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ON THE SOCIALIZATION OF TRANSFER PHYSICS MAJORS ENROLLED WITHIN UPPER-DIVISION PHYSICS COURSES AT TRANSFER RECEIVING INSTITUTIONS: QUALITATIVE RESEARCH

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by

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Dedications

I dedicate this research study to my loving wife Vicki. She has always supported my ongoing drive to learn and grow. Vicki, without your support, love, and patience, my studies would have been impossible.

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Abstract

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Carol C. Thompson, Ph.D.
Doctor of Education

A host of individual and institutional sociocultural factors mediate transfer physics students' socialization experiences at 4-year transfer receiving institutions. The purpose of this study is to understand how sociocultural factors mediate transfer physics students' socialization while participating in upper-division physics coursework at a 4-year public transfer-receiving university. This study, rooted in sociocultural constructivism, aimed to shape discussion of seven transfer physics students', six regular admit physics students', and a physics course instructor's experiences connected to physics studies that emerged from qualitative data. These data included student and faculty surveys, interviews, and classroom observations. Several key findings emerged. First, a multitude of sociocultural factors mediate students' participation in classroom and co-curricular activities. Second, the instructor's deficit beliefs about transfer physics students contradict the students' expectations for success in their physics studies, the value that transfer physics students placed on participation in physics studies, and transfer physics students' interactions in physics-related educational settings. Last, the physics course instructor's pedagogy approach mediated physics students' classroom interactions and the students' critical evaluation of their own approach to problem solving, or other students' physics-related approach to problem-solving in classroom settings.

Table of Contents

Table of Contents (Continued)

Table of Contents (Continued)

Table of Contents (Continued)

Table of Contents (Continued)

Table of Contents (Continued)

List of Figures

List of Tables

Chapter I

Introduction

Beyond providing the resources for transfer physics students to acquire physics-related skills and dispositions, addressing the needs of transfer physics majors requires an understanding of factors that influence their participation in the culture of their transfer-receiving institutions (Airey & Linder, 2009; Gee, 1999; Eccles et al., 1983). Several professional organizations provide knowledge of the best practices that inform the understanding of factors that influence students' experiences within undergraduate physics programs (American Association of Physics Teachers, 2005; Harlow & Otero, 2006; Kozminski et al. 2014). Despite possessing knowledge of best practices, understanding the vast array of sociocultural factors that influence students' socialization connected to their participation in upper-division physics coursework or related co-curricular activities requires additional and ongoing inquiry (Eccles et al., 1983).

Most of the relevant research investigating transfer science, technology, engineering, and mathematics (STEM) majors' experiences has been limited to (a) empirical studies that measured statistical relationships among a wide array of sociocultural variables, educational activity at 4-year institutions, and transfer students' academic outcomes; and (b) one qualitative study that provided insights into female STEM transfer majors' influences to pursue STEM studies and their post-transfer experiences, including adjustment, assistance from faculty or advisors, and involvement at 4-year transfer receiving institutions (Aciksoz, Ozkan, & Dokme, 2020; Appianing & Van Eck, 2018; Davis, Harris & Talley, 2019; Jackson & Lanaan, 2015; Jackson, Starobin, Lanaan, 2013; Starobin, Jackson, & Lanaan, 2016; Van Dinh, 2017; Van Dinh

& Zhang, 2020; Wang, 2020). Yet, research focused specifically on transfer physics majors' socialization experiences is limited. This study at Grand Lakes University (a pseudonym for a transfer-receiving institution) sought to identify how a wide variety of individual and institutional sociocultural factors shaped students' participation in educational activities and socialization activities that further mediate students' acquisition of physics-related ways of being or discourses. Individual factors investigated within this study included students' previous educational experiences, psychological beliefs regarding self-concept related to abilities, the value students placed on participating in physics-related educational activities, their perceptions of their peers and course instructors, and their sense of belonging as physics majors at Grand Lakes University. Institutional factors investigated in this study included practitioner behaviors including pedagogy and the facilitation of activities to promote student curricular and co-curricular activities.

Conceptual Framework

Extant literature places little doubt on the significance of sociocultural influences as related to students' educational activities in the higher education setting (Eccles et al., 1983; Kahu, 2013; Weidman, 1989). The sociocultural research perspective recognizes that individual and institutional factors, both containing structural and psychosocial dimensions, impact students' interactions and relationships in the educational setting. From a constructivist viewpoint, an array of interrelated sociocultural factors mediates one's object-oriented activity, which in this study is includes the classroom participants' participation in achievement-related classroom or co-curricular behaviors or the course instructor's or other practitioners' facilitation of activities that promote students' participation in classroom or cocurricular activities. Object-oriented activity represents the objective of activity, or prospective outcomes, that “motivate and direct activities, around which activities are coordinated” (Kaptelinin & Nardi 2006, p. 66). Theoretical and conceptual frameworks presented in Chapter II will rely on existing knowledge related to sociocultural factors that shape individuals' activity toward desired outcomes. Such activities in the context of transfer-receiving institutions involve participation in classroom or co-curricular activities that lead to student socialization or the adoption of ways of being (i.e, discourse acquisition) related to physics-disciplines. A discussion of the individual (i.e., student-related) and institutional (i.e., university-related) sociocultural factors that influence students’ educational experiences will provide background information related to the research problem, the purpose of the study, research questions this study seeks to answer, and the methods for data collection and analysis.

Individual Sociocultural Factors

Individuals originate in communities that use cultural practices shaped to satisfy the values, motivations, goals, and needs of the community. When individuals enter new surroundings (e.g., home to the higher education setting, transferring from a community college to a four-year institution, etc.), their ingrained cultural practices, described by Gee (1990) as primary discourses (i.e., ways of communicating or being) predispose their educational experiences. Where students' beliefs, values, motivations, goals, or skills imparted by family or previous educational experiences are inconsistent with those of their new institution or community of practice, maladjustment to their new circumstances may occur.

Individual Factors

There is copious research on individual structural and psychosocial sociocultural influences including (a) transfer student population in terms of degree aspirations, (b) transfer rates from community colleges to four-year institutions, and (c) degree attainment rates. Jackson and Lanaan (2015) examined individual and institutional factors across all transfer college majors and for transfer STEM majors addressing factors associated with degree attainment and adjustment to their new learning surroundings. Matriculation status represents one of the many markers of individual difference that potentially shape an individuals' educational experiences. This chapter addresses student matriculation pathways, an individual psychosocial factor that I categorized as a form of identity. Assessment data, specific to the transfer student population at Grand Lakes University, a pseudonym for the proposed site (presented later in this chapter), provided background knowledge related to educational outcomes that prompted my interest in studying physics transfer students' socializations experiences at Grand Lakes University.

Transfer Student Demographics. The Community College Resource Center (2015) recognizes that 80% of community college students intend to earn a bachelor's degree. Presuming that four-year institutions cannot accommodate the larger number of aspiring college students who intend to pursue bachelor's degrees, the community college system and transfer pathway to four-year institutions enhances the capacity of the higher education system for roughly 40% of undergraduates in the United States by providing an pathways to higher education degrees for a large number of students. However, only one-quarter of community college students who intend to earn a bachelor's degree transfer to study at other institutions, and less than one-fifth complete bachelor's degrees.

Transfer Student Attainment and Adjustment. Several empirical studies inform our understanding of factors that alter transfer students' baccalaureate attainment rates and adjustment upon entering the transfer-receiving institution (aggregate data including all majors). The study by Freeman, Conley, and Brooks (2006) drew upon data from the National Center for Educational Statistics to examine factors that may influence baccalaureate attainment for students who initially attend community colleges and transfer to a four-year institution. This study revealed differences in degree attainment as a function of transfer students' (a) individual sociodemographic characteristics (e.g., gender, age, risk factors including delayed higher education enrollment, single-parent status, marital status, number of dependents, high school completion, and financial independence); (b) institutional geographic characteristics (e.g., level of urbanicity of high school and first college attended); and (c) personal goals or motivation (e.g., financial goals, distance from family during post-secondary study, social mobility for children).

As related to transfer STEM majors, Jackson and Laanan's (2015) quantitative study analyzed the academic and social adjustment at four-year research-intensive institutions. The findings of this study revealed variability in academic adjustment (i.e., anxiety related to participating in large classes/student body, Grade Point Average (GPA) dip during first semester after transfer, stress during first semester) that was predicted by (a) individual sociocultural factors including student background (e.g., family members' level of education, gender, degree aspirations) and (b) institutional sociocultural factors (inherently related to the individual) including community college experiences (e.g., GPA, academic credits transferred, associate's degree attainment, hours dedicated to study, advising, experiences with faculty, course experiences) and university experiences (e.g., financial motivation for attending, perceptions of faculty, university climate; perceived reception of transfer students at transfer-receiving institution).

