geosciences (e.g. earth science, geology, geography, meteorology, atmospheric science, or oceanography) on a Likert scale of 1 = no to 6 = definitely.

Independent variables. To answer research questions one through four, a large number of independent variables were analyzed as part of this study as shown in the proposed model in Chapter 2, Figure 1. Survey items related to the independent variables for this study fell into four key sections which were structured into four different blocks: demographic and background characteristics, 2YC student academic characteristics, 2YC student academic engagement experiences (student-faculty interaction, undergraduate research experiences, field-study experiences), and academic advising and pre-transfer advising activity. The first block comprised demographic and high school background characteristics, including gender, race and ethnicity, age, Pell eligibility, parent's highest education, highest level of high school math, number of high school science courses, and highest academic degree intent (survey questions 1-3 and 30-

35). The second block included 2YC student academic characteristics containing 2YC enrollment background, current class level, associate's degree intent, developmental math placement, highest math intent at the 2YC, number of science courses taken at the 2YC (questions 5, 7, 9, 12, 13, and 14). These variables were used in addressing research questions one and two, examining what background characteristics and what entry-level mathematics placement at the 2YC predict intended transfer and physical science or geoscience degree aspirations.

Survey items assessing the third block of independent variables related to academic engagement fell into three key components. The first focused on student interaction with faculty members and utilized a composite faculty interaction variable derived from answers to survey question 20 along with the variable of faculty discussing physical science related careers (question 21). The second component measured 2YC student undergraduate research experiences from answers to question 23. The third component measured 2YC student field study engagement based on student answers to question 25. These four independent variables were used in addressing research question 3, examining what academic experiences, such as faculty-student interaction, undergraduate research experiences, or field-study experiences, predict intended transfer and physical science or geoscience aspirations.

The fourth block contained independent variables of academic advisor engagement (a composite variable derived from respondent answers to question 17), academic advisor discussing physical science related careers (question 18), spoke to a transfer advisor (question 27), visited intended four-year transfer institution (question 28), and participated in a transfer orientation (question 29). The academic advising and pre-transfer advising activity block of independent variables was used to answer research question 4, what academic advising experience and pre-transfer advising activities predict intended transfer and physical science or geoscience degree aspirations.

Data Analysis

This study used a quantitative research approach. Quantitative data was collected using the pre-transfer survey instrument and was analyzed using IBM SPSS 22.0 software. Data analysis, including both descriptive statistics and sequential multiple regression, was utilized to answer the study's research questions one through four.

Descriptive statistics. To provide a better understanding of 2YC students enrolled in introductory physical science courses, the descriptive statistical analysis of the overall sample of respondents was performed. Descriptive analysis including frequencies, percentage of the sample, and number of missing responses for each variable was reported. Mean values for the six faculty interaction statements in question 20 were used to compute a composite faculty interaction variable to measure respondents' overall interaction with faculty at the 2YC. Similarly, mean values for the three advisor interaction statements in question 17 were used to compute a composite advisor interaction variable to measure respondents' overall interaction with advisors at the 2YC.

Regional comparisons. Although the study sample includes respondents from 17 different states, the responses were clustered regionally. Therefore, to examine if regional variation existed within the sample and the subsequent need to be controlled for in regression analysis, the responses from each respective 2YC were grouped into four broad regions based on the 2YC location; South, East, Midwest, and West. Chi-square tests were then conducted to examine relationships between region and nominal demographic background variables and a one-way ANOVA was conducted on ordinal high school background variables by region. Post-hoc Tukey's HSD tests were then conducted on the variables included in the one-way ANOVA analysis that had significant difference in means. Chi-square tests were also conducted to examine regional differences for nominal variables of 2YC student characteristics along with a one-way ANOVA was also conducted to compare the means of 2YC student characteristic continuous variables. As with high school background characteristics, post-hoc Tukey's HSD tests were conducted on the variables of 2YC student characteristics included in the on-way ANOVA analysis that had significant difference in means. Results revealed regional variation existed within the sample and an independent variable of region was constructed for inclusion in multiple regression models to control for and determine what effect, if any, regionality had on dependent variables. The constructed region variable was coded as 0 = Midwest and 1 = other regions.

Sequential multiple regression analysis. To examine the relationship between the dependent variables of transfer intent, physical science degree aspirations, and geoscience degree aspirations and the independent variables included in background characteristics, 2YC student academic characteristics, 2YC academic engagement experiences, and academic advising and pre-transfer advising activity, this study used the statistical technique sequential (also called hierarchical) multiple regression. Multiple regression is a powerful statistical tool that enables researchers to calculate the effects of multiple independent variables on a dependent variable (Cohen, Manion, & Morrison, 2011). Sequential multiple regression is a specific multiple regression technique where entry of the predictor variables into the model occurs in steps or blocks with determination of the order of entry made by the researcher (Keith, 2014). Prior to the sequential multiple regression analysis, each variable was compared with one another to examine for multicollinearity using Pearson correlation coefficients. Independent variables found to be highly correlated were removed from the model. After checking for multicollinearity, three sequential multiple regression models were conducted for each dependent variable. In each model, independent variables were entered into the regression model sequentially in four separate blocks; first the background demographic and high school block, second the 2YC student characteristics block, third the 2YC academic engagement block, and lastly the advising engagement block. The independent variables contained within in each block is shown in Table 1. The ordering of the variable block entry was based on "presumed time precedence" (Keith, 2014, p. 83) and Astin's (1999) I-E-O model as discussed in Chapter 2 (see figure 1). Chapter 4 provides a greater discussion of the results of the Pearson correlation coefficients, highly correlated variables, and the three sequential multiple regression models.

Table 1

Independent variables included in each block of the sequential multiple regression models

Order of entry	Independent variables
Block 1	Region Gender Age Race/Ethnicity Pell Eligibility Parent highest level of education Highest degree intent Highest high school math Number of high school science courses
Block 2	2YC enrollment background Associates degree intent Class level Developmental math placement Highest math intent at the 2YC Number of high school science courses at the 2YC

Table 1 (continued)

Order of entry	Independent variables
Block 3	Faculty interaction Faculty discussed physical science degrees Participation in URE at the 2YC Participation in field experiences at the 2YC
Block 4	Advisor interaction Advisor discussed physical science degrees Spoke to transfer advisor at the four-year institution Visited the intended four-year transfer institution Attended a transfer orientation at the four-year institution

Limitations

This study was limited by using self-reported data on demographic and academic record items from survey respondents, including demographic items, completed coursework, academic engagement experiences, and future transfer and degree intentions. Due to the self-reporting nature of the survey instrument, students may misrepresent themselves, falsify their answers, or not be truthful in indicating their transfer and degree aspirations.

The nature of the pre-transfer survey instrument is that students reported their intentions to transfer as well as their intended degree aspirations at the receiving four-year institution. As this study is cross-sectional in nature and not longitudinal, it is possible that some of these students will not successfully transfer to a four-year institution. For those students that do transfer, it is possible they may not complete a baccalaureate degree in a physical science or geosciences major.

This study did not conduct a random sample of 2YC students, instead purposefully sampled 2YC students who were enrolled in a2YC introductory physical science course in the spring of 2016. Participation in the study was by 2YC science faculty volunteers who self-selected their introductory physical science courses to disseminate the survey instrument.

Although the survey was distributed to 2YC science faculty members via a nationwide listserv, not all states or regions nor all 2YC students intending to pursue physical science or geoscience degrees were represented. As with other national geoscience surveys which received response rates heavily weighted to Texas, California, and Washington (Gonzalez, 2013; Wilson, 2014a), the response rates in this study were likewise regionalized.

The hypothesis of this study assumed the direction of interaction with academic advisors and pre-transfer advising engagement by 2YC students leads to greater transfer intent. It is possible that those students who already have high intent to transfer upon entry to the 2YC are predisposed to seek out and have greater amounts of advisor interaction or engage in pre-transfer activities.

In this research, only certain relationships of student engagement were examined, specifically student-faculty interaction and academic engagement experiences in the form of UREs and field experiences. While this approach allows for greater exploration of these variables on student intent to transfer and intent to pursue physical science or geoscience degrees, many other important influences of student engagement, such as co-curricular or extra-curricular activities, were not considered.

Summary

This study sought to understand the relationship between the background demographics, academic preparedness, transfer preparedness, academic engagement, and pre-transfer advising experiences of 2YC students enrolled in an introductory physical science course and their subsequent transfer intentions and physical science or geoscience degree aspirations. This study employed a quantitative research approach utilizing 2YC student responses to a pre-transfer survey instrument. This chapter included an overview of the methodology guiding this study, including the research questions, research design, population and setting, ethical considerations, variables in the study, proposed data analysis, and limitations. The following chapter details the quantitative results of the study.

Chapter 4: Results

The following chapter details the quantitative results of this study. The purpose of this study was to examine how the background characteristics and the academic engagement of students enrolled in a 2YC introductory physical science class predict intent to transfer to a four-year institution and to pursue a degree in a physical science related field, or more specifically a degree in the geosciences. First, a descriptive analysis of the overall sample of respondents is presented. The second section examines the sample for regional differences in demographic, high school, and 2YC student characteristics. This is followed by reporting of the results of three sequential multiple regression analysis of the three dependent variables; 2YC student transfer intent, transfer with physical science degree intent, and transfer with geoscience degree intent. The last section provides a summary of the chapter.

Descriptive Analysis of Overall Sample

A total of 828 students responded to the pre-transfer survey administered in introductory physical science courses at 24 individual 2YCs across 17 states (see Figure 3). An initial analysis of student enrollment type from respondents revealed 19 current high school students, 26 current four-year college students, 22 four-year college graduates, and 10 international students enrolled in 2YC introductory physical science courses. These respondents were removed from the sample leaving 751 surveys completed for the final sample. A complete list of 2YCs and the total number of respondents by institution included in this study is provided in Appendix C.

Background characteristics. Descriptive analysis of background and demographic characteristics of survey respondents is presented in Table 2. Background characteristics of the study sample included gender, race/ethnicity, age, Pell eligibility, mother's highest level of education, father's highest level of education,

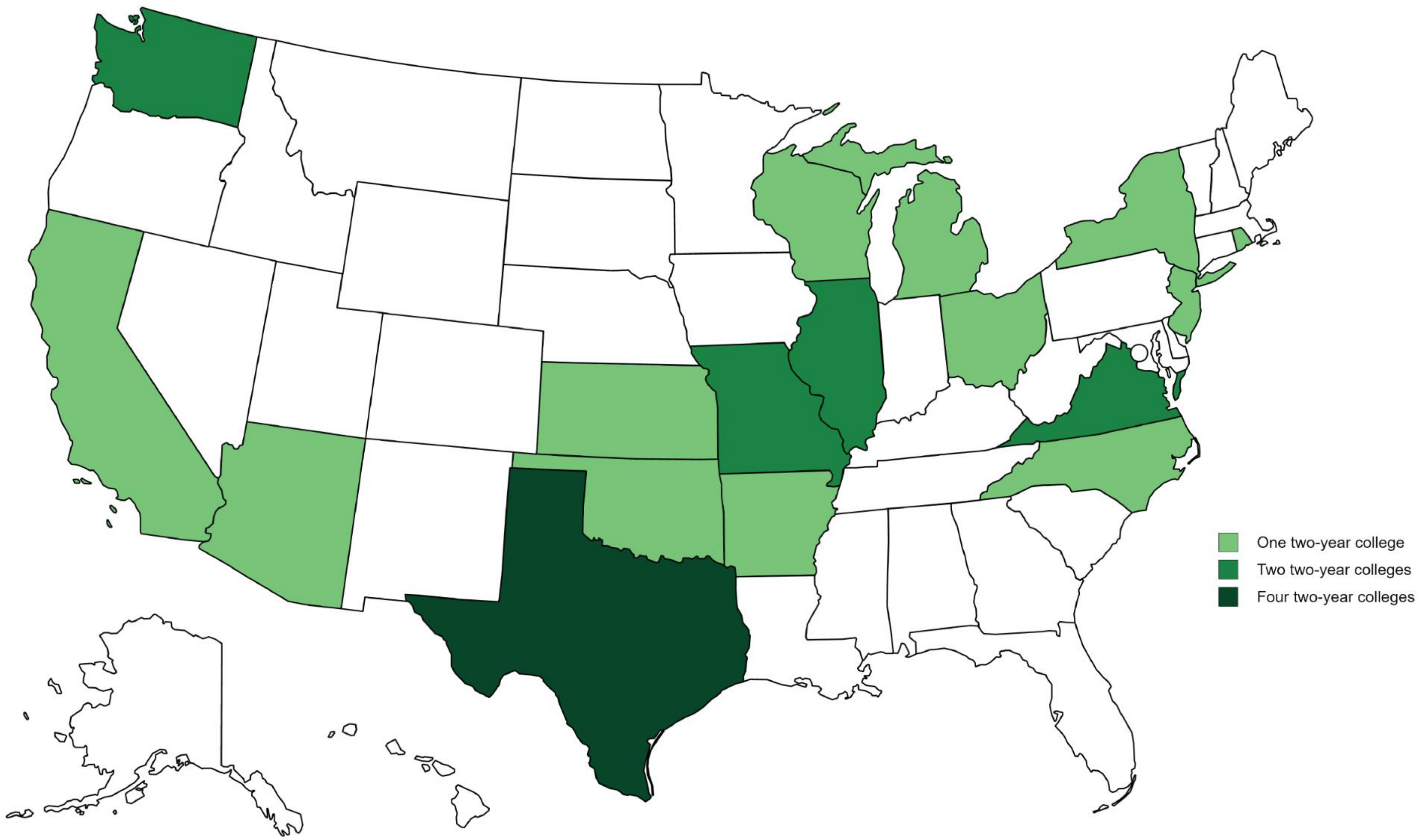

Figure 3. Locations of the two-year colleges from which respondents participated in this study.

highest level of high school math, number of high school science courses, and highest academic degree intent. Female respondents (50.9%) slightly outnumber male respondents (49.1%). The majority of respondents were White (66.9%), followed by Hispanic (13.0%), two or more races (8.7%), Black (3.9%), Asian (3.3%), Other (2.4%), American Indian (1.4%), and Native Hawaiian/Pacific Islander (0.4%). Most of the respondents were traditional aged students between the ages of 18 to 23 (77.5%) with less than a quarter of respondents (22.5%) as non-traditional students.