Further, Jackson and Laanan's (2015) quantitative study revealed variability in social adjustment (i.e., adjusting to transfer-receiving institutions, making friends, ease of making friends). These adjustments are predicted both by individual sociocultural factors including student background (e.g., family members' level of education, parents' income, gender, degree aspirations) and by institutional sociocultural factors. The latter include community college experiences (e.g., time spent studying for class, academic advising, and course learning) and university experiences (e.g., financial or reputational reasons for attending, perception of course learning, college housing, perceptions of faculty, and overall institutional satisfaction).

Students' Linguistic Ability. Linguistic ability represents an individual structural sociocultural factor that alters students' educational experiences. Language use represents a form of cultural capital that predetermines an individual's or group member's position in society as delegated by powerful institutions such as subject matter disciplines within learning communities. Several studies recognized that studying Science, Technology, Engineering, and Mathematics (STEM) requires learners to acquire new requisite patterns of language and expression through an immersion in practices in STEM fields (Airey & Linder, 2009; Gee, 1999; National Academies of Science, Engineering, and Medicine, 2018; Starobin, Smith, & Laanan, 2016; Van Dinh, 2017; Xu, Slonki, McPartlan, & Sato, 2018). Activity Theory serves as a useful lens within the constructivist viewpoint. Within the Activity Theory framework, language serves as a mediating artifact (i.e., tool) that in many cases alters educational interactions and assists in understanding student socialization (Engeström, 1996). Extant literature describes the importance of educational interactions during the socialization of transfer STEM students (i.e., acquiring requisite language or other ways of being). Many of these studies fail to provide context-specific data related to linguistic interactions during the socialization process (Eccles et al., 1983; Laanan, Starobin, & Eggleston, 2010; Starobin, Smith, & Laanan, 2016; Van Dinh, 2017; Xu, 2015).

Expectancies and Task-Related Values as Predictors. Atkinson (1957) first postulated a theory to understand individual’s motivation and achievement, and then Eccles and colleagues (1983) formulated a developmental model to related achievement behaviors that are regulated by achievement-related motives and expectancies for success. A plethora of recent quantitative studies use these models to assess how combination of connections between students' competence beliefs, task values, and perceived costs can predict motivation for participation, persistence, and degree attainment (Aciksoz, Ozkan, & Dokme, 2020; Appianing & Van Eck, 2018; Davis, Talley, & Harris, 2019; Perez et al., 2019). Despite providing generalizable data regarding a multitude of sociocultural factors that mediate STEM students’ experiences, none of these studies directly address the transfer student physics major population. Given the unique circumstances that shape transfer physics majors’ educational experiences, these studies fall short in relating student expectancies and motivational factors impact their achievement behavior, socialization, or physics-related ways of being connected to physics students’ discourse acquisition.

Sociocultural Influences and Ways of Being

Within social contexts, a network of individual and institutional sociocultural factors constructs the reality of situations. According to Gee (1999) these circumstances follow interconnected components including (a) semiotic aspects (e.g., language, gestures, images, and other symbolic systems) that construct or construe reality; (b) activity aspects (e.g., specific activities in which participants engage); (c) material aspects (e.g., the time, location, objects, or people present); (d) political aspects (e.g., distribution of social goods); and (e) psychosocial and structural sociocultural aspects (e.g., personal, social, or cultural knowledge, beliefs, values, identities, and relationships associated with interactions along with specialized knowledge of semiotic resources, activities, material aspects, and politics). According to Gee (1999), knowledge of the aspects of the combined network of components leads to an understanding of individual or group members' distinct ways of being. Organizations such as higher education academic programs display discipline-specific processes that are repeatedly habitualized, ritualized, or stabilized that create forces that ensure the standardization practices or other culturally defined discourses (i.e., ways of communicating or ways of being).

Discourse Appropriation and Socialization

Gee (1990) recognized that other forms of communication recruit and use several modes (e.g., verbal, visual, written, mathematical, symbols, sounds, gestures, graphs, and other semiotic resources) to convey information and make meaning. Within physics, learners must acquire disciplinary affordances across a variety of semiotic domains. Therefore, discipline-specific discourse appropriation requires the acquisition and enactment of language along with other ways of acting, interacting, feeling, believing, valuing with various sorts of objects, symbols, tools, and objects that distinguish individuals or groups in specific ways. Gaining requisite affordances that as a whole constitute an individual's ability to communicate and exist within Communities of Practice are best achieved when attached to social or cultural practices. Lave and Wenger (1991) and Rogoff (1990) both suggest that learning takes place through culturally-based collaborative endeavors with social others that extend skill and involvement (e.g., cooperative activities, apprenticeships).

To gain competency, learners must have a deep conceptual understanding of physics; they need to understand, articulate, and relate concepts by developing a disciplinary affordance related to physics discourse and form a conceptual framework through interactions with classroom participants. Interactions with more knowledgeable social others may assist learners in organizing factual understanding (i.e., low-order conceptual knowledge and comprehension) in a manner that allows for higher-order processes (e.g., application, synthesis, evaluation, creation of new knowledge). Harlow and Otero (2006) recognize that physics students must develop and link both disciplinary-specific discourses and conceptual understanding. As individuals gain a disciplinary affordance (i.e., language and concept mastery), they can refine their use of terminology in order to engage in higher-order processes. In physics and other related discourses, discipline-specific terminology represents one of many tools that help learners make meaning. Collaborative learning processes, an institutional sociocultural influence, are influenced by individual factors (e.g., linguistic ability, motivation, self-efficacy, etc.), which assist individuals in becoming acquainted with the tasks, vocabulary, and organizing principles of the community's practitioners, eventually gaining identity as a socialized member within a community of practice (Lave & Wenger, 1991).

Student Factors Alter Socialization

Individual and institutional factors alter STEM transfer students' socialization at the family, community college, and university level. Several scholars examined the relationships between background characteristics of STEM transfer students and social and academic adjustment at the transfer-receiving institution (Van Dinh, 2017; Jackson & Lanaan, 2015; Jackson, Starobin, & Lanaan, 2013). These findings assist practitioners in identifying ways of approaching the problems that prevent the successful transition from the two-year institution to, and socialization at, four-year institutions. While the findings of the previously mentioned studies within this chapter are helpful in framing the understanding of factors that shape transfer STEM majors educational experience, these studies fall short in uncovering discipline-specific (physics discipline-related) connections among context-specific sociocultural factors that mediate transfer physics majors' educational experiences (Laanan, Starobin, & Eggleston, 2010; Starobin, Smith, & Laanan, 2016; Van Dinh, 2017; Xu, 2015).

Since these studies did not specifically focus on transfer physics majors, the studies fall short on establishing connections among (a) individual transfer physics student's physics-related ability beliefs or the value they place on participation in physics coursework or related activities; (b) how the physics course instructor's beliefs about transfer physics majors physics-related abilities, motivations for studying physics, physics-related language use, and physics-study related interactional tendencies; (c) how these factors impact practitioners' approaches to facilitating physics classroom or physics-related co-curricular activities; (d) how classroom and co-curricular activities mediate transfer students' socialization (i.e, their sense of belonging, the importance they place on belonging, and the adoption of ways of being of that of physics majors). The next portion of this chapter will provide a discussion of what is known about long-term trends of physics students' learning outcomes at Grand Lakes University.

Local Student Assessment Data

Students' type of matriculation pathway represents an individual psychosocial sociocultural influence (i.e., identity) that mediates educational experiences. These pathways traditionally involved matriculating as regular-admit students (typically freshmen with no post-secondary study experiences), having not completed post-secondary coursework before enrolling, or transferring from another institution after completing higher education coursework at another institution.

Assessment data revealed significant differences in learning outcomes for transfer physics majors at Grand Lakes University compared to physics majors admitted (i.e., regular-admit) to Grand Lakes University as a freshman. A quantitative analysis (Chestnut & Smith, 2017) of aggregated data collected from 2009 – 2017 at Grand Lakes University that compared regular-admit and transfer undergraduate physics majors' overall grade point average revealed disparate learning outcomes. An independent-samples t-test was conducted to compare overall grade point averages for senior-level regular-admit and transfer undergraduate physics majors. There was a significant difference in overall grade point average scores for transfer physics majors (M = 2.86, SD = 0.47) compared to regular-admit physics majors (M = 3.189, SD = 0.63) conditions; $t'(148) = 3.78$, $p = 0.00023$; medium effect. Furthermore, descriptive statistics reveal that

54% of transfer physics majors sampled earned grade point averages lower than 3.0 on a 4.0 point scale as compared to 31% of regular-admit physics majors sampled (Chestnut & Smith, 2017). Moreover, significant disparities exist in grade outcomes within the entry-level upper-division physics course exists between transfer physics majors and regular-admit physics majors. Historical assessment data from 2009 – 2020 revealed significant differences in the entry-level upper-division physics courses grade outcomes for transfer students (M = 2.598, SD = 1.12) compared to regular-admit physics students (M = 3.153, SD = .81); t' = 5.009, p = 0.0001; medium effect. Results from a quantitative analysis suggested that significant disparity in learning outcomes exists between transfer and regular-admit physics majors, thus warranting inquiry to understand how students' socialization affects learning outcomes as those students participate in upper-division physics classrooms, the typical entry point at Grand Lakes University for transfer physics majors.