Slightly more than half reported Pell eligibility (51.9%). Over half (53.5%) report the highest level of their mother's education is some college or less, while 20.7% of mothers hold a bachelor's degree and 12.9% a graduate degree. A slightly higher percentage of respondent's fathers completed some college or less (56.6%) with 38.9% completing high school or less. A similar percentage of fathers hold bachelor's degrees (20.8%) and graduate degrees (12.6%). When combining the two variables to account for the parent with the highest level of education, 21.0% of respondents report being a first generation college student. The highest degree most commonly held by a parent was a bachelor's degree (26.3%), followed by graduate degree (19.5%) and associates degree (13.7%).

Background high school academic characteristics indicate that 45.5% of respondents completed at least pre-calculus or higher level math. Over a third of respondents identified completing algebra (37.2%) as their highest level of math with the remainder identifying geometry (6.0%) or other math course (11.3%). Close to two-thirds of respondents report having completed three or more science courses in high school (62.9%), while 21.1% report completing two science courses, 15.2% completing at least one science course. The bachelor's degree was

Table 2

Background and demographic characteristics of the study sample

Variable	*n*	Sample %
Gender		
Female	380	50.9%
Male	367	49.1%
Missing (no response)	4	
Race/Ethnicity		
Asian	24	3.3%
Black	29	3.9%
Hispanic	96	13.0%
American Indian	10	1.4%
Native Hawaiian/Pacific Islander	3	0.4%
White	493	66.9%
Other	18	2.4%
Two or more races	64	8.7%
Missing (no response)	14	
Age		
Traditional (18-23)	564	77.5%
Non-Traditional (24 or older)	164	22.5%
Missing (no response)	22	
Pell Eligible		
Yes	340	51.9%
No	315	48.1%
Missing (no response)	96	
Highest level of education completed by mother		
Some High School	66	9.0%
High School Graduate	163	22.3%
Some College	162	22.2%
Associates degree	95	13.0%
Bachelor's degree	151	20.7%
Graduate degree	94	12.9%
Missing (no response)	20	
Highest level of education completed by father		
Some High School	92	12.8%
High School Graduate	187	26.1%
Some College	127	17.7%
Associates degree	72	10.0%
Bachelor's degree	149	20.8%
Graduate degree	90	12.6%
Missing (no response)	34	

Table 2 (continued)

Variable	*n*	Sample %
Highest level of High School math		
Geometry	45	6.0%
Algebra	279	37.2%
Pre-Calculus	174	23.2%
Trigonometry	84	11.2%
Calculus	83	11.1%
Other	85	11.3%
Missing (no response)	1	
High School science courses		
Zero	6	0.8%
One	114	15.2%
Two	158	21.1%
Three or more	472	62.9%
Missing (no response)	1	
Highest academic degree intent		
AA/AS/AAT	62	8.3%
BA/BS	346	46.6%
MA/MS	236	31.8%
PhD/EdD	58	7.8%
MD/DDS/DVM	13	1.7%
JD	14	1.9%
Other	14	1.9%
Missing (no response)	8	

identified by the greatest number of respondents as their highest academic degree intent (46.6%), followed by master's degree (31.8%).

Two-year college students' characteristics. Table 3 presents the descriptive analysis of respondents' 2YC academic characteristics. The 2YC student characteristics include enrollment background upon entry to the current 2YC, class level (freshman or sophomore), developmental math placement upon entry to the 2YC, the highest math intent at the 2YC, the number of 2YC science courses completed, intent to complete the associates degree prior to transfer, the likelihood of transferring to a four-year college or university in the next two years, the likelihood of pursuing a major in a physical science related discipline (physics or chemistry), and the likelihood of pursuing a major in a geoscience related discipline.

Table 3

Descriptive analysis of respondents' 2YC academic characteristics

Variable	*n*	Sample %
2YC enrollment background		
Enrolled in the 2YC less than one year after graduating high school	401	53.5%
Enrolled in the 2YC after more than one year after graduating high school	215	28.7%
Attended another 2YC before started attending the current 2YC	43	5.7%
Attended a four-year college but left before started attending the current 2YC	90	12.0%
Missing (no response)	2	
Current class level		
Freshman	171	23.9%
Sophomore	545	76.1%
Missing (no response)	35	
Developmental math placement upon entry to the two-year college		
Yes	388	52.0%
No	358	48.0%
Missing (no response)	5	
Highest math intent at the two-year college		
No math	48	6.5%
Beginning algebra	16	2.2%
Intermediate algebra	30	4.1%
College algebra	269	36.4%
Trigonometry	42	5.7%
First level calculus	161	21.8%
Advanced calculus	63	8.5%
Other	111	15.0%
Missing (no response)	11	
Two-year college science courses		
Zero	110	14.7%
One	375	50.0%
Two	192	25.6%
Three or more	73	9.7%
Missing (no response)	1	
Associates degree completion intent before transfer		
Yes	597	80.2%
No	147	19.8%
Missing (no response)	7	
How likely in the next two years do you plan on transferring to a four-year college		
None	10	1.3%
Unlikely	27	3.6%
Somewhat unlikely	23	3.1%
Somewhat likely	70	9.3%
Likely	128	17.1%
Definitely	491	65.6%

Missing (no response)	2	

Table 3 (continued)

Variable	*n*	Sample %
How likely to pursue a major in a physical science related discipline such as chemistry or physics		
None	498	66.7%
Unlikely	72	9.6%
Somewhat unlikely	40	5.4%
Somewhat likely	56	7.5%
Likely	44	5.9%
Definitely	37	5.0%
Missing (no response)	4	
How likely to pursue a major in the geosciences (e.g. earth science, geology, geography, meteorology, atmospheric science, or oceanography)		
None	495	67.3%
Unlikely	92	12.5%
Somewhat unlikely	32	4.4%
Somewhat likely	39	5.3%
Likely	38	5.2%
Definitely	39	5.3%
Missing (no response)	16	

Slightly over half of respondents (52.0%) indicated testing into or being advised of the need for developmental math courses upon entry to the 2YC. In terms of highest math course intent while at the 2YC, 36.4% of respondents intend to complete college algebra. Another 36% intend to complete higher math levels than college algebra and 15% report other math intent. Only 12.8% of respondents report an intent to complete less than college algebra or plan to take no math at the 2YC. Half (50.0%) of respondents report having completed one science course at the 2YC, another quarter (25.6%) having completed two science courses. The vast majority of respondents indicate an intent to complete their associate's degree before transferring (80.2%).

An overwhelming majority of respondents (82.7%) reported they are definitely or likely to transfer to a four-year college or university within the next two years. Another 9.3% indicated they are somewhat likely while 3.1% are somewhat unlikely, 3.6% unlikely, and 1.3% indicating no intent to transfer within the next two years. Only about 10.9% of respondents indicated they were definitely or likely to pursue a major in a physical science related discipline. Similarly, only 10.5% of respondents indicated they were definitely or likely to pursue a major in a geoscience related discipline.

Academic engagement characteristics. Respondents were asked to answer a set of questions that pertained to their academic engagement experiences at the 2YC including experiences interacting with 2YC faculty, participation in undergraduate research experiences, and participation in field-study experiences (see Table 4). To gain an understanding of respondents' interactions with 2YC faculty, they were asked to what extent they disagreed or agreed with a series of six statements using a Likert scale. Two additional questions related to faculty interaction specifically focused on discussion of physical science and geoscience related majors or careers. The remaining two questions measured whether or not respondents participated in undergraduate research experience or field-study activity.

In regards to experiences interacting with 2YC faculty, nearly three-fourths of respondents (74%) either agreed or strongly agreed that their 2YC faculty were available before, after, or outside of class. A majority of respondents (57.3%) strongly agreed or agreed with the statement that they collaborated with faculty on one or more activities related to coursework at the 2YC. More respondents somewhat agreed (26.3%) than agreed (25.3%) that they collaborated with faculty on one or more activities outside of class. Similarly, more respondents somewhat agreed (25.3%) than agreed (21.6%) that faculty at the 2YC helped create connections with other faculty or staff at the 2YC. In contrast, a majority of respondents (43.7%) either strongly disagreed or disagreed that their 2YC faculty helped create connections with other faculty and staff at a four-year college or university. Nearly a quarter of respondents somewhat agree (24.3%) that their 2YC faculty helped them explore a specific major, degree, or career.

Table 4

Descriptive analysis of respondents' academic engagement experiences

Variable	*n*	Sample %
Faculty available before, after, or outside of class		
Strongly disagree	13	1.7%
Disagree	7	0.9%
Somewhat disagree	24	3.2%
Somewhat agree	150	20.1%
Agree	322	43.1%
Strongly Agree	231	30.9%
Missing (no response)	4	
Collaborate with faculty on one or more activities related to coursework at the two-year college		
Strongly disagree	15	2.0%
Disagree	40	5.4%
Somewhat disagree	69	9.3%
Somewhat agree	194	26.1%
Agree	279	37.5%
Strongly Agree	147	19.8%
Missing (no response)	7	
Collaborate with faculty on one or more activities outside of class at the two-year college		
Strongly disagree	25	3.4%
Disagree	102	13.7%
Somewhat disagree	111	15.0%
Somewhat agree	195	26.3%
Agree	188	25.3%
Strongly Agree	121	16.3%
Missing (no response)	9	
Faculty helped create connections with other faculty/staff at the two-year college		
Strongly disagree		
Disagree	42	5.6%
Somewhat disagree	129	17.3%
Somewhat agree	130	17.5%
Agree	188	25.3%
Strongly Agree	161	21.6%
Missing (no response)	94	12.6%
	7	
Faculty helped create connections with other faculty/staff at a four-year college		
Strongly disagree		
Disagree	117	15.7%
Somewhat disagree	208	28.0%
Somewhat agree	124	16.7%
Agree	145	19.5%
Strongly Agree	86	11.6%
Missing (no response)	63	8.5%
	8	

Table 4 (continued)

Variable	*n*	Sample %
Faculty helped explore a specific major, degree, or career		
Strongly disagree	56	7.6%
Disagree	109	14.7%
Somewhat disagree	102	13.8%
Somewhat agree	180	24.3%
Agree	168	22.7%
Strongly Agree	125	16.9%
Missing (no response)	11	
Faculty discussed or encouraged physical science majors and related careers		
Yes	200	26.8%
No	547	73.2%
Missing (no response)	4	
Faculty discussed or encouraged geoscience majors and related careers		
Yes	175	23.4%
No	572	76.6%
Missing (no response)	4	
Participated in undergraduate research experience at the two-year college		
Yes	73	9.8%
No	672	90.2%
Missing (no response)	6	
Participated in a field trip or outdoor learning experience in a science course at the two-year college		
Yes	340	46.1%
No	397	53.9%
Missing (no response)	14	

Over a quarter (26.8%) of respondents indicated that their faculty member discussed or encouraged physical science majors or related careers. Slightly less (23.4%) indicated the faculty member discussed or encouraged geoscience majors or related careers.

In terms of other academic engagement activities, respondents were asked to indicate if they participated in either an undergraduate research experience or a field trip or outdoor learning experience in a science course while at the 2YC. Only 9.8% of respondents indicated they had participated in an undergraduate research experience. A much larger number of respondents (46.1%) indicated that they had participated in a field trip or other outdoor learning experience while at the 2YC.

Mean values for the faculty interaction statements are reported in Table 5. The six faculty interaction items were found to be highly reliable ($\alpha = .86$). To measure the respondents' overall interaction with faculty at the 2YC, a faculty interaction composite variable was calculated from the average of the responses to the six faculty interaction related questions. Missing responses were not included in the calculation. The composite variable was computed as an average value from those faculty interaction questions in which a respondent reported a value (n=748).

Table 5

Mean and standard deviation for responses to faculty interaction statements

Variable	*n*	Min	Max	Mean	St. Dev.
Faculty available before/after class	747	1	6	4.95	1.00
Collaborate with faculty in class	744	1	6	4.51	1.18
Collaborate with faculty outside of class	742	1	6	4.05	1.38
Faculty create connections with other 2YC faculty	744	1	6	3.78	1.43
Faculty create connections with 4YC faculty	743	1	6	3.09	1.53
Faculty helped explore major, degree, or career	740	1	6	3.91	1.52
Faculty interaction composite[1]	748	1	6	4.05	1.02

[1]Faculty interaction composite calculated from the average of the responses to the six faculty interaction related questions by each respondent.

Advising and pre-transfer advising activity characteristics. To gauge the interaction with academic advising and pre-transfer advising activities, respondents were asked to respond to a set of questions pertaining to their academic advising experiences. Respondents indicated to what extent they disagreed or agreed with a series of three statements using a Likert scale pertaining to their academic advising experiences, along with two additional questions asking if academic advisors discussed physical science and geoscience related majors or careers. The remaining questions measured whether or not respondents participated in any pre-transfer

Table 6

Descriptive analysis of respondents' academic advising characteristics

Variable	*n*	Sample %
Consulted an academic advisor regarding transfer		
Strongly disagree	69	9.6%
Disagree	54	7.5%
Somewhat disagree	59	8.2%
Somewhat agree	147	20.4%
Agree	208	28.9%
Strongly Agree	183	25.4%
Missing (no response)	31	
Information provided by academic advisors helpful in preparing for transfer		
Strongly disagree	64	9.1%
Disagree	76	10.8%
Somewhat disagree	80	11.4%
Somewhat agree	182	25.9%
Agree	172	24.5%
Strongly Agree	129	18.3%
Missing (no response)	48	
Academic advisor identified courses needed to meet general education or major requirements of four-year college		
Strongly disagree	50	7.1%
Disagree	70	9.9%
Somewhat disagree	69	9.8%
Somewhat agree	161	22.8%
Agree	206	29.2%
Strongly Agree	150	21.2%
Missing (no response)	45	
Academic advisor discussed or encouraged physical science majors and related careers		
Yes	106	14.2%
No	639	85.8%
Missing (no response)	6	
Academic advisor discussed or encouraged geoscience majors and related careers		
Yes	58	7.8%
No	686	92.2%
Missing (no response)	7	
Spoken to a transfer advisor at intended transfer four-year institution		
Yes	333	44.6%
No	414	55.4%
Missing (no response)	4	

Table 6 (continued)

Variable	*n*	Sample %
Visited the intended transfer four-year institution		
Yes	434	58.1%
No	313	41.9%
Missing (no response)	4	
Attended a transfer orientation session at the intended transfer four-year institution		
Yes	151	20.3%
No	594	79.7%
Missing (no response)	6	

advising activities including consulting a transfer advisor at the intended four-year college, visiting the intended transfer institution campus, or participating in a transfer orientation at the four-year college or university. Table 6 presents the results of descriptive analysis of respondents' academic advising characteristics.

Over half of respondents either agreed (28.9%) or strongly agreed (25.4%) that they had consulted an academic advisor at the 2YC regarding transferring to a four-year college or university. Only 42.8% of respondents however indicated that they either strongly agreed or agreed that the information provided by an academic advisor was helpful in preparing for transfer. Half of respondents either strongly agreed or agreed that academic advisors identified courses that were needed to meet general education or major requirements at the intended four-year transfer institution. When asked if academic advisors discussed or encouraged physical science majors and related careers, only 14.2% of respondents indicated an academic advisor had done so. Even less (7.8%) indicated an academic advisor had discussed or encouraged a geoscience major or related career.

As for pre-transfer activities, slightly less than half (44.6%) of respondents indicated they had spoken to a transfer advisor at their intended four-year transfer institution. The majority of respondents (58.1%) did indicate that they had visited their intended four-year transfer institution. Although, only 20.3% indicated they had attended a transfer orientation at their intended four-year college or university.

Mean values for the advising interaction statements are reported in Table 7. The three advising interaction items were found to be highly reliable ($\alpha = .84$). To measure the respondents' overall interaction with advisors at the 2YC, an advising interaction composite variable was calculated from the average of the respondent's reported values to the three advising interaction related questions. Missing responses were not included in the calculation. The composite variable was computed as an average value from those advising interaction statements in which a respondent reported a value (n=720).

Table 7

Mean and standard deviation for responses to advising interaction statements

Variable	*n*	Min	Max	Mean	St. Dev.
Consulted academic advisor regarding transfer	720	1	6	4.28	1.57
Information provided by advisor helpful in preparing for transfer	703	1	6	4.01	1.53
Advisor identified courses that meet general education requirements at 4YC	706	1	6	4.21	1.49
Advising interaction composite[1]	720	1	6	4.13	1.35

[1]Advising interaction composite calculated from the average of the responses to the three advising interaction related questions by each respondent.

Regional Comparisons

Respondents from 24 2YCs from 17 states participated in this study. The 24 2YCs were not evenly distributed across the U.S., rather they were clustered regionally (see Figure 3). Although not a specific research question in this study, it was important to determine if regional variation existed within the sample, and if so needed to be controlled for in the regression analyses. Therefore, the responses from each respective 2YC were grouped into four broad general regions based on the 2YC location; South, East, Midwest, and West. The Midwest region contained the highest number of respondents (*n*=307) followed by the East region (*n*=234), the South region (*n*=125), and the West region containing the fewest (*n*=85).

Chi-square tests were then conducted to examine relationships between region and nominal demographic background variables of gender, race (white versus non-white), and age (traditional aged versus non-traditional aged). Results of the chi-square test for each variable are shown in Appendix D, Table D1. Results of the chi-square tests indicate gender (χ^2 [3, 747] = 16.94, p <.01) race (χ^2 [3, 737] = 53.53, p <.001), and age (χ^2 [3, 728] = 10.82, p <.05) significantly differ by region.

Additionally, to test for regional differences in means of high school background characteristics of respondents, a one-way ANOVA was conducted on ordinal variables of highest degree intent, highest high school math completed, and number of high school science courses by region (see Appendix D, Table D2). Results of the one-way ANOVA reveal there were significance differences in means by region for highest high school math completed [F(3, 746) = 3.44, p =.017] and number of high school science courses [F(3, 746) = 4.16, p =.006]. Post-hoc Tukey’s HSD tests results revealed respondents from the West region differed significantly in terms of highest level of high school math completed than those from the South and Midwest regions at the .05 significance level. Respondents in the West region also differed significantly from those in the East and Midwest regions in the number of high school science courses completed at the .05 significance level. All other comparisons were not significant.

To examine if regional differences exist for 2YC student characteristics, chi-square tests were conducted for nominal variables of associate of arts degree completion intent, class level, and developmental math (Appendix D, Table D3). Results of the chi-square tests indicate associates degree intent (χ^2 [3, 744] = 16.73, *p* <.01), class level (χ^2 [3, 716] = 9.32, *p* <.05), and developmental math placement (χ^2 [3, 746] = 10.89, *p* <.05) all differ significantly by region.

A one-way ANOVA was also conducted to compare the means of 2YC student characteristic variables of number of 2YC science courses completed and highest level of 2YC math intent (Appendix D, Table D4). Significant differences in means by region exists for number of 2YC science courses [F(3, 746) = 3.41, *p* =.017], and highest level of 2YC math intent [F = (3, 736) = 9.04, *p* =<.001]. Post-hoc Tukey's HSD tests showed respondents in the Midwest region reported having taken a higher number of other science courses at the 2YC in addition to the current physical science courses than those from the East region at the .05 significance level. Respondents from the East and West regions reported higher level math intent than those from the Midwest at the .01 and .001 significance level respectively.

Since regional variation existed within the sample, an independent variable of region was constructed for inclusion in multiple regression models to control for and determine what effect, if any, region had on dependent variables. Post-hoc analysis of significant demographic variables, high school variables, and 2YC student characteristic variables revealed a greater difference between the Midwest and other regions. Therefore, the constructed region variable was coded as 0 = Midwest and 1 = other regions.

Predictors of Transfer and Intent to Pursue Physical Science or Geoscience Degrees

In order to answer research questions one through four, three sequential multiple regression models were conducted on the dependent variables of transfer intent, physical science degree intent, and geoscience degree intent. Prior to sequential multiple regression analysis, independent variables were compared with one another to check for multicollinearity. Pearson correlation coefficients were used to establish if any relationships exist among the independent variables (see correlation matrix table in Appendix E). Correlation coefficients indicate the strength of the relationship between variables with values near zero indicating weak relationships, while those nearer to +1 or -1 suggest stronger relationships (Cohen et al., 2011). Tabachnick and Fidell (2007) indicate that most issues associated with multicollinearity occur when variables are highly correlated and suggest caution when including any variables that are correlated at .70 or higher. Almost all variables in this study were found to be not strongly related, most correlating less than r = .40. One pair of independent variables were found to be highly correlated; faculty discussed physical science degrees and faculty discussed geoscience degrees (r = .65). As both variables measure whether the faculty member discussed a STEM related degree in class, only the independent variable of faculty discussed physical science degrees was included in the regression models. Similarly, although the pair of independent variables of advisor discussed physical science degrees and advisor discussed geoscience degrees were not as highly correlated (r =.53), only the advisor discussed physical science degree variable was included in the models using the same reasoning.

From the results of the Pearson correlation coefficient analysis, a number of weaker or moderate, yet significant, relationships between variables are worth noting. The correlation coefficients between developmental math placement and highest high school math course (r = -.26, p<.001) and between developmental math placement and number of high school science courses completed (r = -.22, p<.001) both reveal a negative relationship. This relationship indicated that those who reported developmental math placement upon entry to the 2YC had lower level high school math courses or had taken a fewer number of high school science courses. Comparing the variable of transfer intent individually with variables of highest degree intent (r =.35, *p*<.001), speaking with a transfer advisor (r = .30, *p*<.001), and visiting the intended four-year transfer institution (r = .33, *p*<.001) revealed positive correlation; those with higher degree intent, speaking with a transfer advisor, or visiting the intended four-year institution increases their intent to transfer. Speaking with a transfer advisor also increased a respondent's likelihood of having visited the four-year institution (r = .38, *p*<.001) or attended a transfer orientation at the four-year institution (r =.37, *p*<.001). Physical science degree intent had a positive correlation between an advisor discussing physical science related degrees (r = .39, *p*<.001) and faculty discussing physical science related degrees (r = .33, *p*<.001). Likewise, geoscience degree intent had a positive correlation between the same variables (r = .29, *p*<.001 and r=.29, *p*<.001) respectively.

After comparing the independent variables for multicollinearity, the three sequential multiple regression models were conducted using the same conceptual framework for each model. The order of the independent variables in each model was dictated by the I-E-O framework (Astin, 1999) discussed in Chapters 1 and 2 and were entered in four separate blocks; a background demographic and high school block, a 2YC student characteristics block, a 2YC academic engagement block, and an advising engagement block.

The first sequential regression model examined the relationship between independent variables and 2YC student transfer intent. Background demographic and high school variables were entered into the model in the first block. These include the region construct variable, gender, age, race/ethnicity, Pell eligibility, parent's highest level education, highest academic degree intent, highest level of high school math, number of high school science courses. The second block includes variables of 2YC student characteristics and consists of 2YC enrollment background, associate's degree intent, class level, developmental math placement, highest math intent, and number of additional science courses taken at the 2YC. The third block, 2YC academic engagement, consists of the composite faculty interaction variable, faculty discussed physical science degrees variable, participation in URE at the 2YC, and participation in field experience at the 2YC. The fourth and final block includes advisor interaction variables which includes the composite advisor interaction variable, advisor discussed physical science degrees, spoke to transfer advisor at the 4YC, visited the transfer 4YC campus, and attended a transfer orientation at the 4YC. Table 8 reports the results of the sequential regression analysis for predictors of 2YC transfer intent.

The full model after all four blocks were entered explains 26.5% of the variance (R^2 = .265, F[24, 528] = 7.93, p<.001). The relationships of race and ethnicity (t[528] = 0.19, p<.05, β = .08), highest degree intent (t[528] = 0.23, p<.001, β = .25), and highest high school math (t[528] = 0.07, p<.05, β = .10), have a significant effect on 2YC student transfer intent. Non-white students, those that have higher degree intent such as a graduate degree, and those that completed higher levels of math in high school have higher transfer intent. Additionally, interaction with advisors at the 2YC (t[528] = 0.12, p<.001, β = .15), speaking with a transfer advisor at the intended 4YC transfer institution (t[528] = 0.38, p<.001, β = .17), and visiting the intended transfer 4YC campus (t[528] = 0.48, p<.001, β = .22) all have significant positive effects in increased 2YC student transfer intent. Respondents who report greater satisfaction in interactions with 2YC advisors, those that have spoken with a transfer advisor at their intended 4YC transfer institution, and those that have visited their intended 4YC transfer campus have higher transfer intent.

Table 8 *Predictors of 2YC student transfer intent*

Predictor	Block 1			Block 2			Block 3			Block 4		
	B	SE B	β	B	SE B	β	B	SE B	β	B	SE B	β
Block 1: Background												
Region	.06	.09	.03	.05	.09	.02	.05	.09	.02	.08	.09	.04
Gender	.00	.09	.00	-.02	.09	-.01	-.03	.09	-.02	-.02	.08	-.01
Age	-.03	.11	-.01	-.04	.12	-.02	-.04	.12	-.02	.04	.11	.02
Race/Ethnicity	.24	.10	.11*	.24	.10	.11*	.23	.10	.10*	.19	.09	.08*
Pell Eligible	-.02	.09	-.01	-.03	.09	-.01	-.03	.09	-.02	.01	.08	.01
Parent highest level of education	.01	.03	.01	.01	.03	.01	.01	.03	.01	.00	.03	.00
Highest degree intent	.28	.04	.30***	.26	.04	.28***	.26	.04	.28***	.23	.04	.25***
Highest high school math	.07	.03	.10*	.07	.03	.10*	.07	.03	.10*	.07	.03	.10*
Number of high school science courses	.01	.06	.01	.00	.06	.00	.00	.06	.00	.00	.06	.00
Block 2: 2YC student characteristics												
2YC enrollment background				.02	.05	.02	.03	.05	.02	.01	.05	.01
Associates degree intent				-.09	.11	-.04	-.11	.11	-.04	.00	.11	.00
Class level				.15	.11	.06	.14	.11	.06	.07	.10	.03
Developmental math				.03	.10	.01	.03	.10	.01	.03	.09	.02
Highest level of math intent at the 2YC				.01	.02	.02	.01	.02	.03	.00	.02	.00
Number of science courses at the 2YC				.15	.05	.11**	.14	.06	.11*	.09	.05	.07
Block 3: 2YC academic engagement												
Faculty interaction							.03	.04	.03	-.07	.04	-.07
Faculty discussed degree in physical science							.03	.10	.01	.06	.10	.03
Participate in URE at 2YC							.08	.16	.02	.04	.15	.01
Participate in field experience at 2YC							-.08	.09	-.04	-.12	.09	-.05
Block 4: 2YC Advising engagement												
Advisor interaction										.12	.03	.15***
Advisor discussed degree in physical science										.04	.13	.01
Spoke to transfer advisor at 4YC										.38	.09	.17***
Visited 4YC transfer institution										.48	.09	.22***
Attended transfer orientation at 4YC										-.06	.11	-.02
R^2			.124			.145			.148			.265
F			8.56***			6.07***			4.86***			7.93***
ΔR^2						.021			.003			.117
ΔF						2.17*			.39			16.89***

*p <.05, **p <.01, ***p<.001

The second sequential multiple regression model examined the relationship between the independent variables and transfer with the intent to pursue a physical science degree or major. The same independent variable blocks from the first model were entered in the same order into the second model. The final R^2 of the analysis indicates 25.7% of the variance was explained by the full model. Results of the full block reveal background demographic characteristics of region ($t[527] = -0.40$, $p<.01$, $\beta = -.12$), gender ($t[527] = -0.30$, $p<.05$, $\beta = -.09$), and age ($t[527] = 0.33$, $p<.05$, $\beta = .09$) are significant factors of student intent to pursue physical science degrees. Those that are older than traditional aged students, are male, and from the Midwest region have greater intent to transfer pursuing a physical science degree. Of the remaining variables, the number of science courses taken at the 2YC ($t[527] = 0.29$, $p<.001$, $\beta = .15$), faculty interaction ($t[527] = 0.13$, $p<.05$, $\beta = .09$), faculty who discussed physical science degrees ($t[527] = 0.64$, $p<.001$, $\beta = .18$), advisor interaction ($t[527] = -0.12$, $p<.05$, $\beta = -.10$), and advisors who discussed physical science degrees ($t[527] = 1.12$, $p<.001$, $\beta = .25$) all have significant effects on transfer with physical science degree intent. Respondents with higher intent to transfer pursuing physical science degrees report greater number of science courses taken at the 2YC, less positive interactions with advisors, had faculty and advisors who discussed physical science degrees, and report greater faculty interaction. The full results for the second regression analysis are reported in Table 9.