Institutional Sociocultural Factors

These are considered to be the crux of learning situations. Much is known about structural and psychosocial sociocultural factors that alter students' higher education experiences.

Institutional Factors

This section will include a discussion of institutional culture's impact on psychosocial dimensions such as student motivation, self-efficacy, ability beliefs, achievement-related behaviors, or sense of belonging. Second, I will provide a detailed discussion of how instructional pedagogy influences social interactions in the instructional setting. A constructivist view of learning recognizes the cumulative effect of various sociocultural artifacts that mediate social action.

Institutional Culture. Regardless of the institution or pathway to STEM credentials, institutional culture represents a structural sociocultural influence that alters educational stakeholders' perspectives and experiences. The National Academies of Sciences, Engineering, and Medicine (2016) report *Barriers and Opportunities to Support Students' Diverse Pathways* recognizes that college campuses and STEM departments and the programs situated in them represent distinct organizational settings with cultures that are created and reinforced by physical structures, policies, values, and norms that govern their functions. The institutional culture shapes students' understanding of standards, expectations, and sense of belonging. The culture that students from all backgrounds encounter while engaging in STEM studies can alter their socialization, performance, and persistence through their self-concept (i.e., self-efficacy), ability beliefs within STEM domains, and their feelings of community and belonging in STEM fields.

In settings where STEM courses are characterized by a culture of highly competitive classrooms that do not promote active learning, students from different backgrounds or students who entered new surroundings (e.g., transfer students, underrepresented students) may experience low expectations, a form of deficit thinking, or these students may encounter "chilly climate" in cases where others question students' ability or potential as members in STEM discipline fields (Bensimon, 2005; Hall & Sandler, 1982).

Institutional Support. Jackson and Laanan (2015) cited significant amounts of literature highlighting the challenges that students face while navigating unsupportive climates while pursuing STEM degrees. Several studies across many content disciplines revealed the importance of positive interactions and supportive classroom environments on students' self-efficacy, capabilities, and content abilities (Bensimon & Dowd, 2009; Cegile & Settlage, 2014; Jackson, Starobin, & Laanan, 2013; Starobin, Smith, & Laanan, 2016; Xu, Solanki, McPartlan, & Sato, 2018).

Socialization Challenges. The challenges students face include circumstances where overt and subtle forms of treatment lead to unequal treatment, a lack of mentors, and variation in math and science preparation. The challenges students face with adjusting to new surroundings may be due, in part, to early socialization into roles different from those of university classrooms or STEM disciplines. These circumstances may create challenges for students in STEM degree programs who find it undesirable to adapt their ways of being to those expected in STEM programs or disciplines.

Teaching Methods. For the last 25 years or so, physics education practitioners have sought to develop empirical methods to evaluate what students learn about physics under various modes of instruction (McNeil, n.d.). The most significant finding of this body of research has revealed that the traditional lecture model of instruction is ineffective at achieving learning goals for physics students (Gatch, 2010; Lowe, 2011).

Within classrooms, instructional pedagogies represent an institutional psychosocial influence that plays a crucial role in mediating individuals' interactions, relationships, and other individual psychosocial factors (e.g., motivation, skills, identity formation, self-efficacy). The discussion in this section will highlight literature that (a) contrasts the characteristics and impacts of teacher-centered and active-learning strategies; (b) relates active learning instructional design strategies to the constructivist approach; (c) defines recommendations and describes tools, methodologies, or models for encouraging higher-order thinking; and (d) highlights recommendations for learning along with the shortcomings of traditional educational programs.

Teacher-Centered Pedagogies. Teacher-centered refers to instructional methodologies, where teachers are actively involved in teaching while learners are in a non-interactive, non-collaborative, or passive mode of receiving information. McNeil's (n.d.) report, grounded in rigorous empirical methods, demonstrated that the traditional lecture-based approach to physics instruction is ineffective in achieving student learning goals. The traditional approach of standard lecturing often involves or leads to the (a) passive acceptance of content by students; (b) measuring student proficiency by solving canonical quantitative problems does not guarantee that students will leave a course with a mastery of physics discourse (i.e., ability to answer questions that require a qualitative understanding and verbal explanations of physics concepts); (c) students leaving physics courses without forming a conceptual framework of the discipline and often failing to understand relationships or differences between concepts; (d) students leaving courses without gaining the skill of scientific reasoning; and, lastly, (e) students leaving courses lacking connections among concepts, formal representations (e.g., equations, graphs), and real-world phenomena (McDermott, 1993). Instructors typically use teacher-centered instructional strategies for purposes of classroom management (Lemke, 1990). These instructional techniques unintentionally constrain learners' ability to define and understand concepts in terms of their emic language and hamper their ability to understand, apply, or relate science concepts (Lemke, 1990).

Active-Learning Strategies. In order to counter the emphasis on teacher-centered pedagogies, Lemke (1990) recommended shifting instructional methods (i.e., activity structure) away from the use of teacher-centered communicative processes (e.g., lecture, triadic dialogue) toward dialogue-based communication approaches that emphasize active learning. Active learning instructional approaches are process-oriented, interactive, and react to student needs, allowing for communication (e.g., dialogue, discussion, debate) among all classroom participants and is dependent upon using a constructive approach with its strategies, tools, and practices. Active learning educational approaches provide learners with opportunities to interact with different kinds of interrelated activities that contribute to discipline-specific language acquisition (Gee, 1990; Lemke, 1990). Further, active learning-oriented activity structures provide instructors with the ability to observe student understanding through language use, expressing their perspectives, or other interactions with and within the content, and then monitor and adjust teaching strategies as needed to maximize learning. The adoption of active learning teaching methodologies serves to increase the opportunity for students to engage in the use of social language, defined as "different styles of language that we use to enact and recognize different identities in different settings, through asking questions or by interacting with classmates" (Gee, 1996, p. 155).

Constructivist Instructional Approaches

According to Vygotsky (1978), the constructivist view of learning assumes that the accumulation of knowledge requires mental engagement by a learner in the presence of oneself (i.e., self-talk, metacognition) or social others, moving the learner from a state of what they can do with assistance to a state of autonomous function. According to Ozola (2012), constructivism works under the assumption that knowledge (e.g., discipline-specific language acquisition, conceptual understanding) is constructed by learners through an active mental process that allows classroom participants to create and make meaning of concepts or phenomena. The constructivist convention is frequently associated with active learning teaching strategies, as this type of activity assists in the development of critical thinking and social skills. Further, constructivism is based on the belief that learners engage in active processes to make new meaning, as opposed to passively receiving and accepting information.

Knowledge Construction. Within the constructivist active learning approach to learning, all classroom participants (e.g., students and teachers) play a role in the learning processes. Ideally, physics pedagogy methods should engage learners in a manner that reconciles conflicts between new knowledge gained in classrooms and previously-constructed preconceptions of physics phenomena. A failure to reconcile preconceptions and knowledge presented in physics courses through dialogue with self and social others may cause students to fail to grasp the discipline-specific language, physics concepts, or other skills needed for future use. To gain competence as a physics student, learners must have a deep conceptual understanding of physics. Students need to understand, articulate, and relate concepts by developing a disciplinary affordance related to physics discourse and a conceptual framework through self-talk (i.e., self-reflection) or dialogue with classroom stakeholders.

Constructivist Instructional Design. Active learning teaching approaches are designed in a manner to see the learning process as a whole, mediated through constructivist approaches and activities. Bloom's (1956) revised taxonomy by Anderson and Bloom (2014) assists in clarifying the complexity of learning processes by viewing thinking skills on a continuum starting with remembering (i.e., low-level thinking), which involves recognizing and recalling, and increasing in complexity to creating knowledge (i.e., high-order thinking). Bloom's Taxonomy allows practitioners to plan instructional activities and organize these goals according to cognitive complexity or the level of abstraction of questions (i.e., low-order versus high-order thought processes). For example, students should be able to (a) recall or recognize information (i.e., remember) in the form it was learned; (b) translate, comprehend, or interpret (i.e., understand) new information based on prior learning; (c) select, transfer, and use data or principles (i.e., application) to solve problems; (d) distinguish, classify, or relate assumptions, hypotheses, and evidence associated with statements (i.e., analysis) using multiple representations (e.g., concepts, graphs, mathematical models); (e) relate, originate, integrate, or combine concepts into new understandings (i.e., analysis); and (f) appraise, assess, or critique statements or data based on pre-specified criteria or standards (i.e., evaluation, creation) and justify beliefs or rationale for decision-making.