The third sequential multiple regression model examined the relationship between the independent variables and 2YC student transfer with the intent to pursue a geoscience degree. As before, the same independent variable blocks from the first and second regression models were entered in the same order into the third regression model. After entering all blocks, the full model

Table 9 *Predictors of intent to pursue degree in physical science*

	Block 1			Block 2			Block 3			Block 4		
Predictor	B	SE B	β	B	SE B	β	B	SE B	β	B	SE B	β
Block 1: Background												
Region	-.31	.14	-.09*	-.31	.14	-.09*	-.37	.14	-.11**	-.40	.13	-.12**
Gender	-.31	.14	-.10*	-.31	.13	-.10*	-.29	.13	-.09*	-.30	.13	-.09*
Age	.35	.17	.09*	.41	.18	.11*	.37	.17	.10*	.33	.17	.09*
Race/Ethnicity	-.09	.15	-.03	-.02	.15	-.01	.03	.14	.01	.04	.14	.01
Pell Eligible	-.03	.14	-.01	-.04	.14	-.01	-.08	.13	-.03	-.14	.13	-.04
Parent highest level of education	-.07	.05	-.07	-.06	.05	-.06	-.07	.04	-.06	-.06	.04	-.06
Highest degree intent	.16	.06	.12**	.09	.06	.07	.06	.06	.04	.05	.05	.04
Highest high school math	.18	.05	.02	-.01	.05	-.01	-.02	.04	-.02	-.01	.04	-.01
Number of high school science courses	.10	.09	.05	.03	.09	.01	.05	.09	.03	.08	.08	.04
Block 2: 2YC student characteristics												
2YC enrollment background				-.01	.07	-.01	-.04	.07	-.03	-.02	.07	-.01
Associates degree intent				-.26	.17	-.07	-.35	.16	-.09*	-.30	.16	-.07
Class level				-.37	.16	-.10*	-.34	.16	-.09*	-.24	.15	-.06
Developmental math				-.21	.14	-.07	-.17	.14	-.05	-.15	.13	-.05
Highest level of math intent at the 2YC				.07	.04	.08*	.06	.03	.08	.06	.03	.08
Number of science courses at the 2YC				.45	.08	.24***	.33	.08	.17***	.30	.08	.15***
Block 3: 2YC academic engagement												
Faculty interaction							.11	.06	.07	.13	.07	.09*
Faculty discussed degree in physical science							.99	.14	.28***	.64	.15	.18***
Participate in URE at 2YC							.36	.23	.07	.33	.22	.06
Participate in field experience at 2YC							-.06	.13	-.02	-.04	.13	-.01
Block 4: 2YC Advising engagement												
Advisor interaction										-.12	.05	-.10*
Advisor discussed degree in physical science										1.12	.19	.25***
Spoke to transfer advisor at 4YC										.13	.14	.04
Visited 4YC transfer institution										-.18	.14	-.06
Attended transfer orientation at 4YC										-.16	.17	-.04
R^2			.040			.109			.197			.257
F			2.53**			4.35***			6.85***			7.60***
ΔR^2						.069			.088			.060
ΔF						6.84***			14.57***			8.59***

*p <.05, **p <.01, ***p<.001

explains 22% of the variance (R^2 = .22, F[24, 519] = 6.09, *p*<.001). Region (*t*[519] = 0.28, *p*<.05, β = .09), age (*t*[519] = 0.46, *p*<.01, β = .13), number of science courses completed at the 2YC (*t*[519] = 0.15, *p*<.05, β = .09), faculty interaction (*t*[519] = 0.21, *p*<.01, β = .14), faculty discussed physical science degrees (*t*[519] = 0.54, *p*<.001, β = .16), and participation in a field experience at the 2YC (*t*[519] = 0.47, *p*<.001, β = .15) are all significant factors. Additionally, advisor interaction (*t*[519] = -0.11, *p*<.05, β = -.10) and advisor discussed physical science degrees (*t*[519] = 0.65, *p*<.01, β = .15) are found to both have significant effects. Those respondents who are older than traditional aged students and from the south, east, and west regions have a higher intent to transfer pursuing a geoscience degree. Respondents with higher geoscience degree intent have also taken a higher number of science courses at the 2YC, had more positive faculty interaction, had faculty who discussed physical science related degrees, and participated in an outdoor field experience. In addition, geoscience degree bound 2YC students report less positive interactions with advisors and had advisors who discussed physical science degrees. See Table 10 for the complete regression analysis results.

Summary

This chapter presented an overview of the quantitative findings of this study. The first section reported the descriptive analysis of respondents for the overall sample. This section examined the background and demographic characteristics of the respondents, the survey respondents' academic engagement experiences at the 2YC including faculty interaction, undergraduate research experiences, and field-study experiences, as well as the academic advising experiences and pre-transfer advising activities of the respondents (such as transfer campus visit or transfer orientation participation). The second section examined for regional differences in the sample and grouped responses into four regions based on 2YC location and

Table 10 *Predictors of intent to pursue degree in geoscience*

Predictor	Block 1			Block 2			Block 3			Block 4		
	B	SE B	β	B	SE B	β	B	SE B	β	B	SE B	β
Block 1: Background												
Region	.34	.14	.12**	.37	.14	.12**	.32	.13	.10*	.28	.13	.09*
Gender	.02	.13	.01	.02	.13	.01	.04	.13	.01	.04	.12	.01
Age	.51	.16	.15**	.29	.17	.17**	.52	.16	.15**	.46	.16	.13**
Race/Ethnicity	-.26	.14	-.08	-.19	.14	-.06	-.11	.14	-.04	-.09	.13	-.03
Pell Eligible	-.09	.13	-.03	-.09	.13	-.03	-.14	.13	-.05	-.19	.12	-.06
Parent highest level of education	.03	.04	.03	.04	.04	.04	.04	.04	.04	.05	.04	.05
Highest degree intent	.01	.06	.01	-.03	.06	-.03	-.05	.05	-.04	-.05	.05	-.04
Highest high school math	.08	.04	.08	.05	.05	.05	.05	.04	.05	.05	.04	.05
Number of high school science courses	.07	.09	.04	.02	.08	.01	.05	.08	.03	.06	.08	.03
Block 2: 2YC student characteristics												
2YC enrollment background				-.04	.07	-.03	-.08	.07	-.06	-.07	.07	-.04
Associates degree intent				-.16	.16	-.04	-.22	.16	-.06	-.24	.16	-.07
Class level				-.36	.16	-.10*	-.36	.15	-.10*	-.26	.15	-.07
Developmental math				-.17	.14	-.06	-.16	.13	-.05	-.13	.13	-.04
Highest level of math intent at the 2YC				.04	.04	.05	.03	.03	.04	.04	.03	.05
Number of science courses at the 2YC				.29	.08	.16***	.18	.08	.08*	.15	.07	.09*
Block 3: 2YC academic engagement												
Faculty interaction							.15	.06	.10*	.21	.06	.14**
Faculty discussed degree in physical science							.77	.14	.23***	.54	.15	.16***
Participate in URE at 2YC							.29	.22	.06	.26	.22	.05
Participate in field experience at 2YC							.44	.13	.14**	.47	.12	.15***
Block 4: 2YC Advising engagement												
Advisor interaction										-.11	.05	-.10*
Advisor discussed degree in physical science										.65	.19	.15**
Spoke to transfer advisor at 4YC										-.20	.14	-.07
Visited 4YC transfer institution										-.19	.14	-.06
Attended transfer orientation at 4YC										-.04	.16	-.01
R^2			.043			.079			.180			.220
F			2.69**			3.03***			6.05***			6.09***
ΔR^2						.036			.101			.040
ΔF						3.41**			16.08***			5.31***

**p* <.05, ***p* <.01, ****p*<.001

compared background demographic, high school, and 2YC student characteristic variables. Regional variation by region was found to exist in the sample and an independent variable of region was constructed for inclusion in sequential multiple regression analysis to control for this variation.

Detailed analysis revealed the racial and ethnic composition of respondents in this study differed from national demographic characteristics of 2YC students. In this study, female respondents slightly outnumbered male respondents, however the proportion of females in this study is less than national average of 57% female student populations at 2YCs (AACC, 2015). The majority of respondents identified themselves as white, a higher percentage than the national 2YC composition of white students (50%) (AACC, 2015). This may be a reflection of a higher number of respondents in this study from 2YCs in the Midwest region where 80% of respondents identified themselves as white as compared to those in the South region (48%). The majority of respondents in this study were also of traditional student ages (18-23). This is in contrast to the national average age of 28 for 2YC students (AACC, 2015).

The third section, in addressing research questions one through four, reported the results of three sequential multiple regression models for the dependent variables of 2YC student transfer intent, transfer with physical science degree intent, and transfer with geoscience degree intent. The first model found that of 2YC students enrolled in introductory physical science courses, non-white students, those with higher degree intent, those who have completed higher levels of math in high school, those with greater satisfaction in interactions with 2YC advisors, those who have spoken with a transfer advisor at their intended four-year transfer institution, and those who have visited their intended 4YC transfer campus have higher transfer intent.

The second analysis revealed that those with higher intent to pursue a physical science degree are those who are older, male, from the Midwest region, have higher degree intent, have taken a greater number of science courses taken at the 2YC, report less positive interactions with advisors, report greater faculty interaction, and had faculty and advisors who discussed physical science degrees. The third and final model found those 2YC students who intend to transfer and pursue a geoscience degree are older, from outside the Midwest region, have taken a higher number of science courses at the 2YC, had more positive faculty interaction, had faculty who discussed physical science related degrees, participated in an outdoor field experience, report less positive interactions with advisors, and had advisors who discussed physical science degrees. A discussion of the implications of these results are presented in the next chapter.

Chapter 5: Discussion, Implications, and Conclusion

This chapter presents a review of the purpose and significance of this study followed by a discussion of the results. Within this discussion, the descriptive analysis of the study sample demographics is revisited and the study's research questions are addressed including interpretation and summary of the findings. The chapter concludes with a discussion of the implications for practice, policy and future research.

Purpose and Significance of the Study

This study sought to gain an understanding of the influence of student engagement on 2YC students' intentions to transfer to a four-year institution with physical science or geoscience degree aspirations. Specifically, using the overarching framework of Astin's (1993; 1999) I-E-O model, this study hypothesized that the background characteristics of the student, the academic preparation prior to and at the 2YC, the student academic engagement experiences (such as faculty-student interaction, undergraduate research experiences, and field-based learning opportunities), and academic advising interactions at the 2YC positively lead to increased student intent to transfer to a four-year institution and intent in physical science degree aspiration, more specifically a geoscience major.

The significance of understanding those factors that increase 2YC student intent to transfer with pursuit of physical science or geoscience degrees cannot be understated. The effort to strengthen and facilitate transfer from 2YCs to four-year institutions has come under greater scrutiny by policymakers (Mongahan & Attewell, 2014), particularly for those pursuing STEM related baccalaureate degrees (Mooney & Foley, 2011, Mosher et al., 2014). Investigating the role of 2YC student academic experiences and pre-transfer advising activities can lead to greater understanding of engagement factors that lead to positive increased transfer intent and subsequent pursuit of STEM related degrees. This understanding will further facilitate policy makers and educators in focusing on and promoting those practices, policies, and support mechanisms that lead to positive 2YC student transfer and baccalaureate degree outcomes. This study also answers the call for greater research focused on transfer pathways and outcomes for students in specific majors and professional programs (Bahr et al., 2013), particularly those seeking a degree in STEM related fields (Starobin & Laanan, 2010). This study contributes to the growing body of research on 2YC student transfer intent and 2YC students' intent to pursue STEM related degrees. It also fills the significant gap in research on the pre-transfer experience within particular subpopulations of 2YC students, specifically in the physical sciences and geosciences.

Discussion of Results

Descriptive analysis of sample demographic characteristics. This study is one of the first to report the make-up of students who enroll in introductory physical science courses at the 2YC. While Gilbert et al. (2012) were one of the first to describe characteristics of students enrolled in introductory geology courses, their study focused primarily on students enrolled in five universities and included only two 2YC institutions in their sample. This study, in contrast, is the first to focus exclusively on a nation-wide sample of 2YC students enrolled in introductory physics, chemistry, and geoscience courses at 24 2YC institutions. Descriptive analysis revealed that 2YC students who take introductory physical science courses are primarily white traditional aged (18-23 years of age) females. Slightly more than half are Pell eligible and one in five is a first generation college student. Most have completed three or more science courses and pre-calculus or higher math course in high school, although half test into developmental math placement upon entry to the 2YC. The overwhelming majority are sophomores and have completed at least one other science course at the 2YC. Over 80% of students intend to transfer to a four-year institution. Most students taking an introductory physical science course have little to no intent to pursue a physical science related major and are likely taking the course to fulfill general education and associate's degree requirements. Only one in ten students indicate they are definitely or likely to pursue a major in the physical sciences or geosciences.

The demographic characteristics of 2YC students enrolled in introductory physical science courses in this study are similar to demographics of gender and age of college students enrolled in introductory geology courses found by Gilbert et al. (2012), although students in the study presented here are racially and ethnically more diverse. However, the demographic characteristics of students enrolled in introductory physical science courses differs from national student demographics for 2YCs (AACC, 2015) reflecting younger, less diverse, and fewer females. A number of factors may explain these differences. For example, it has been shown that fewer female students enter into STEM fields than male students (Chen & Weko, 2009; Meyers et al., 2015) and therefore the current sample may just be reflective of this larger national trend of males taking physical science courses. It may be the higher percentage of traditional aged students in this study enrolled in introductory physical science courses as opposed to the national 2YC average age of 28 (AACC, 2015) is a reflection of the higher percentage of traditional aged students from the Midwest region included in this study. Another possibility could be that demographically 2YCs are becoming more traditional aged in population as greater numbers of traditional aged students use 2YCs as their entry point into post-secondary education. Certainly, the higher percentage overall of traditional aged students in this study is similar to the ages of students enrolled in introductory geoscience courses at four-year institutions (Gilbert et al., 2012).

Differences in age and diversity of students in this study from national 2YC demographics could also be attributed to the difference in the number of responses from suburban 2YC institutions versus urban 2YC institutions. The sample of 2YCs included in this study were mostly from suburban and rural 2YCs. Urban institutions often reflect a greater demographic diversity of age, race, ethnicity, income, and education levels typical of urban cores, versus suburban and rural institutions which are often more demographically and economically homogenous. However, this differentiation between urban, suburban, and rural 2YC institutions was not included in this study and would need to be accounted for in future research to fully explore if this difference is indeed a factor.

Predictors of two-year college student transfer intent. This study sought to determine what effect (1) background characteristics, (2) developmental mathematics placement, (3) academic engagement experiences, and (4) academic advising and pre-transfer advising activity has on 2YC student transfer intent and pursuit of physical science or geoscience related degrees. The following is a discussion of those factors that influence transfer intent and intent to pursue physical science or geoscience degrees in order of the four research questions guiding this study.

Background characteristics. The results of the study revealed that several background factors significantly predict positive 2YC student transfer intent; race and ethnicity, higher degree intent, and higher high school math. Although the majority of students enrolled in introductory physical science courses identify as white, this study found those with greater intent to transfer were non-white students. A possible explanation of this may be attributed to the fact that minority students are more likely to enter higher education through 2YCs (Cohen & Bower, 2008) and may result in a larger number of minority students seeking to transfer from a 2YC in order to earn a baccalaureate degree, versus seeking just an associate’s degree. This finding is promising as it indicates minority students enrolled at the 2YC have high intent to transfer. As four-year institutions seek to diversify their study bodies, it appears a pipeline exists of diverse 2YC students who are eager to transfer.

Two-year college students with greater intentions beyond a baccalaureate degree were more likely to intend to transfer to a four-year institution. This is not surprising, as those seeking a graduate degree are likely to be highly motivated to transfer and complete a bachelor's degree in order to proceed on to graduate programs. Similarly, those 2YC students who completed higher levels of math courses (such as pre-calculus or higher) may be more academically prepared for college-level coursework and therefore have greater self-efficacy in transitioning to a four-year institution than those who enter the 2YC less academically prepared. However, further investigation is needed to determine if self-efficacy is a factor.

This study also found several background characteristics are significant as they relate to physical science or geoscience degree intent. Interestingly, for both physical science and geoscience degree intent, region of the U.S. was a significant factor. Students intending to pursue physical science degrees were more likely to be from the Midwest, while the opposite was true for geoscience degree intent with students more likely to be from outside the Midwest region. It is possible one potential reason for this finding could be tied to the regional differences in pre-exposure by high school students to certain STEM fields. Geoscience courses and content offered or required in high schools varies greatly across states and local communities and it may be that high school students in the Midwest have less exposure to earth science and greater exposure to other physical sciences, such as physics and chemistry, versus other regions. Similarly, career fields that are more geoscience focused, such as the petroleum or mining industry, vary greatly by region with less geoscience workforce present in the Midwest than other regions. Regardless, this finding warrants further examination as this study only controlled for region in the regression models and regional differences was not specifically examined in depth.

Likewise, age was a significant factor in both physical science and geoscience degree intent although not a significant predictor of overall intent to transfer. Students with intent to pursue either degree were older than traditional aged students. This confirms Meyers et al. (2015) who also found that older students are more likely than younger students to possess STEM aspirations. This finding may be a reflection that 2YC students are typically older than traditional four-year college or university students (Starobin & Laanan, 2010) and are more likely to interrupt or delay enrollment (Alfonso, 2006) therefore arriving at their intended major later than more traditional aged four-year students. Additionally, lack of exposure to geoscience disciplines in high school may translate to students generating interest in the discipline later in their college experience. Gender was significant only for those with physical science degree intent. As is true in STEM related majors, being male was a significant predictor of pursuing a physical science degree.

***Two-year college student characteristics*.** Interestingly, no 2YC student characteristics such as associates' degree intent, class level, developmental math placement, highest level of math, or number of science courses taken at the 2YC were related to 2YC student intent to transfer. However, for those who intend to pursue physical science or geoscience degrees, the number of science courses taken at the 2YC is a significant predictor. Since these degrees typically require a greater background in the sciences, it is reasonable to expect that those intending to major in a science field will have higher motivation to complete a greater number of science courses in preparation for transfer in the major. Surprisingly, this study found developmental math placement is not a significant predictor of transfer intent nor intent to pursue a physical science or geoscience related degree. This finding is in contrast to Crisp and Delgato (2014) who suggest that developmental coursework may serve to decrease students' odds of transfer and instead confirms Attewell et al. (2006) and Bettinger and Long (2005) that developmental math placement has no effect on student transfer intent.

Two-year college academic engagement experiences. Interestingly, this study found 2YC academic engagement experiences are not related to overall 2YC student transfer intent. However, a number of characteristics were found to be significant factors in 2YC student intent to pursue physical science or geoscience degrees. For both outcomes, faculty interaction and faculty discussion of degrees in physical science fields were positive predictors. Those 2YC students who had more contact with faculty or those whose faculty members intentionally discussed physical science majors or degrees were more likely to intend to pursue either physical science or geoscience degrees. This corroborates that purposeful student-faculty contact is related to positive student retention outcomes (Astin, 1993, 1999; Chickering and Gamson, 1987; Kuh et al., 2007; Pascarella and Terenzini, 2005). More so, it has been shown that student-faculty interaction is important for persistence of women in STEM related majors (Packard et al., 2011); this is particularly significant as this study found that females outnumber male students in introductory physical science courses at 2YCs. The importance of faculty discussing career opportunities in physical science related fields also supports the work of Levine et al. (2007) who showed that students obtaining information from professors about a geoscience major was important in their choice of a major.

Of particular importance to the geosciences, participation in field experiences at the 2YC was found to be a significant factor in increased 2YC student intent to pursue geoscience degrees. Others have shown field experiences provide learning experiences that positively affect student motivation, attitudes, perceptions, and values (Mogk & Goodwin, 2012; Wolfe & Martin, 2013) and are a factor associated with recruitment and retention that appear to be geoscience-specific (Levine et al., 2007). Indeed, many geoscientists report that an early experience with geosciences during a field trip or field experience played a formative role in their career choice (Levine et al., 2007) and sense of themselves as geoscientists (van der Hoeven Kraft, Srogi, Husman, Semken, & Fuhrman, 2011). Field engagement activities can serve as a means to connect students with the earth, think geologically as scientists, and enhance their enjoyment of the outdoors (Stokes et al., 2015). van der Hoeven Kraft et al. (2011) termed this affective domain as "Connection to Earth" in which student interest "may change from temporal to sustained individual interest, which could lead to a greater desire to learn more" (p. 73). The significant role field engagement experiences played in increased intent to pursue geoscience related degrees reveals these same positive student outcomes of field experiences extend to students at 2YCs.

Surprisingly, participation in undergraduate research experiences (UREs) did not have a significant effect on intent to pursue either physical science or geoscience degrees. This may be that UREs are relatively rare at the 2YC due to lack of resources as well as limited on-going and funded research by 2YC instructors whose primary responsibility is teaching as opposed to research. Recently, a greater number of course based UREs have been employed at 2YCs (Kortz & van der Hoeven Kraft, 2016). However, there may be a lack of recognition by students that these activities are UREs unless explicitly made aware. Instead, students may equate these experiences with regular course work and activities, possibly leading to under-reporting of URE activities by 2YC students and reflected in survey responses in this study. Although not found significant in this study, other researchers have demonstrated positive impacts of URE on retention in science disciplines (Houser et al., 2013; Stokes et al., 2015; Kortz & van der Hoeven Kraft, 2016) including a call for UREs to be included as an integral part of undergraduate geoscience students' education (Mosher et al., 2014).

***Advising and pre-transfer advising activity*.** Several academic advising experiences and pre-transfer advising activities were significant in predicting 2YC student intent to transfer and pursuit of physical science or geoscience degrees. Greater satisfaction in interactions with 2YC academic advisors, speaking with a transfer advisor at the intended four-year institution, and visiting the intended four-year institution campus prior to transfer were all significant predictors of increased 2YC student intent of transfer. This is consistent with research that has found pre-transfer academic advising has significant impacts on student transfer outcomes (Hagedorn et al., 2008; Packard et al., 2012) as well as instilling greater transfer student capital (Laanan et al., 2010). Greater student-advisor interaction and student satisfaction with information provided by advisors at the 2YC can increase their motivation and commitment to transferring (Packard & Jeffers, 2013). Others have shown students who consult their academic advisor at the 2YC prior to transferring regarding courses and career plans are more likely to have a positive social adjustment at the transfer institution (Jackson & Lannan, 2015). Receiving information about the transfer process including transferability of coursework taken at the 2YC and support services of the receiving four-year institution through consultations with a transfer advisor can have positive impacts on student transfer motivation. This finding is aligned with Flaga (2006) who found that the collaboration among 2YC and university advisors assisted in students' understanding and comfort level with the transfer process and expectations. Helpful transfer advising has been shown to be particularly important for women in STEM majors in positioning towards transfer

(Packard et al., 2011). In addition, by visiting the intended four-year transfer institutions 2YC students can familiarize themselves with the new environment so as to navigate the new institution identifying and locating critical support resources and offices. Most importantly, the significance effects of academic advising and pre-transfer advising experiences on increased student transfer intent points to the likelihood that students with greater transfer readiness may be a predictor of successful student transfer.

Just as important, this study also found advising experiences were significantly related to the pursuit of physical science or geoscience degrees. These advising experiences included advisor interaction and advisor discussion of degrees in physical science fields. As with faculty discussion of physical science degrees, advisors who shared similar information had a significant positive effect in increased student pursuit of physical science or geoscience majors. This is an important finding as it has been shown greater knowledge of STEM careers influence students' career choices, particularly for careers in the geosciences (Levine et al., 2007).

However, unlike the positive influence of advisor interaction on student transfer intent, for both physical science and geoscience pursuit intent, advisor interaction was negatively related to 2YC student physical science or geoscience degree aspirations. Those with higher advisor interactions had less intent to major in physical sciences or the geosciences. This finding is opposite of Stokes et al. (2015), who found a departmental academic adviser facilitated transition into a geoscience major after a positive advising experience in an introductory science course. Their study focused on geoscience majors at the university level and their interactions were with a departmental academic advisor whom likely had more specific knowledge of the geoscience curriculum, prerequisites, different concentrations of geoscience fields, and different geoscience careers. This dedicated academic discipline advisor model is not typical of advising at 2YCs where advisors typically are generalists and advise a broad student population with wide ranging majors and career interests. As such, advisors at 2YCs typically focus on advising students of general academic pathways that lead to an associate's degree or general education requirements that transfer directly to a four-year institution. It might be that the students with greater advisor interactions in this study did not receive accurate or adequate information regarding transfer to a four-year institution with specific physical science or geoscience majors.

It should be noted that these results assume a directionality that advising interaction leads to greater student transfer intent. It is possible that the opposite is true, those students with high transfer intent seek out advisor interaction to prepare for transfer. Either way, academic advising is critical in preparing and positioning students for transfer to a four-year institution. This seems to be particularly true for students at 2YCs who lean heavily on academic advisors for advice of general education courses, prerequisites, transferability of courses and academic credit, academic majors, degree plans, and possible careers. This study reinforces the significant role advisors play in raising awareness of careers and degrees in the physical sciences through intentional discussion of physical science majors and careers with 2YC students early in their academic pursuits.