The mutually linked and sequentially connected nature of the stages of cognitive complexity during the learning process are rooted in the constructivist worldview based on the fact that (a) individuals' prior understanding promotes future learning (e.g., higher levels of cognitive complexity); (b) connections between pieces of knowledge leads to knowledge structures that aid future use; (c) in order to develop and achieve higher levels of cognitive complexity, individuals must acquire skills, practice integrating them, and apply new knowledge; and (d) learning best occurs when coupled with feedback from self, through reflection, and social others that help them move from what they can do with assistance towards autonomous activity. Although learning may occur on the individual level, learning is also a social activity, facilitated by an individual's connection and interaction with social others (e.g., peers, teachers, family, etc.) or other material or immaterial semiotic tools that shape learners to make meaning and move them to higher levels of cognitive understanding.

Recommendations for Sound Educational Processes. Various agencies and scholars communicated standards for physics education, including content recommendations that require knowledge of science and mathematics in general, a pedagogy framework that requires the teacher's understanding of how to establish and maintain active learning classroom processes. The next portion of this discussion defines educational processes and tools that incorporate active learning activities intended to assist learners in achieving knowledge at higher levels of cognitive complexity. Shifting pedagogy toward active learning processes involves considering which methods are most likely to assist students in achieving learning goals. Transforming physics courses to incorporate active learning processes that include higher-order thinking involves selecting, adapting, and implementing suitable pedagogy methods within physics courses.

As Lemke (1990) recognized the need for students to develop a conceptual framework that allows students to implicitly and explicitly understand and state the relationships among concepts, researchers concluded that this framework is best achieved through active learning strategies that incorporate methodologies or semiotic learning resources including (a) interactive learning processes that first engage learners such as tutorials that use formative assessments coupled with Socratic dialogue that highlight misconceptions or difficulties students encounter (i.e., Just-In-Time-Teaching, Problem-Based Learning, Physics for Everyday Thinking, etc.) and (b) then encourage the use of cooperative group problem-solving that focuses on students classifying the problem (i.e., locating the concept within the physics discipline), planning the solution, executing the solution, and evaluating the plausibility of the solution within and beyond the group setting.

Active Learning Instructional Tools and Processes. These processes may incorporate learning tools such as (a) audience response systems; (b) interactive lecture demonstrations; (c) computer-based simulations (i.e., physlets, applets); (d) web-based homework delivery systems that encourage student interaction with physics content and provide feedback to students and faculty about progress toward achieving learning goals (e.g., Blackboard, Expert TA, Mastering Physics); (e) physics modeling software (e.g., Interactive Physics) that help students model phenomena that falls beyond the capability of interactive lecture demonstrations (Belloni & Christian, 2004; Dufresne, Gerace, Hardiman, & Mestre, 1992; Heller, Keith, & Anderson, 1992; Judson & Sawada, 2002; Leonard, Dufresne & Mestre, 1996; Mazur, 1997; Novak, 1999; Shaffer & McDermott, 2005; Schwarz & Ertel, 2004; Sokoloff, & Thornton, 1997; Sokoloff & Thornton, 1999).

Active Learning in the Laboratory Classroom. A staple of physics instruction, laboratory activities address learning goals for physics courses through the experiential process of making direct observations and physical experimentation through the collection of real data in the laboratory classroom setting. Since physics is a way of approaching problem-solving, engagement in the laboratory setting requires learners to synthesize and employ a broad spectrum of knowledge and skills such as mathematics, computation, experimentation, and other practical skills. The American Association of Physics Teachers (AAPT) made specific recommendations for the undergraduate laboratory curriculum that bases higher-order learning goals on learners' ability to (a) collect, analyze, and interpret real data from observations to develop a physical worldview (i.e., construct knowledge); (b) develop abstract representations of physical systems observed in the laboratory (i.e., modeling); (c) develop, engineer, and troubleshoot experiments to test models or hypotheses (i.e., designing experiments); (d) gain skills or practical knowledge of common laboratory equipment (i.e., develop technical skills); (e) analyze and display data using an array of statistical methods and critically analyze the validity and limitations of assertions made based on data (i.e., analyzing and visualizing data); and, lastly, (f) present results and ideas with well-reasoned arguments supported by empirical evidence (Kozminski et al., 2014).

Inquiry-Based Learning and Higher-Order Thinking. Inquiry-based activities promote higher-order active learning processes by requiring classroom participants to (a) ask or answer questions; (b) make observations; (c) conduct research to determine extant knowledge related to problems; (d) design experiments to test models or hypotheses; and (e) choose instruments for data collection, followed by the collection, critical analysis, interpretation, and evaluation of data for the purpose of considering possible explanations or developing future study of the problem (Goldberg, Robinson, & Otero, 2006; Aclufi, 2005).

Levels of Inquiry. Banchi and Bell (2008) outline various levels of inquiry that elicit student activity of various levels of cognitive complexity (e.g., low-order versus high-order thought) such as activities where (a) the teacher poses questions that guide activities so that students perform tasks to confirm content previously taught in lectures (i.e., confirmation inquiry); (b) the teacher provides a question and procedure for the students to collect data, though the students formulate explanations from empirical evidence (i.e., structured inquiry); (c) the teacher provides a question and the students are responsible for constructing experiments, collecting data, and communicating results (i.e., guided inquiry); and, lastly, (d) students formulate their own research questions, construct experiments, collect data, and communicate results (i.e., free, open, or true inquiry).

Inquiry as a Constructivist Approach. Aligned with Vygotsky's (1978) approach to scaffolded learning, Banchi and Bell (2008) assert that instructors should aim to move learners from lower-level (e.g., confirmation and structured inquiry) to higher-level (e.g., free-inquiry) forms of experiential active learning. Evidence suggests that only using lower-level confirmation-based inquiry methods within laboratory settings is insufficient in developing higher-order thinking skills such as critical and scientific thinking (Banchi & Bell, 2008). While free-inquiry exercises allow classroom participants to exercise high-order thinking skills, this type of activity conflicts with traditional forms of classroom curricula (Berg, Bergendahl, Lundberg & Tibell, 2003; Zion & Sadeh, 2007).

To accomplish learning goals in instructional settings, instructors can engage learners in various inquiry-based approaches to learning. Inquiry-based learning activities find antecedents in the constructivist learning theory, assuming learners generate knowledge and make meaning through interactions with a variety of semiotic resources (e.g., laboratory equipment, social others) within the learning environment (Kozminski et al., 2014). Inquiry-based learning occurs in the context of experiential learning because these activities involve active questioning, investigating, collaborating, and interacting with semiotic resources while engaging reflection with oneself or social others to make meaning of the physical world (Bächtold, 2013; Roth & Jornet, 2013).

Overarching Learning Recommendations for Physics Classrooms

The American Association of Physics Teachers (AAPT) made recommendations regarding educationally effective learning processes, mostly addressed through a call for active and interactive higher-order learning strategies to increase conceptual understanding while reinforcing problem-solving skills (American Association of Physics Teachers, 2005). Professional knowledge standards related to pedagogy include (a) both knowledge of and skill in teaching students to use effective inquiry practices and (b) an understanding of how to establish and maintain effective active learning classroom atmospheres that serve to motivate student learning. Despite calls for the creation of active learning environments, in many cases, course instructors adhere to teacher-centered pedagogical approaches such as monologue (e.g., lecture accompanied with initiation-response-feedback patterns of Socratic instruction), or low-order confirmation-based lab activities that often limit interaction and thinking, which then discourage higher-order thought processes (Lemke, 1990). Bar-Yam et al. (2002) asserted that rapid changes and increased complexity of today's world places new challenges and demands on our educational systems. A growing awareness of the necessity to change and improve the preparation of students for function in a continually changing and demanding environment in and beyond higher education requires that practitioners adapt teaching methods by using a diverse repertoire of pedagogies to address students' learning needs.

Rationale to Study Socialization Experiences of Transfer Students

Addressing gaps or inadequacies in the literature regarding students' socialization experiences forms the rationale for studying the socialization experiences of transfer physics majors enrolled in transfer-receiving undergraduate physics programs. While the literature provides generalizable and useful knowledge about antecedent sociocultural factors that mediate student experiences, more information is needed to provide a context-specific understanding of the problem of transfer physics, or other transfer STEM majors' socialization experiences while studying at transfer-receiving institutions. At this time, no previous studies have investigated this issue, necessitating the need for research related to transfer physics majors' linguistic-based interactions or other relevant activities, content-related ability beliefs, course expectations, the utility, importance of, or interest in physics content, or other perspectives related to socialization within undergraduate STEM programs. Predictive relationships generated from these studies, along with the recommendations made by authoritative professional organizations are generalizable or applicable to transfer physics majors' educational experiences (Laanan, Starobin, & Eggleston, 2010; Starobin, Smith, & Laanan, 2016; Van Dinh, 2017; Xu, 2015). However, the complex nature of transfer physics students' educational experiences emphasizes the need for additional and ongoing inquiry.

Statement of Problem

Ideally, personal or social circumstances (e.g., educational pathway via community college transfer), are not deterministic educational obstacles to achieving educational potential. Assessment data from previous research studies revealed that transfer physics majors attending Grand Lakes University experience significantly different educational outcomes (i.e., lower cumulative graduating grade point averages) compared to regular-admit physics majors. While the long-term consequences of transfer physics majors' disparate educational outcomes at Grand Lakes University are unknown, their educational outcomes limit their prospects of advanced studies (i.e., graduate studies) or competitiveness in the workforce. For example, access to graduate-level teacher preparation programs requires a minimum grade point average, excluding a higher proportion of physics transfer students from careers in public education. Further, lower grade point average can impact students' academic standing and access to financial aid (e.g., scholarships, grants, loans). Despite strong recommendations, based on a large body of extant research and literature for addressing challenges associated with individual and institutional sociocultural factors that influence student experiences, these studies fail to provide a context-specific understanding of how a variety of individual and institutional sociocultural factors mediate participation in educational activities and socialization. A lack of context-specific inquiry about how sociocultural factors shape transfer physics majors' participation in educational activities and socialization experiences at Grand Lakes University calls for the use of qualitative inquiry approaches to research. Qualitative inquiry is an appropriate research approach, as this methodology captures student interactions along with personal feelings, values, lived experiences associated with the participation in physics-related educational activities and socialization as physics majors at Grand Lakes University.

Purpose of the Study

The purpose of this study was to gain an understanding of how transfer physics students' participation in educational activities was influenced by a host of individual psychosocial factors, such as their beliefs about their own capacity to study physics, expectations for success in physics coursework, value beliefs related to studying physics, unique past educational and transitional experiences, institutional perceptions, perceptions of faculty and peers, how transfer students experienced belonging as physics majors, their perception about the meaning of socialization, and how they experienced socialization. Additionally, this study revealed how institutional factors such as practitioners' teaching and the promotion of co-curricular activities influenced students' participation in educational activities.

Research Questions

1. How do regular-admit physics students, transfer physics students, and the physics course instructor describe personal beliefs related to their own or others' (a) physics content ability; (b) expectations for success in physics studies; and (c) how values attached to the value they place on their physics studies (i.e., utility of, importance of, and interest in) change as a result of participation in upper-division physics coursework?
    a) How do ability beliefs, expectations for success in physics coursework and the values students attach to physics studies influence students' participation in classroom or co-curricular activities?
2. How do individuals or groups of transfer physics majors or the physics instructor describe their own or others' socialization experiences related to participation in upper-division physics classrooms at transfer receiving institutions?

3. In what ways do transfer physics majors enrolled in upper-division physics courses at Grand Lakes University interact when participating in classroom activities?
    a) What are the larger or main activities (or sets of activities) occurring within upper-division physics classrooms at Grand Lakes University?
    b) What upper-division physics classroom sub-activities comprise this or other activities?
4. To what extent do transfer physics majors enrolled in upper-division physics courses at Grand Lakes University engage in social language related to physics or other related disciplines?
    a) What discipline-specific content-based social languages are relevant (i.e., closely related to physics or other related discourses) or irrelevant (i.e., not connected to physics or related discourses)?
5. How is transfer students' at Grand Lakes University use of physics-related language or classroom activities developed over time within upper-division physics classrooms?
    a) How do individuals or groups of transfer physics majors adapt social language use throughout their experiences within their initial upper-division physics course?
    b) How does transfer physics majors' use of social language or activities become stabilized or transformed?

Methods

As a part of qualitative inquiry, researchers validate sources of knowledge using multiple sources of data while engaging in an iterative and inductive process that allows for the identification of patterns and themes associated with humans' lived experiences of a concept or phenomenon (Creswell, 2018; Patton, 2001). This qualitative study examined transfer physics majors' social language use and other meaningful activities occurring during classroom interactions, as well as ability beliefs, expectations, the task-values (i.e., utility, importance of, interest in) of physics educational experiences, and other aspects of socialization while enrolled in upper-division physics courses throughout an academic semester. Qualitative research data sources included classroom observations, pre- and post-surveys, student interviews, and faculty interviews to understand the nature of transfer physics majors' educational activities and socialization experiences at Grand Lakes University, a mid-sized public university comprised of a significant transfer student population located in the mid-Atlantic section of the United States.

A criteria-based, purposeful sampling included all participants associated with upper-division physics courses (e.g., regular-admit physics majors, transfer physics majors, and course instructors). Following approval from the Institutional Review Board (IRB), I solicited participants' participation and fully explained the purpose for the investigation, the data collection methodologies, security measures to ensure privacy, and potential harms and benefits of participation. After explaining aspects of the study, I allowed the participants to ask questions and decide whether they would like to voluntarily participate or decline participation without penalty before signing, and then I provided the participants with a copy of the signed informed consent form. In order to avoid disclosing the identity of unwilling participants, I instructed participants who did not wish to participate in this study to submit consent forms without signing for consent. In the event that participants were unwilling to participate, I excluded data related to these individuals (e.g., Audio, Video, or Digital (AVD) recordings) from the analysis portion of this study. Additionally, all willing participants' school or personal identity were assigned a pseudonym (e.g., covering logos or using photo effects to mask identifying features) within the analysis and dissemination of data.

For this qualitative study, participant interactions were audio and video recorded. Detailed data were collected through classroom observations (audio and video) to capture verbal interactions using voice transcription, and other classroom activities (i.e., STEM classroom practices) were characterized (at two-minute intervals during classes) using Smith and colleagues' (2013) *Classroom Observation Protocol for Undergraduate STEM* (COPUS) instrument (attached in Appendix A). I used a modified version of the Wigfield and Eccles (2000) survey (attached in Appendix B), administered around the second week of the academic semester and again around week twelve, to gather demographic information and measure changes, if any, of individual social cognitive variables including students' physics-based ability beliefs, expectations for success in physics coursework, values attached to studying physics throughout an academic semester. Further, I collected student interview data near the end of the academic semester using a modified version of Deluca's (2017) semi-structured interview questions (note that written permission to use this survey is attached in Appendix D) derived from Weidman and Stein's (2003) *Doctoral Student Socialization Questionnaire* (attached in Appendix C). The interview questions were modified to reflect experiences related to participation in physics-related studies prior to attending, while transitioning into, and while participating in physics coursework at Grand Lakes University. Last, I performed an interview with the instructor who taught the upper-division physics courses using a faculty interview protocol (faculty interview protocol is attached in Appendix H) to gather the instructor's beliefs about transfer students' expectations for success, their motivations for studies, their physics-related discourse patterns, and interactional tendencies as related to physics studies at Grand Lakes University. The individual student and faculty interview data were collected near the end of the academic semester and captured a cross-comparison of transfer physics students' perspectives related to their socialization experiences. The observational data, field notes, and interview data describing additional contextual data were double coded. I presented the survey data using descriptive statistics. Traditionally, survey data are used for the purpose of constructing quantitative descriptors among variables. However, the use of survey instruments within this study is useful in establishing an understanding of the diversity of topics (e.g., sociocultural factors) within a given population (Groves et al., 2004). Additional analysis tools included analytic memos, a codebook listing the rationale for coding schemes, and research journaling to maintain an audit trail.

Lincoln and Guba (1985) state that trustworthiness in data is achieved by taking measures to ensure that research is credible (i.e., truthfulness or plausibility of data), dependable (i.e., reproducible across participants; replicable), confirmable (i.e., findings derived from data), transferable (i.e., applicable to other contexts), and reflexive (i.e., involve critical self-reflection regarding bias). I expanded the above definitions in Chapter III, along with describing specific considerations related to the validity of studies using discourse analysis methodologies.

Role of the Researcher and Collaboration with the Participants

Despite all intentions for researchers to maintain an objective approach toward inquiry, as previously mentioned, one's personal biases, preferences, and preconceptions invariably influence the research design and interpretation (Rossman & Rallis, 2012). As a physics educator, I was guided by understandings that emphasize the importance of active learning social interactions during learning processes. While working in physics instructional settings, I was conscious of how my influences alter the learning environment. As required in the research process, I included participants in the research process by clarifying my interpretation of classroom observation transcripts content through a process of member checking (Miles & Huberman, 1994; Rossman & Rallis, 2012).

Ethical Considerations

Ethical considerations impact the trustworthiness of inquiry (Miles & Huberman, 1994; Patton, 2001; Rossman & Rallis, 2012; Salloch, Wascher, Vollmann, & Schildmann, 2015). Prior to data collection, I sought approval from the research site Institutional Review Boards and my dissertation committee. After recruiting and selecting participants, I communicated the purpose of the study and the data collection procedures, defined my role as a non-participatory observer in upper-division physics classrooms, outlined the benefits or risks associated with research participation, stated methods of maintaining confidentiality, and discussed the scope and sequence of the study. The participants were provided with an opportunity to pose questions or clarify unclear processes before I acquired informed consent. Last, I followed the predetermined methodological design and maintained a research journal and wrote analytical memos to maintain the trustworthiness of inquiry (Miles & Huberman, 1994).