Implications

The results of this study validates the work of Laanan et al. (2010) regarding the importance of transfer student capital on student intent to transfer. This study reveals 2YC students who acquire higher levels of transfer student capital (in the form of academic engagement experiences, faculty interaction, faculty discussing physical science degrees, advisor interaction, advisor discussing physical science degrees, speaking with a transfer advisor, or visiting the intended four-year transfer institution) are significantly more likely to have higher intent to transfer or higher intent to pursue physical science or geoscience degrees. This points to a number of practical educational practices and policies for 2YCs and receiving four-year transfer institutions.

Implications for institutional practice. The results of this study verifies the critical importance of positive student-faculty interaction and the role that 2YC faculty members play in developing transfer student capital. This also extends to the significance of faculty members sharing knowledge of and opportunities in STEM related careers in building 2YC student interest in physical science or geoscience majors. Clearly, this study reveals 2YC students with greater faculty interaction and those whose faculty discussed physical science related majors and careers significantly increased student intent to transfer and pursuit of physical science or geoscience degrees. Administrators and educators at the 2YC should consider ways to encourage and facilitate academic engagement activities, both curricular and co-curricular, that promote intentional positive student-faculty interaction. This includes the incorporation of active learning practices in the classroom, UREs, faculty advising, or faculty-student mentoring activities. In addition, 2YC institutions could benefit from offering faculty professional development opportunities focused on the important role that faculty members play in preparing 2YC students for successful transfer to the receiving four-year institution.

Further, additional efforts on the part of administrators at 2YCs should encourage faculty in science-related disciplines to be intentional in discussing and raising awareness of physical science or geoscience majors and careers to female students. Disturbingly, this study found female students were less likely than men to continue to pursue physical science related degrees. Science faculty reaching out specifically to female students in these typically male dominated disciplines, incorporating examples of women researchers in course content and materials, highlighting the work of female colleagues, and creating a welcoming culture in the discipline may be the extra push needed to encourage female students to pursue physical science related careers. Additionally, leaders at 2YCs should consider offering faculty professional development focused on diversity and STEM education to help raise awareness of the gap in underrepresented population participation in science and mathematics fields, particularly within the geosciences (Wilson, 2014b). Faculty professional development in this area can equip faculty with the knowledge, strategies, and practices that in turn help encourage and support minority students interested in pursuing physical science or geoscience degrees.

With respect to those factors that strengthen the pipeline of geoscience majors from 2YCs, this study found field-based engagement experiences to be especially significant in increasing 2YC student intent to pursue geoscience degrees. In order to grow the number of 2YC students interested in geoscience related fields, 2YCs should incorporate intentional field-based learning experiences such as field trips, field oriented activities, and field-based courses into the introductory physical science curriculum at 2YCs. Not only can field-based learning be a key component to making the sciences stimulating and engaging (Wolfe & Martin, 2013), they in turn increase 2YC student awareness of, and interest in, geoscience related degrees and careers.

This study confirms the importance of the relationship between the 2YC student and their academic advisor and pre-transfer advising experiences. Positive student interactions with advisors, including information shared regarding transfer and career information in STEM fields, is a critical factor in increased student transfer intent. Results from this study show discussion of STEM related careers by an advisor is a strong prediction of transfer with pursuit in physical sciences – yet less than 10% of students in this study reported that an advisor discussed possible careers in physical science related fields. It is important that 2YCs encourage student-advisor engagement practices. This includes consideration of requiring mandatory academic advising for all incoming first-time freshman, re-entry, or non-traditional students with discussion focused on the student's academic degree plan, intended major and possible careers, and plans for transferring to a four-year institution. Institutions may also consider assigning students an academic success coach who has regular check-ins with the student to assess academic progress, address the student's academic concerns, help the student become aware of academic support resources, or refer the student to support services if they are dealing with personal issues impacting them academically.

Implications for policy. Students with high intent to transfer and pursue physical science and geoscience degrees reported negative academic advising interactions. Often these negative advising experiences can be a result of a lack of information shared regarding transfer requirements (Glass & Bunn, 1998; Hagedorn et al., 2008; Packard et al., 2012). Townsend (2008) found that the most frequent frustration for 2YC transfer students to a large, public, research university involved the transfer of course credits taken at the 2YC. As most science curriculum is sequenced, requiring prerequisite science and introductory discipline courses, greater course sequencing alignment between 2YC and four-year institutions and a greater understanding by academic advisors of that sequence is necessary to provide students with the knowledge needed to make informed decisions as they navigate their way through the transfer process. Therefore, it is critical that strong cooperation exists between advisors and faculty at the 2YC and corresponding academic science departments at the receiving four-year institution. This includes the need for developing stronger articulation agreements allowing for seamless STEM degree transfer pathways (Freeman et al., 2006; Starobin & Laanan, 2010). Packard et al., (2012) suggest that curriculum alignments between 2YCs and four-year institutions is still in need of further development. As such, open and ongoing communication needs to be fostered and maintained between 2YCs and four-year institutions to promote strong transfer articulation agreements, transfer guides, concurrent enrollment, and joint advising strategies to develop clear pathways leading to successful completion of degrees for 2YC transfer students. To help facilitate ongoing communication and apprising of curricular alignment, policies and structures should be in place among academic programs and advisors at each institution. This should include common course catalog numbering between institutions, curriculum alignment, and course-level student outcome alignment to reduce challenges faced by transfer students.

This study found academic engagement experiences are important factors in 2YC student transfer intent and building transfer student capital. Those receiving institutions that have a transfer student receptive culture can reduce “transfer shock” and help 2YC students draw upon the transfer student capital they have accumulated at the 2YC. As such, 2YC and four-year institutions should develop collaborative or joint field trips and research opportunities to promote greater 2YC student interaction with four-year institution faculty members. More so, exposure of 2YC students to research experiences at the four-year institution connect them with four-year faculty members and may help prepare them for the expectations of four-year institution degree programs. Additionally, collaborative partnerships strengthen communication and relationships between 2YC and four-year faculty and facilitate greater awareness and understanding of differences in culture between institution types.

Implications for future research. This study asked for respondents to report their intent to transfer to a four-year institution intent to complete their baccalaureate degree in the physical sciences or geosciences. Not all students will successfully transfer, nor those that do transfer with intent to pursue a physical science degree or geoscience degree will persist in the major to graduation. Longitudinal studies are needed to explore the adjustment of 2YC students post-transfer and those factors at the receiving institution that facilitate successful retention and completion in the major. Additionally, the data collected for this study is self-reported data. A longitudinal study following students through the entire transfer process and experience at the receiving institution could provide greater understanding of factors that lead to greater retention of 2YC transfer students in physical science and geoscience majors.

This study employed sequential multiple regression analysis in which respondents were structured into four region groups based on 2YC location. This variable was included in the regression models to account for, and determine what effect, regional variation had on the dependent variables. Although regional differences were found to exist in background and 2YC student characteristic variables, the small sample size of 2YCs (N = 24) and the variation of respondents by institution (between 3 and 65), led the researcher to choose not to use hierarchal linear modeling (HLM) in this study. Future studies with a greater number of 2YCs as level-two units or state-specific sampling may be able to further explore the regional differences suggested in this study using HLM. This includes exploring other clustered differences that may exist such as between urban, suburban, and rural 2YC institutions. The sample of 2YCs included in this study were mostly suburban and rural 2YCs which may reflect the higher percentage of traditional aged and white students enrolled in 2YC introductory physical science courses in this study. However, the differentiation between urban, suburban, and rural 2YC institutions is not addressed in this study and future research is needed to fully explore if this difference is indeed a factor.

Additionally, regional variation may be a result of the differences in networks of 2YC and four-year college institutions that are state-based versus those institutions that have greater local governance and independence. Some 2YC institutions are governed at the state-level along-side or underneath the state four-year institutions. These networks may have stronger or more developed articulation agreements, transfer pathways, and curriculum alignment than 2YCs in other regions that are governed at a local level and are independent of other state 2YCs or state four-year institutions. Differences between 2YC state systems or the impact of transfer articulation agreements were not addressed in this study and future research is needed to fully explore if articulation agreements or state-based networks of 2YCs are a factor.

In this study, developmental math placement was not found to be a significant predictor of 2YC student transfer intent. Nor did developmental math placement impact 2YC student intent to pursue physical science or geoscience related degrees. Although surprising, this finding does raise questions worthy of further exploration. In this study, students were only asked if they had tested into a developmental math course upon entry to the 2YC. They were not asked to specify the level of developmental math into which they tested, which can range from basic math, intermediate algebra, to advanced algebra. Further research is necessary to fully explore what, if any, the impact of placement into lower levels of developmental math may have on 2YC transfer intent and pursuit of physical science or geoscience degrees. In addition, this study did not examine other developmental or remedial needs, such as in English or reading, of 2YC students. As with higher levels of math competency, the ability to read and write at the college level is critical for successful academic outcomes in STEM related degrees. Future studies should therefore also examine the impact of developmental or remedial coursework beyond mathematics on student transfer intent and pursuit of physical science or geoscience degree.

This study also found participation in UREs does not have a significant effect on 2YC student intent to transfer nor pursuit of physical science or geoscience degrees. However, only a small number of 2YC students in this study reported participation in an URE at the 2YC. As discussed earlier, this may be that UREs are relatively rare at the 2YC and only recently are UREs occurring with greater frequency at 2YCs (Kortz & van der Hoeven Kraft, 2016). As the number of URE opportunities increase for students at 2YC, it would be meaningful for future studies to reexamine the effect of URE on 2YC student transfer intent and pursuit of STEM degrees.

Lastly, this study responded to the call for greater understanding of 2YC student academic engagement experiences. Future research should examine the relationship of student engagement outside the classroom including co-curricular and non-academic engagement on 2YC student transfer intent with pursuit of a physical science or geoscience degree. This includes the influence, if any, of non-academic factors common to 2YC students such as part-time versus full-time enrollment, working while attending school, and family commitments and responsibilities.

Conclusion

Colleges and universities are facing greater attention by state governments on college performance outcomes including accountability for successful 2YC student transfer and eventual completion of academic degrees (Dougherty et al., 2014; Tandberg et al., 2014; Townsend & Wilson, 2006). It is therefore critical for policymakers and educators in higher education to identify and implement practices that increase the number of 2YC students who transfer and complete baccalaureate degrees. However, exacerbating this challenge is physical science and geoscience disciplines lag far behind the other sciences in baccalaureate and graduate degree completion rates of students transferring from 2YCs (Wilson, 2014b). Recognition of this disparity has driven conversations to strengthen the pipeline of geoscience students beginning at

2YCs (Mosher et al., 2014; Wolfe et al., 2015). In an effort to address this gap, this study sought to gain an understanding of those factors that influence 2YC students' intentions to transfer to a four-year institution, specifically with physical science or geoscience degree aspirations.

Results from this study demonstrated the direct effects of background characteristics, academic engagement experiences, and academic advising experiences on 2YC student transfer intent and intent to pursue physical science or geoscience degrees. The significance of positive academic interactions, including interactions with a transfer advisor or visiting the intended four-year transfer institution, in accumulating transfer student capital and subsequent increased transfer intent was reinforced. Similarly, the critical importance of student-faculty interaction and the impact of faculty raising awareness of career opportunities in the physical sciences in increasing student intent to transfer pursuing physical science or geoscience degrees was substantiated. Lastly, and unique to the geosciences, this study corroborated the significant role field based experiences play in growing student interest in geoscience related fields and careers.

The findings presented here point to practices and policies that provide 2YC students opportunities of transfer student capital acquisition in turn strengthening the pipeline of physical science and geoscience students beginning at 2YCs and successfully matriculating to four-year colleges or universities. It is clear that intentional opportunities for student-faculty and student-advisor interaction in pre-transfer experiences results in a "heating up" of student transfer intent and pursuit of physical science or geoscience majors. More importantly, the findings of this study support the suggestion that 2YCs can serve as an intervention point to broaden participation, particularly those from underrepresented groups, in physical science or geoscience related majors and careers.

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APPENDIX A: Pre-Transfer Survey Instrument

Informed Consent Statement

The Department of Educational Leadership and Policy Studies at the University of Kansas supports the practice of protection for human subjects participating in research. The following information is provided for you to decide whether you wish to participate in the present study. You should be aware that even if you agree to participate, you are free to withdraw at any time without penalty.

We are conducting this study to better understand the factors and experiences of students at community colleges that influence their intent of transferring to a four-year college or university. This will entail your completion of a survey. Your participation is expected to take approximately 15 minutes to complete. The content of the survey should cause no more discomfort than you would experience in your everyday life.

Although participation may not benefit you directly, we believe that the information obtained from this study will help us gain a better understanding of how colleges and universities can better prepare and support students transferring from community colleges. Your participation is solicited, although strictly voluntary. You may stop taking the survey during any time with no penalty. In addition, you may skip any question you do not feel completely comfortable answering. Your name will not be associated in any way with the research findings. Information obtained during this study which would identify you will be kept strictly confidential. Your identifiable information will not be shared unless (a) it is required by law or university policy, or (b) you give written permission.

If you would like additional information concerning this study before or after it is completed, please feel free to contact us by phone or mail. Completion of the survey indicates your willingness to take part in this study and that you are at least 18 years old. If you have any additional questions about your rights as a research participant, you may call (785) 864-7429 or write the Human Subjects Committee Lawrence Campus (HSCL), University of Kansas, 2385 Irving Hill Road, Lawrence, Kansas 66045-7563, email irb@ku.edu.

Sincerely,

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I am fully aware of the nature and extent of my participation in this research project as stated above. I hereby voluntarily agree to participate in this research project. I acknowledge that I have read this consent statement. I am 18 years of age or older.