Significance of the Study

This study has significance for instruction within undergraduate physics programs. Recent trends point to the value of creating educational environments that investigate specific factors that affect students' success or failure in physics and astronomy (American Institute of Physics, 2020). Such research accounted for factors such as (a) belonging; (b) physics identity; (c) academic support; (d) student support; (e) and leadership structures that lead to findings that inform institutional educational policy, research, and practice. While the findings from the AIP study provided information related to best practices related to supporting all undergraduate physics students, a context-specific research study is needed to inform the understanding of the transfer physics major community. The findings of this study may impact instructional design, articulation within and among institutions, and reflection about institutional practices (Lemke, 1990; Osterman & Kottkamp, 2004). This study has implications for instructional practices when practitioners engage in strategic planning and practice, policy development, or future research (Schloss & Cragg, 2013). The findings of this study will be disseminated among the faculty participants with the aim of creating a consciousness of inquiry-informed frameworks that higher education practitioners employ to promote participation in classroom and co-curricular activities that in turn, promote student socialization or discipline-specific discourse appropriation.

Organization of the Study

This investigation is organized into six chapters. Chapter I discusses a working conceptual framework, relevant definitions within the study, trends in adapting physics course instruction, a statement of the problem, a statement describing the purpose of the study, methodology, the role of the researcher, ethical considerations, and the significance of the study. Chapter II includes theoretical and conceptual frameworks, and a review of relevant literature. Chapter III includes a discussion related to researcher assumptions and the rationale for qualitative research methods. Chapter III further describes the setting, participant selection criteria, data collection and analysis methods, measures to ensure the trustworthiness of data and findings, ethical considerations, and limitations of the study. Chapters IV and V discuss the research findings and relationships to the literature. Chapter VI will present conclusions from the research findings. Finally, I will discuss the implications of the findings on future research, policy, and practical considerations.

Chapter II

Theoretical Framework and Review of the Literature

Addressing the needs of transfer physics majors requires an understanding of how students participate in the culture of their transfer-receiving institutions. Classroom and co-curricular activities play a significant role in the appropriation of physics discourses and other aspects of socialization within upper-division physics courses at the transfer-receiving institution (Gee, 1999; Lemke, 1990). Most of the research investigating transfer STEM majors' interactions is limited to quantitative empirical studies that measured relationships among sociocultural variables and distal learning consequences (e.g., academic and social outcomes). These research findings suggest the importance that campus-based interactions and various individual background factors have on the persistence and attainment rates of transfer STEM majors. Despite the generalizability and applicability of these findings from previous research studies about transfer STEM majors to the transfer physics major population, gaining an understanding of how transfer physics majors acclimate to their new surroundings requires context-specific research to understand how a complex network of individual and institutional sociocultural factors influence transfer students' participation in physics-related classroom or co-curricular activities. Participation in physics-related classroom and co-curricular activities further mediate students' socialization as physics majors or the adoption of physics-related ways of being.

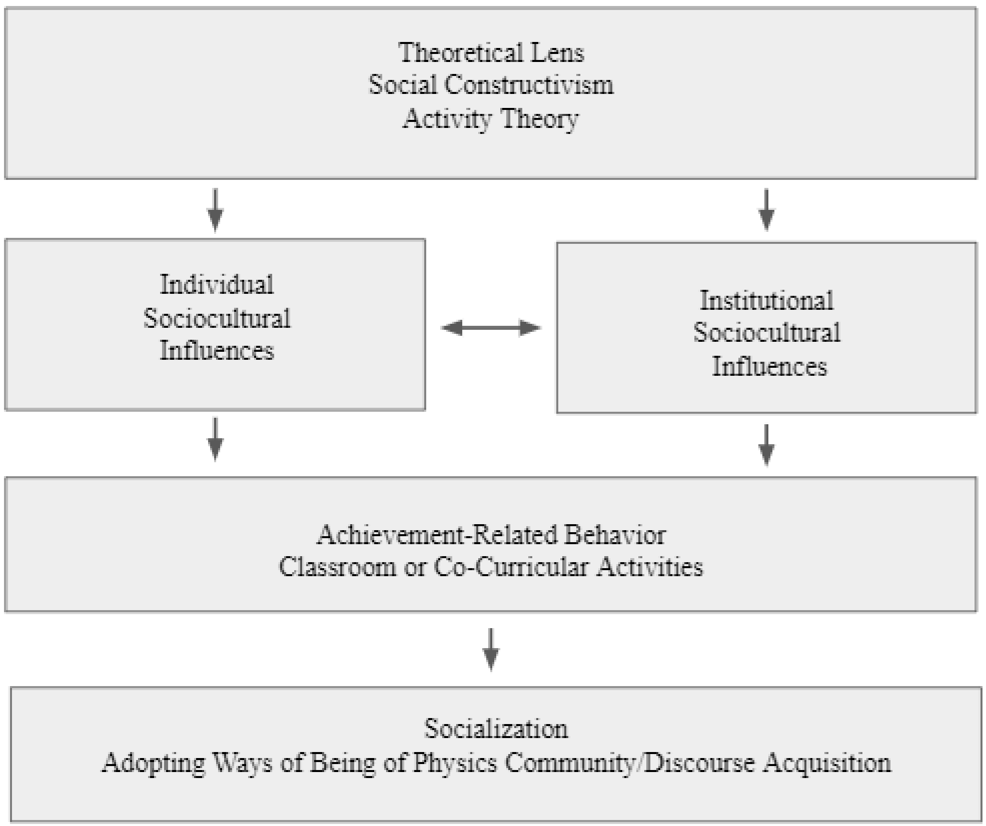
The purpose of this study was to gain an understanding of how transfer physics students' participation in educational activities was influenced by a host of individual psychosocial factors, such as: (a) their beliefs about their own capacity to study physics;

(b) expectations for success in physics coursework; (c) value beliefs related to studying physics; (d) unique past educational and transitional experiences; (e) institutional perceptions; (f) perceptions of faculty and peers; (g) how transfer students experienced belonging as physics majors, (h) their perception about the meaning of socialization, and (i) how they experienced socialization. Additionally, this study revealed how institutional factors such as practitioners' teaching and the promotion of co-curricular activities influenced students' participation in educational activities.

In this chapter I will discuss the theoretical and conceptual frameworks that underpin this study. First, I define constructivist theories including Activity Theory that suggest the relationships among a series of interconnected sociocultural factors that mediate activity and influence the desired outcomes attached to social interactions. Next, I present a conceptual framework that situates a series of relevant sociocultural concepts within the Eccles et al. (1983) developmental model that parallels Engeström's (1996) Activity Theory model. Third, I define, describe, and relate concepts connected to the theoretical framework (i.e., constructivist theory, activity theory). Last, I provide the rationale for the use of qualitative methods to provide answers to the research questions for this study. Figure 1 depicts a conceptual framework for this study.

Figure 1

Conceptual Framework



Several questions about classroom actions or interactions guide this research.

Research Questions

1. How do regular-admit physics students, transfer physics students, and the physics course instructor describe personal beliefs related to their own or others' (a) physics content ability; (b) expectations for success in physics studies; and (c) how values attached to the value they place on their physics studies (i.e., utility of, importance of, and interest in) change as a result of participation in upper-division physics coursework?

a) How do ability beliefs, expectations for success in physics coursework and the values students attach to physics studies influence students' participation in classroom or co-curricular activities?

2. How do individuals or groups of transfer physics majors or the physics instructor describe their own or others' socialization experiences related to participation in upper-division physics classrooms at transfer receiving institutions?

3. In what ways do transfer physics majors enrolled in upper-division physics courses at Grand Lakes University interact when participating in classroom activities?

a) What are the larger or main activities (or sets of activities) occurring within upper-division physics classrooms at Grand Lakes University?

b) What upper-division physics classroom sub-activities comprise this or other activities?

4. To what extent do transfer physics majors enrolled in upper-division physics courses at Grand Lakes University engage in social language related to physics or other related disciplines?

a) What discipline-specific content-based social languages are relevant (i.e., closely related to physics or other related discourses) or irrelevant (i.e., not connected to physics or related discourses)?

5. How is transfer students' at Grand Lakes University use of physics-related language or classroom activities developed over time within upper-division physics classrooms?

a) How do individuals or groups of transfer physics majors adapt social language use throughout their experiences within their initial upper-division physics course?

b) How does transfer physics majors' use of social language or activities become stabilized or transformed?

Theoretical Framework

Higher education practitioners must consider how classroom interactions enhance key skills or competencies needed to succeed in learning environments in and beyond the university setting. Most frameworks and studies recognize the importance of sociocultural factors that alter the nature of learners' participation in learning communities. What we do not understand is the nature of transfer STEM majors' interactions within the upper-division physics courses at Grand Lakes University, a transfer-receiving institution. In this literature review, I use (a) concepts of Constructivist Theory that underpin Activity Theory; (b) knowledge of sociocultural factors that shape one's achievement-related behavior and other related factors including students' psychological beliefs that mediate activity, students' social capital (e.g., sense of belonging and benefits associated with social interactions), and students' linguistic capital (i.e., social language use and critical thinking); (c) knowledge of the relationships between sociocultural factors and attrition rates; and (d) knowledge of how classroom experiences can alter learners' socialization experiences (Bourdieu, 1986; Eccles et al., 1983; Engeström, 1996; Vygotsky, 1978).

Vygotsky and Activity Theory

Activity Theory is a framework that helps researchers understand and analyze the process where individuals interact with, are influenced by, and in turn, alter an environment. Activity Theory is underpinned by the assumption that (a) humans function as a group, learn experientially, and exchange information through and by their activity;

(b) humans create, employ, reshape, and incorporate tools to gain knowledge and communicate; and (c) human interaction with social others or semiotic resources is central to learning, communicating, and acting (Leontiev, 1978). Activity Theory frameworks are useful in understanding the dynamics of complex social systems.

Rooted in 1920's Russian scholarship, Vygotsky and his colleagues reformulated psychological theories, steering away from reflexology, classical conditioning, psychoanalysis, or behaviorism to capture the influence that components of social systems (e.g., social others, material, and nonmaterial semiotic resources) exert on each other (Bedny & Meister, 1997). Vygotsky's theories revolutionized the scientific study of the human mind that once treated individuals and their environment as separate entities. Within Vygotsky's new psychological model, individuals connect to the environment through stimulus and response relationships. Assuming the interconnected nature of individuals and the environment, Vygotsky's concept of sociocultural constructivism assumes a person's cultural development appears twice: first, on the social level and then on the individual level (Vygotsky, 1978). Vygotsky used the idea of internalization on a social level to explain how individuals process information and make that a part of one's nature by learning in the presence of social others using private speech (i.e., self-talk), interactions with others, or other semiotic resources through the concept of mediated action. Mediated action focuses on how humans use cultural tools when engaging in various forms of activity (Wertsch, 2017).

Mediated Action. Vygotsky first introduced mediated action as a concept to explain the semiotic process that enables individuals to develop consciousness through interactions with self, others, or objects that help make meanings in their world

(Yamagata-Lynch, 2010). Vygotsky assumed one's consciousness was not constant, but changed over time as the result of newly internalized knowledge. Mediated action involves exchanges between an individual and mediating artifacts (i.e., semiotically produced cognitive tools) that result as a part of interactions with social others, tools, or artifacts. Vygotsky assumed that environmental (and self) interactions allow for the accumulation and internalization of knowledge or alteration of one's consciousness. Using this understanding, Vygotsky created a conceptual model to represent the relationship between mediated action between a subject (i.e., the individual), mediating artifacts (i.e., semiotic tools or processes), and the object (i.e., the goal of activity). Interactions within the environment allow individuals to transform new knowledge and then use that knowledge in new circumstances.

Following Vygotsky, Lave and Wenger (1991) asserted that interactions with more knowledgeable social others (i.e., apprenticeships) provides the proper context for learning to take place. In ideal classroom settings, novice learners or new community members (e.g., transfer students) move from legitimate peripheral participation (i.e., limited community participation) in the presence of social others to a point of higher ability (i.e., full participation) as a result of engaging in the discipline-specific practices of the community. Participation in discipline-specific activities (i.e., achievement-related behaviors) promotes the assumption of identity in relation to the community (Wenger, 1999). Vygotsky's theory of social constructivism is situated within and underpins the Activity Theory framework, and serves as a useful lens for qualitative research methodologies to understand and analyze social phenomena. When considering the case of transfer physics majors in upper-division undergraduate physics classes, Activity

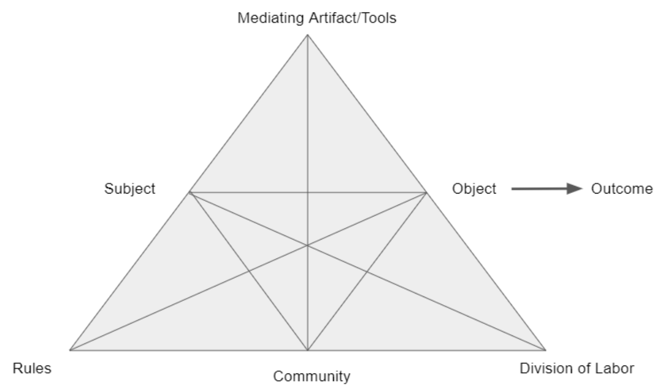
Theory provides a useful construct to frame how classroom interactions or other sociocultural factors alter transfer physics majors use of discipline-specific language, the development of critical thinking or other activities within upper division physics classrooms. Additionally, Activity theory is useful in framing how social interaction in classroom or co-curricular activities mediate students' sense of belonging and socialization as physics majors.

Activity Theory. Activity Theory permits analysis of aspects of human activity through several related elements (listed and described below). Engeström (1996) defines three distinct approaches to Activity Theory. As previously mentioned, the first approach, Vygotsky's mediated action model, is commonly referred to as the first-generation model, relating the subject, mediated action, and outcomes. Leontiev and Engeström contributed to a second-generation Activity Theory that emphasized the collective nature of human activity and expanded the conceptual models adding social and historical aspects of mediated action not accounted for by Vygotsky. Engeström's contributions to a third-generation model adapted previous Activity Theory models to include the impact of rules, community, and divisions of labor. Rules include informal or formal regulations that determine action within social settings (e.g., learning communities). The community is the social group (e.g., classroom composed of educational stakeholders such as students, faculty, and other practitioners) to which the subject identifies and where mediated action occurs. Lastly, the division of labor describes the sharing of tasks within the community.

All of the components of activity systems (e.g., mediating artifacts, tools, rules, community, and division of labor) can alter object-oriented activity, consisting of social activity and the use of other semiotic tools that serve as a precursor condition for all forms of mental activity (Rambusch, 2006). A later discussion will define institutional and student sociocultural influences that alter collective or culturally mediated activity. Activity Theory provides a theoretical framework to frame and understand the nature and adaptations of transfer physics majors' social language, beliefs regarding content ability, expectations for success, and the value students place on participation in physics studies within upper-division physics classrooms. The below figure shows a system of interrelated variables that mediate, or influence the "object" of the activity system, the reason the activity is carried out. In physics classrooms or co-curricular spaces, the object (participation in achievement-related behavior) is defined by the subject (classroom participants) and is influenced by a wide array of sociocultural influences. For example, teaching techniques employed by instructors in classroom shape the nature of interactions among classroom participants. Additionally, divisions of labor (i.e., social roles that individuals or groups of people adopt or adhere to), whether real, or perceived may alter students' participation in meaningful educational activities in educational settings. Activity theory offers a useful mental model to frame one's understanding of the relations among variables, or interrelated systems amongst individuals on the communal plane. Figure 2 illustrates the system of interrelated social and cultural variables that mediate object-oriented activity, which is defined as individual or collective change (outcomes) that arises from societal activity.

Figure 2

Cultural Historical Activity Theory Model



Mediating Artifacts. Mediating artifacts encompass tools, instruments, signs, and all types of material, both semiotic and conceptual, as a means for accomplishing a human activity. In social settings such as classrooms, semiotic tools influence an individual's interaction and participation in educational activities that alter one's ability to internalize facts, gather information, and learn new skills. The types of mediating artifacts deployed in discipline-specific culturally-influenced social settings allow for the transmission, accumulation, and internalization of both academic and social knowledge. Mediating artifacts influence and are affected by the agents (a wide variety of stakeholders) present in classrooms, including students, faculty, and other practitioners who shape instructional settings and resources.

Mediated action as it relates to socialization (i.e., discipline-specific discourse appropriation) involves the use of a variety of semiotic resources, which are themselves mediating artifacts that encourage mediated action. Examples of semiotic resources used in physics classrooms during meditated action include spoken and written language, mathematics, gestures, pictorial representations (e.g., pictures, graphs, diagrams), experimental apparatus (e.g., lab equipment), and activities (e.g., ways-of-working) (Airey & Linder, 2009). Classroom socialization depends on individuals' ability to gain a disciplinary affordance, described as the ability of individuals (i.e., classroom participants such as the teacher and students) to identify the circumstances and then apply appropriate semiotic and conceptual resources during object-oriented activity. The accumulation, internalization, and use of a variety of semiotic resources in social settings assists individuals in object-oriented activity, advancing them through what Vygotsky (1978) referred to as the Zone of Proximal Development, the difference between what a learner can do without help and what they can achieve with guidance. From an Activity Theory perspective, the Zone of Proximal Development serves as a metaphorical tool for understanding the complexities of interaction within the environment. Human activity, particularly the nature of the interaction (e.g., the extent of learning; participation, association, involvement, etc.), inevitably alters an individual's ability to accumulate and internalize knowledge and move from limited to full participation within communities of practice.