- Yes
- No (Please do not complete this survey any further)

KU Lawrence IRB # STUDY00003902 | Approval Period 3/25/2016

Background

1. What is the highest academic degree that you intend to obtain at any college? (Check only one.)
   - Associate's (A.A, A.S., A.A.S, or A.A.T)
   - Bachelor's (B.A. or B.S.)
   - Master's (M.A. or M.S.)
   - Doctorate (Ph.D. or Ed.D)
   - Medical (MD, DDS, DO, or DVM)
   - Law (JD or LLB)
   - Other ____________________

2. What is the highest level of math you completed in high school?
   - Geometry
   - Algebra
   - Pre-Calculus
   - Trigonometry
   - Calculus
   - Other (please specify) ____

3. What science course(s) did you take while in high school? (Check all that apply.)
   - None
   - Earth science (such as geology, meteorology, oceanography, or environmental science)
   - Biology
   - Chemistry
   - Physics
   - Other (please specify) ____

4. What was your high school GPA upon graduation? _______________

5. Which of the following best describes you? (Choose only one)
   - I am a current High School student taking a science class at the community college.
   - I enrolled in the community college less than one year after graduating high school.
   - I enrolled in the community college after more than one year after graduating from high school.
   - I attended another community college before I started attending my current community college.
   - I attended a four-year college or university but left before I started attending my community college.
   - I am currently attending a four-year college or university while taking a science class at the community college.
   - I graduated from a four-year college or university but I am taking a science class at a community college.
   - I am an international student.

Community College Experiences

6. How likely in the next two years do you plan on transferring to a four-year college or university?
   - None
   - Unlikely
   - Somewhat unlikely
   - Somewhat likely
   - Likely
   - Definitely

7. Do you plan on completing your Associates degree before transferring?
   - Yes
   - No

8. What is your current community college grade point average (GPA)? _______________

9. What is your class level?
   - Freshman
   - Sophomore

10. If you are planning to transfer are you pursuing or do you intend to pursue a major in a physical science related discipline such as chemistry or physics?
    - No
    - Unlikely
    - Somewhat unlikely
    - Somewhat likely
    - Likely
    - Definitely

11. If you are planning to transfer are you pursuing or do you intend to pursue a major in the geosciences (e.g. earth science, geology, geography, meteorology, atmospheric science, or oceanography)?
    - No
    - Unlikely
    - Somewhat unlikely
    - Somewhat likely
    - Likely
    - Definitely

12. Which of the following other science courses have you completed while at your community college? (Check all that apply.)
    - Biology
    - Chemistry
    - Physics
    - Earth science (such as geology, meteorology, oceanography, or environmental science)
    - Other (please specify) ____

13. What is the highest level of math you plan to complete while at your community college?
    - I don't plan to take a math class at my community college
    - Beginning algebra
    - Intermediate algebra
    - College algebra
    - Trigonometry
    - First Level Calculus
    - Advanced Calculus
    - Other (please specify) _______________________________________

14. Upon entering the community college, were you advised or did you take a placement test that indicated you needed developmental, remedial, basic skills, or college preparatory courses in math?
    - Yes
    - No (Skip to question 17)

15. How many developmental, remedial, basic skills, or college preparatory math courses have you completed?
    - 0
    - 1
    - 2
    - 3 or more

16. Did you repeat a developmental, remedial, basic skills, or college preparatory math course (due to withdrawing, failing the course, or desiring a higher grade)?
    - Yes
    - No

17. Academic Advising/Counseling Services (at your community college). The following items address your use of academic advising/counseling services at your community college. Please indicate the extent to which you disagree or agree with each statement.

	Strongly Disagree	Disagree	Somewhat Disagree	Somewhat Agree	Agree	Strongly Agree
I have consulted with academic advisors/counselors regarding transfer to a four-year college or university.	O	O	O	O	O	O
Information received from academic advisors/counselors has been helpful in preparing for the transfer process.	O	O	O	O	O	O
Academic advisors/counselors identified courses needed to meet the general education/major requirements of a four-year college or university I am interested in attending.	O	O	O	O	O	O

18. Has an academic advisors/counselors discussed or encouraged you to explore physical science majors and related careers?
    - O Yes
    - O No

19. Has an academic advisors/counselors discussed or encourage you to explore geoscience majors and related careers?
    - O Yes
    - O No

20. To what extent do you disagree or agree that your faculty at the community college:

	Strongly Disagree	Disagree	Somewhat Disagree	Somewhat Agree	Agree	Strongly Agree
Were available to you either before or after class or outside of class.	O	O	O	O	O	O
Provided an opportunity to collaborate with them on one or more activities related to you course work at your community college.	O	O	O	O	O	O
Provided an opportunity to collaborate with them on one or more activities outside of class at your community college.	O	O	O	O	O	O
Helped you create connections with other faculty/staff members at your community college.	O	O	O	O	O	O
Helped you create connections with other faculty/staff members at a four-year college or university.	O	O	O	O	O	O
Helped you explore a specific major, degree or career.	O	O	O	O	O	O

21. Has a faculty member at your community college discussed or encouraged you to explore a physical science major and related career?
    - O Yes
    - O No

22. Has a faculty member at your community college discussed or encouraged you to explore geoscience majors and related careers?
    - O Yes
    - O No

23. Did you participate in undergraduate research while at the community college?
    - O Yes
    - O No (Skip to question 25)

24. If Yes, to what extent do you disagree or agree that your undergraduate research experience:

	Strongly Disagree	Disagree	Somewhat Disagree	Somewhat Agree	Agree	Strongly Agree
Provided an opportunity for regular contact with a faculty or staff member.	O	O	O	O	O	O
Helped you create connections with other faculty/staff members at your community college.	O	O	O	O	O	O
Helped you create connections with other faculty/staff members at a four-year college or university.	O	O	O	O	O	O
Provided an opportunity to practice "authentic science."	O	O	O	O	O	O
Increased an interest in pursuing physical science majors and related careers.	O	O	O	O	O	O
Increased an interest in pursuing a geoscience major and related career.	O	O	O	O	O	O

25. Did you participate in a field trip or outdoor learning experience in a science course at the community college?
    - O Yes
    - O No (skip to question 27)

26. If Yes, to what extent do you disagree or agree that your field trip or outdoor learning experience:

	Strongly Disagree	Disagree	Somewhat Disagree	Somewhat Agree	Agree	Strongly Agree
Provided an opportunity for regular contact with a faculty or staff member.	O	O	O	O	O	O
Helped you create connections with other faculty/staff members at your community college.	O	O	O	O	O	O
Helped you create connections with other faculty/staff members at a four year college or university.	O	O	O	O	O	O
Provided an opportunity to practice "authentic science."	O	O	O	O	O	O
Increased an interest in pursuing physical science majors and related careers.	O	O	O	O	O	O
Increased an interest in pursuing a geoscience major and related career.	O	O	O	O	O	O

<u>Pre-Transfer Experience</u>

27. Have you spoken to a transfer advisor at your intended transfer school?
    - O Yes
    - O No

28. Have you visited the campus of the four-year college or university transfer school you plan to transfer?
    - O Yes
    - O No

29. Have you participated in a transfer orientation session at your four-year college or university you plan to transfer?
    - O Yes
    - O No

<u>Demographic information</u>

30. What is your gender?
    - O Male
    - O Female

31. What is your age? _______________

32. What is your race/ethnic background? (You may select more than one answer)
    - American Indian or Alaska Native
    - Asian
    - Black or African American
    - Hispanic or Latino/a
    - Native Hawaiian or other Pacific Islander
    - White (non-Hispanic or non-Latino/a)
    - Other

33. Are you Pell eligible?
    - Yes
    - No

34. What is the highest level of education completed by your Mother?
    - Some high school
    - High School graduate
    - Some college
    - Associates degree from two-year college
    - Bachelor's degree
    - Graduate degree

35. What is the highest level of education completed by your Father?
    - Some high school
    - High School graduate
    - Some college
    - Associates degree from two-year college
    - Bachelor's degree
    - Graduate degree

36. If you are intending to pursuing a major in the physical sciences (chemistry, physics, or geosciences) when you transfer to your college or university, what experiences at the community college increased your interest in the physical sciences?

37. What experiences at your community college do you think have prepared you to adjust to the college or university to which you plan to transfer?

If you indicated that you are interested in pursuing a major in the geosciences upon transferring to a four-year college or university, would you be willing to be contacted for a follow-up brief interview regarding your experiences at the community college? If so please provide an email address other than your school email address that we may use to contact you below. Your contact information and identity will be kept strictly confidential.

Your E-mail contact: ____

APPENDIX B: Internal Review Board Approval

THE UNIVERSITY OF KANSAS
Research

APPROVAL OF PROTOCOL

March 25, 2016

Benjamin Wolfe
ben.wolfe@ku.edu

Dear Benjamin Wolfe:

On 3/25/2016, the IRB reviewed the following submission:

Type of Review:	Initial Study
Title of Study:	Tapping the Physical Science Two-Year College Student Reservoir: Factors that Influence Student Transfer Intent and Physical Science Related Degree Aspirations
Investigator:	Benjamin Wolfe
IRB ID:	STUDY00003902
Funding:	None
Grant ID:	None
Documents Reviewed:	• Survey Informed Consent Statement.docx, • Interview HSCL_signed_consent_form_ 7_13.docx, • HSCL-NewSubmission-Form-V3_BW.pdf, • Interview Protocol.docx, • Survey Administration Instruction Script.docx, • Transfer_Student_Survey.docx, • Geoscience Faculty Recruitment Email.docx

The IRB approved the study on 3/25/2016.

1. Notify HSCL about any new investigators not named in the original application. Note that new investigators must take the online tutorial at https://rgs.drupal.ku.edu/human_subjects_compliance_training.
2. Any injury to a subject because of the research procedure must be reported immediately.
3. When signed consent documents are required, the primary investigator must retain the signed consent documents for at least three years past completion of the research activity.

Continuing review is not required for this project, however you are required to report any significant changes to the protocol prior to altering the project.

Please note university data security and handling requirements for your project:
https://documents.ku.edu/policies/IT/DataClassificationandHandlingProceduresGuide.htm

You must use the final, watermarked version of the consent form, available under the "Documents" tab in eCompliance.

Sincerely,

Stephanie Dyson Elms, MPA
IRB Administrator, KU Lawrence Campus

APPENDIX C: List of Two-Year Colleges Represented in the Study

Table C1

Number of respondents by two-year college included in the Study

State	Two-Year College	*n*
Arizona	Scottsdale Community College	3
Arkansas	Northwest Arkansas Community College	24
California	San Jose City College	36
Illinois	Illinois Valley Community College	49
	Waubonsee Community College	27
Kansas	Johnson County Community College	64
Michigan	Muskegon Community College	34
Missouri	Metropolitan Community College – Kansas City	62
	State Fair Community College	31
New Jersey	Bergen Community College	32
New York	Monroe Community College	38
North Carolina	Wake Technical Community College	3
Ohio	Sinclair Community College	19
Oklahoma	Northeast Oklahoma A&M College	17
Rhode Island	Community College of Rhode Island	38
Texas	Austin Community College	9
	Blinn College	32
	El Centro College	5
	El Paso Community College	35
Virginia	Northern Virginia Community College	65
	Thomas Nelson Community College	61
Washington	Highline College	6
	Whatcom Community College	40
Wisconsin	University of Wisconsin Richland	21
		751 Total

APPENDIX D: Chi-square and One-Way ANOVA results

Table D1

Demographic response results by region and chi-square results

Variable	South *n*	East *n*	Midwest *n*	West *n*	χ^2	*df*	*p*
Gender	124	234	304	85	16.94	3	.001
Male	50	139	144	34			
Female	74	95	160	51			
Race/Ethnicity	122	230	301	84	53.53	3	<.001
White	59	149	242	43			
Non-white	63	81	59	41			
Age	124	225	294	85	10.82	3	.013
Traditional	95	171	242	56			
Non-traditional	29	54	52	29			

Note: Traditional age range is 18-23. Non-traditional age range is >23.

Table D2

One-way ANOVA of high school background characteristics by region

	South		East		Midwest		West				
Variable	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	F	*df*	*p*
Degree intent	2.51	1.19	2.65	1.04	2.59	1.14	2.73	1.23	.80	3, 739	.494
High School math	3.32	1.45	3.16	1.44	3.26	1.49	2.73	1.46	3.47	3, 746	.017**
High School science	2.44	.85	2.56	.73	2.47	.74	2.21	.87	4.16	3, 746	.006**

*p <.05, **p <.01, ***p<.001

Note: Degree intent ranges from 1 (associates degree) to 7 (other graduate degree). High school math ranges from 1 (geometry) to 6 (other higher math). High school science ranges from 0 (none) to 3 (three or more).

Table D3

Two-year college student characteristics response results by region and chi-square results

	South	East	Midwest	West			
Variable	*n*	*n*	*n*	*n*	χ^2	*df*	*p*
AA degree intent	123	230	306	85	16.73	3	.001
No	39	39	60	9			
Yes	84	191	246	76			
Class Level	122	225	286	83	9.32	3	.025
Freshman	17	57	79	18			
Sophomore	105	168	207	65			
Developmental math	125	232	305	84	10.89	3	.012
No	60	111	160	27			
Yes	65	121	145	57			

Table D4

One-way ANOVA of 2YC student characteristics by region

	South		East		Midwest		West				
Variable	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	F	*df*	*p*
2YC science	1.26	.84	1.20	.82	1.42	.83	1.24	.84	3.41	3, 746	.017*
2YC math intent	5.16	1.83	5.30	1.96	4.67	1.87	5.71	1.79	9.04	3, 736	<.001***

*p <.05, **p <.01, ***p<.001

Note: The number of 2YC science courses completed ranges from 0 (none) to 3 (three or more). Highest 2YC math intent ranges from 1 (no math) to 8 (other higher level math).

APPENDIX E: Correlation Matrix

Table E1 *Pearson Correlation Coefficient Matrix*

Variable			1	2	3	4	5	6	7	8	9	10	11
1	Degree intent	Pearson Correlation	1										
		Sig. (2-tailed)											
		N	743										
2	Highest High Sch. Math	Pearson Correlation	.061	1									
		Sig. (2-tailed)	.095										
		N	742	750									
3	# of High Sch. Sci. Courses	Pearson Correlation	.137**	.183**	1								
		Sig. (2-tailed)	.000	.000									
		N	742	749	750								
4	Enrollment status	Pearson Correlation	.031	.067	-.006	1							
		Sig. (2-tailed)	.394	.067	.860								
		N	741	748	749	749							
5	Transfer intent	Pearson Correlation	.347**	.100**	.062	.041	1						
		Sig. (2-tailed)	.000	.006	.092	,263							
		N	741	748	748	747	749						
6	AA degree intent	Pearson Correlation	-.186**	-.095**	-.141**	-.100**	-.106**	1					
		Sig. (2-tailed)	.000	.010	.000	.007	.004						
		N	736	743	743	742	743	744					
7	Class level	Pearson Correlation	-.039	-.082*	-.063	.174**	.075*	.040	1				
		Sig. (2-tailed)	.302	.028	.092	.000	.045	.292					
		N	709	715	715	714	715	711	716				
8	Phys. Degree intent	Pearson Correlation	.103**	.031	.060	.003	.111**	-.078*	-.062	1			
		Sig. (2-tailed)	.005	.391	.103	.931	.002	.034	.098				
		N	739	746	746	745	746	741	714	747			
9	Geo. Degree intent	Pearson Correlation	.019	.050	.015	.004	.004	-.015	-.107**	.501**	1		
		Sig. (2-tailed)	.600	.175	.684	.910	.921	.684	.004	.000			
		N	739	734	734	733	734	729	703	735	735		
10	# of 2YC Sci. Courses	Pearson Correlation	.124**	.000	.061	-.031	.120**	-.047	.213**	.194**	.112**	1	
		Sig. (2-tailed)	.001	.995	.095	.394	.001	.205	.000	.000	.002		
		N	742	749	749	748	748	743	715	746	735	750	
11	Highest math intent @2YC	Pearson Correlation	.061	.099**	.088*	-.003	.089*	.071	.036	.083*	.041	-.005	1
		Sig. (2-tailed)	.098	.007	.016	.925	.016	.054	.342	.024	.271	.890	
		N	732	739	739	738	738	734	708	736	725	739	740

Table E1 (continued)

Variable			1	2	3	4	5	6	7	8	9	10	11
12	Dev. math placement	Pearson Correlation	-.061	-.263**	-.217**	-.044	-.094*	.121**	.121**	-.100**	-.094*	-.031	-.015
		Sig. (2-tailed)	.096	.000	.000	.226	.010	.001	.001	.006	.011	.393	.675
		N	738	745	745	744	744	739	712	742	730	745	737
13	Advisor discussed phy. careers	Pearson Correlation	.096**	.023	-.034	-.019	.040	-.003	-.081*	.386**	.289**	.159**	.056
		Sig. (2-tailed)	.009	.525	.353	.602	.279	.927	.031	.000	.000	.000	.131
		N	737	744	744	743	743	739	710	741	729	744	735
14	Advisor discussed geo. careers	Pearson Correlation	-.004	.024	.033	.048	.006	-.034	-.030	.226**	.406**	.074*	.063
		Sig. (2-tailed)	.910	.520	.364	.194	.871	.355	.419	.000	.000	.045	.087
		N	736	743	743	742	742	738	709	740	728	743	734
15	Faculty discussed phy. careers	Pearson Correlation	.078*	.022	-.001	.047	.065	.026	-.014	.327**	.285**	.171**	.057
		Sig. (2-tailed)	.033	.556	.980	.197	.076	.472	.705	.000	.000	.000	.123
		N	739	746	746	745	745	740	712	743	731	746	736
16	Faculty discussed geo. careers	Pearson Correlation	.029	.024	.013	.103**	.025	.051	-.001	.200**	.414**	.102**	.044
		Sig. (2-tailed)	.433	.511	.719	.005	.498	.168	.979	.000	.000	.005	.231
		N	739	746	746	745	745	740	712	743	731	746	736
17	URE participation @2YC	Pearson Correlation	.007	.024	-.004	.033	.035	.062	.101**	.024	.043	.051	-.074*
		Sig. (2-tailed)	.848	.509	.905	.367	.336	.092	.007	.520	.247	.165	.044
		N	737	744	744	743	743	738	711	741	729	744	736
18	Field experience @2YC	Pearson Correlation	-.050	-.044	-.030	.080*	-.035	.009	.051	.060	.193**	.060	.031
		Sig. (2-tailed)	.177	.238	.416	.031	.344	.804	.178	.105	.000	.102	.405
		N	729	736	736	736	735	730	702	733	721	736	727
19	Spoke with transfer advisor	Pearson Correlation	.141**	.007	.000	.030	.304**	-.171**	.168**	.034	-.089*	.171**	.075*
		Sig. (2-tailed)	.000	.852	.999	.415	.000	.000	.000	.358	.016	.000	.042
		N	739	746	746	745	745	740	713	744	732	746	736
20	4YC visit	Pearson Correlation	.092*	.081*	.122**	.063	.332**	-.166**	.066	-.032	-.064	.097**	.064
		Sig. (2-tailed)	.013	.026	.001	.087	.000	.000	.079	.387	.082	.008	.082
		N	739	746	746	745	745	740	713	744	732	746	736
21	Attended transfer orientation	Pearson Correlation	.022	.020	.037	.004	.162**	.126**	.093*	-.015	-.039	.140**	-.010
		Sig. (2-tailed)	.548	.586	.313	.919	.000	.001	.013	.678	.298	.000	.793
		N	737	744	744	743	743	738	711	742	730	744	734
22	Gender	Pearson Correlation	.023	.016	-.015	-.002	.061	.036	.077*	-.106**	-.016	.124**	-.090*
		Sig. (2-tailed)	.540	.656	.673	.966	.095	.322	.040	.004	.657	.001	.015
		N	739	746	747	746	745	741	714	743	731	746	736

Table E1 (continued)

Variable			1	2	3	4	5	6	7	8	9	10	11
23	Pell eligibility	Pearson Correlation	-.036	-.068	-.084*	-.010	-.023	.059	.033	-.008	-.026	.011	.026
		Sig. (2-tailed)	.363	.082	.032	.802	.549	.132	.412	.841	.506	.773	.509
		N	650	654	654	653	653	651	631	652	643	654	648
24	Race/ Ethnicity	Pearson Correlation	.037	-.030	.039	.148**	.073*	.007	.065	-.027	-.057	-.050	.072
		Sig. (2-tailed)	.323	.413	.292	.000	.046	.854	.086	.470	.129	.172	.053
		N	729	736	737	736	735	731	706	733	721	736	728
25	Parent highest education	Pearson Correlation	.102**	.101**	.158**	.027	.051	-.100**	-.011	-.011	.059	.036	-.050
		Sig. (2-tailed)	.006	.006	.000	.466	.165	.007	.763	.774	.110	.334	.182
		N	730	737	737	736	736	733	708	734	722	737	729
26	Age	Pearson Correlation	-.057	-.103**	-.304**	.335**	-.076*	.131**	.080*	.035	.098**	.003	.031
		Sig. (2-tailed)	.125	.005	.000	.000	.041	.000	.035	.350	.009	.942	.411
		N	721	727	728	727	726	723	698	724	712	727	718
27	Faculty interaction	Pearson Correlation	-.022	.003	-.059	.000	.031	.064	.044	.081*	.092*	.063	-.045
		Sig. (2-tailed)	.550	.941	.109	.990	.390	.082	.245	.027	.012	.084	.218
		N	740	747	747	746	746	742	713	744	732	747	738
28	Advisor interaction	Pearson Correlation	.069	-.019	-.025	-.010	.205**	.096*	.044	-.027	-.059	.035	.044
		Sig. (2-tailed)	.065	.607	.499	.785	.000	.011	.251	.464	.117	.345	.236
		N	714	719	719	718	719	713	686	716	704	719	711

Table E1 (continued)

	Variable		12	13	14	15	16	17	18	19	20	21	22
12	Dev. math placement	Pearson Correlation	1										
		Sig. (2-tailed)											
		N	746										
13	Advisor discussed phy. careers	Pearson Correlation	-.054	1									
		Sig. (2-tailed)	.142										
		N	740	745									
14	Advisor discussed geo. careers	Pearson Correlation	-.051	.527**	1								
		Sig. (2-tailed)	.166	.000									
		N	739	744	744								
15	Faculty discussed phy. careers	Pearson Correlation	-.049	.440**	.282**	1							
		Sig. (2-tailed)	.183	.000	.000								
		N	742	743	742	747							
16	Faculty discussed geo. careers	Pearson Correlation	-.038	.238**	.318**	.643**	1						
		Sig. (2-tailed)	.297	.000	.000	.000							
		N	742	743	742	747	747						
17	URE participation @2YC	Pearson Correlation	.041	.033	.038	.005	.074*	1					
		Sig. (2-tailed)	.260	.371	.299	.901	.045						
		N	742	740	739	743	743	745					
18	Field experience @2YC	Pearson Correlation	.035	.047	.147**	.121**	.226**	.152**	7				
		Sig. (2-tailed)	.344	.201	.000	.001	.000	.000					
		N	733	731	730	734	734	733	737				
19	Spoke with transfer advisor	Pearson Correlation	.002	-.008	-.015	-.006	-.040	-.007	.044	1			
		Sig. (2-tailed)	.966	.825	.679	.864	.272	.842	.236				
		N	742	741	740	743	743	741	734	747			
20	4YC visit	Pearson Correlation	-.086*	-.017	-.013	.010	.016	.097**	.032	.381**	1		
		Sig. (2-tailed)	.019	.637	.722	.786	.655	.008	.382	.000			
		N	742	741	740	744	744	742	734	746	747		
21	Attended transfer orientation	Pearson Correlation	-.022	-.041	.017	-.023	-.002	.081*	.023	.372**	.359**	1	
		Sig. (2-tailed)	.553	.265	.648	.524	.965	.027	.531	.000	.000		
		N	740	739	738	742	742	740	732	744	745	745	
22	Gender	Pearson Correlation	.045	-.048	-.047	-.014	-.014	-.073*	-.040	.049	-.009	-.048	1
		Sig. (2-tailed)	.220	.192	.198	.695	.712	.046	.284	.180	.815	.194	
		N	742	741	740	744	744	742	734	743	744	742	747

Table E1 (continued)

Variable			12	13	14	15	16	17	18	19	20	21	22
23	Pell eligibility	Pearson Correlation	.129**	.089*	.070	.045	.014	.008	.045	-.068	-.081*	-.049	-.044
		Sig. (2-tailed)	.001	.024	.076	.256	.713	.829	.251	.085	.038	.210	.258
		N	651	650	649	651	651	651	643	652	652	650	652
24	Race/ Ethnicity	Pearson Correlation	.116**	.016	.001	-.034	-.071	.060	-.050	-.007	.004	.013	-.001
		Sig. (2-tailed)	.002	.660	.970	.356	.056	.106	.176	.852	.909	.715	.982
		N	733	732	731	734	734	733	725	733	734	732	736
25	Parent highest education	Pearson Correlation	-.128**	.003	.017	-.005	.034	.011	-.048	.019	.124**	.049	-.025
		Sig. (2-tailed)	.001	.938	.648	.889	.362	.767	.200	.604	.001	.188	.491
		N	734	733	732	734	734	733	724	734	734	732	735
26	Age	Pearson Correlation	.183**	.015	.026	.066	.123**	.017	.098**	-.017	-.114**	-.039	.063
		Sig. (2-tailed)	.000	.688	.478	.077	.001	.646	.009	.656	.002	.293	.087
		N	723	724	723	724	724	722	715	724	724	722	727
27	Faculty interaction	Pearson Correlation	.046	.140**	.097*	.117**	.096**	.059	.067	.121**	.094*	.067	.104**
		Sig. (2-tailed)	.208	.000	.008	.001	.009	.106	.069	.001	.010	.067	.004
		N	743	744	743	745	745	743	734	744	744	742	744
28	Advisor interaction	Pearson Correlation	.035	.109**	.058	.031	-.033	.034	.030	.206**	.127**	.123**	.037
		Sig. (2-tailed)	.347	.003	.123	,408	.386	.369	.426	.000	.001	.001	.329
		N	717	714	713	716	716	716	711	717	716	714	716

Table E1 (continued)

Variable			23	24	25	26	27	28
23	Pell eligibility	Pearson Correlation	1					
		Sig. (2-tailed)						
		N	655					
24	Race/ Ethnicity	Pearson Correlation	.122**	1				
		Sig. (2-tailed)	.002					
		N	649	737				
25	Parent highest education	Pearson Correlation	-.191**	-.201**	1			
		Sig. (2-tailed)	.000	.000				
		N	651	729	738			
26	Age	Pearson Correlation	.152**	.018	-.083*	1		
		Sig. (2-tailed)	.000	.621	.025			
		N	640	722	720	728		
27	Faculty interaction	Pearson Correlation	.103**	-.028	-.048	.041	1	
		Sig. (2-tailed)	.008	.453	.196	.275		
		N	653	735	736	726	748	
28	Advisor interaction	Pearson Correlation	.087*	.072	-.054	-.016	.355**	1
		Sig. (2-tailed)	.028	.057	.154	.673	.000	
		N	630	708	708	697	717	720

*p <.05, **p <.01