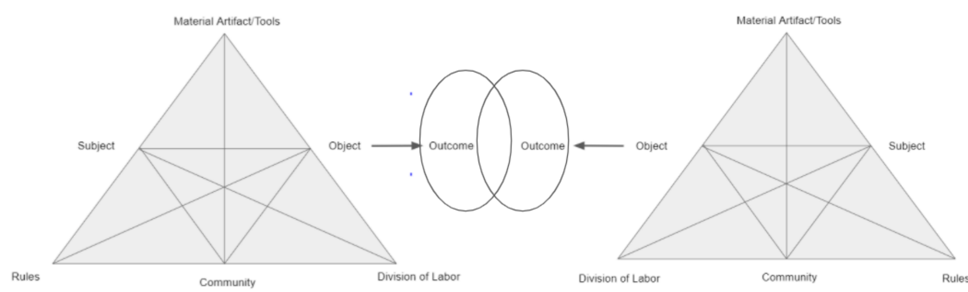
Object-Oriented Activity. Leontiev (1978) defined object-oriented activity as an aspect of life mediated by mental reflection whose real function is to orient an individual to activities leading to the object (e.g., goal). Leontiev's definition implied that mediated action or consciousness development as a self-regulated meaning-making activity is driven by goals in which individuals voluntarily participate. Object-oriented activity encompasses the ability to accumulate, internalize, and then later apply socially constructed understandings to gain or contribute to further knowledge. While engaging in mediated action, the events and outcomes that individuals experience can change the individual, the environment, and the activity. According to Davydow (1999) and Rogoff (1995) mediated action occurs through a reciprocal social process that changes the individual, the goal of the activity, and the contextual relationship between individual and outcome. Once an activity becomes an established cultural practice, it informs future action and practice.

Activity Settings. Activity settings identify the communal context (e.g., physics classrooms) where object-oriented activity occurs. Identifying activity settings provides an interpretive and methodological frame of reference that allows for a connection between an individual's action and the social environment. Furthermore, defining the activity setting (e.g., learning space, third-space) defines specific boundaries that allow for the analysis of relevant social phenomena. The three planes of sociocultural analysis allow for the identification of object-oriented activity into bounded systems that assist researchers in activity system analysis. Within this analysis, object-oriented activity is the unit of analysis, however, the subject can be the individual, group, or the learning community at large. The overwhelming number of independently variable factors that affect a social system necessitates focusing on one aspect of the unit of analysis (e.g., individual, group, or the learning community at large) to identify salient features of interest within activity settings.

Rogoff (1995) defined three planes of sociocultural analysis that help identify object-oriented activities into units within bounded systems. The activity of an individual takes place within the personal plane. Interactions between individuals and social others (e.g., interaction with classmates or faculty) occur within the interpersonal plane. Communal activities shared by all members of an institution or organization take place within the community/institutional plane (e.g., discourses). Figure 3 presents a depiction of Engeström's third-generation CHAT model that shows object-oriented activity that leads to shared communal outcomes, an important aspect of socialization within community settings. Figure three illustrates how individuals' sociocultural mediated object oriented activity mediates object-oriented activity, then on the communal plan, overlaps to mediate group members' movement through the ZPD to accomplish tasks that might have been impossible to accomplish on the individual level.

Figure 3

Engeström's Third-Generation CHAT Model



The concept of sociocultural planes has both theoretical and methodological dimensions that help address the complexity of social systems: viewing social systems through the individual components of activity systems (e.g., mediating artifacts, rules, community, and divisions of labor) or across various sociocultural planes (e.g., personal, interpersonal, community/institutional) assists in identifying the salient features of social systems (e.g., classrooms, learning spaces). Communal-based object-oriented activities which occur during interactions with social others or material resources in classrooms or co-curricular spaces that ideally, lead to shared outcomes, that in turn further assist in adopting shared ways of being (i.e., discipline-specific discourses) consistent with that of socialized members of academic communities (*Engeström, 1999)*.

Connecting Social Constructivism and Socialization

Vygotsky and other theorists contribute to the argument that limitations in student socialization are secondary to individual and institutional antecedent factors (e.g., structural and psychosocial influences) that inhibit mediated action and fail to produce a Zone of Proximal Development for learners (Vygotsky, 1962). Viewing socialization processes through a constructivist lens recognizes the connectedness of individuals and their environment through ongoing interaction with social others. Lave and Wenger (1991) argued that learning (e.g., discourse appropriation, socialization) is a social process, where knowledge and learning are co-constructed and involve participation in the social world. Lave and Wenger's (1991) view of learning involves a process (i.e., socialization) where newcomers become part of a community of practice by moving from limited to full participation. Interactions with social others or other material or immaterial semiotic tools help to shape learners' understanding and make meaning, which over time, alters one's identity and shapes their relationship with other community members. Although Lave and Wenger (1991) refer to the process of gaining new knowledge and the alteration of community members' identity, as legitimate peripheral participation, in this study, I will describe this process as moving from "limited to full participation." This process will include adaptations in students' discipline-specific discourse appropriation (i.e., language acquisition plus ways of acting, interacting, feeling, believing, valuing with various sorts of objects, symbols, tools, and objects) that distinguish individuals or groups in certain ways (Gee, 1999).

An undetermined number of influences, themselves mediating artifacts, act to impact students' educational activities in an object-oriented activity that contributes to movement from limited to full participation (i.e., socialization). Frequently, pedagogical practices used in higher education classrooms are based on the assumption that learners have developed abilities (e.g., linguistic, mathematical, interaction skills, etc.) in previous educational experiences. Antecedent and subsequent individual and institutional sociocultural influences (e.g., individual abilities, attitudes, dispositions, institutional climate or culture, instructional pedagogies) potentially alter learners' movement from limited peripheral to full participation within educational settings. The next portion of this chapter will discuss relevant literature related to theories and concepts regarding an individual's or groups of students' inherent sociocultural characteristics that mediate educational activities or socialization experiences.

Review of the Literature Related to Capital and Socialization

Within this section I present a discussion of extant literature pertaining to (a) how an individual's historical and cultural experiences that mediate individual expectancies, values, and achievement behaviors; (b) relations among social and cultural capital and student socialization; (c) capital as a antecedent factor of socialization; (d) social capital and inequity in classrooms; (e) linguistic capital and inequity classroom settings; (f) antecedent sociocultural factors and student attrition; (g) sociocultural factors and individual's ways of being; and (h) sociocultural factors and student socialization. While much of this literature is useful for understanding student socialization or discourse acquisition, many of these qualitative studies are not generalizable, nor do these studies fully account for the context-specific or individualized educational activities or socialization experiences of transfer physics majors at Grand Lakes University.

Sociocultural Factors Mediate Expectancies, Values, and Behavior

Eccles et al. (1983) posited that seminal research conducted by Atkinson (1964), Crandall et al. (1962), and Weiner (1974) regarding the concepts of cognitive constructs of expectancies (i.e., self-concept related to success) are useful in determining behavior choice. Such cognitive constructs included (a) causal attributions (i.e., previous outcomes that mediate one's expectations for success or their ability beliefs); (b) subjective expectancies (i.e., self-determined probabilities of task-related success); (c) self-concept of ability (i.e., belief about one's own ability to perform tasks); (d) perceptions of task difficulty, and (e) subjective task values (i.e., value attached to success or failure in completing tasks) that were useful in formulating a systems model to understand factors that influence an individual's development. This systems model linked developmental and causal links among individuals' cultural factors, historical events and their beliefs about their ability, expectations for successful completion of tasks, the value they place on completing tasks, all of which mediate their participation in endeavors that support the accomplishment of tasks. These cognitive constructs potentially mediate student's object-oriented activity (i.e., achievement-related behavior academic or co-curricular settings). Examples of cultural factors that mediate present and future achievement-related behaviors include the cultural capital (i.e., social assets that promote social mobility) that students possess or accumulate while acquiring primary discourses, or gather from academic or social exposures within educational settings. Examples of historical events that mediate one's cultural capital may include previous educational experiences that resulted in the acquisition of content knowledge, skills, or academic credentials that further their mobility as learners. Furthermore, cultural factors and historical events impact an individual's habitus (i.e., their intellectual dispositions) and field (i.e., social position in relation to others) that also represent causal attributions that mediate one's expectations for success or their ability beliefs and influence participation in achievement-related behavior (King, 2005). From a constructivist standpoint, an individual's psychological beliefs represent one of many mediating factors that potentially mediate object-oriented activity.

Social Capital, Linguistic Capital, and Socialization

Social and linguistic capital represent embodied forms of cultural capital that are acquired or inherited, by socialization to a culture or tradition (Bourdieu, 1990). The next portion of the discussion will visit research that (a) defines various forms of capital; (b) describes connections between capital and potential sources of inequity in learning processes; (c) describes research related to antecedent influences that alter access to social or linguistic capital; (d) defines factors that alter STEM students' attainment rates in higher education; and lastly, (e) discusses research about socially mediated processes of socialization.

Bourdieu (1986) defined social capital as (a) "the aggregate of the actual or potential resources which are linked to possession of a durable network of more or less institutionalized relationships of mutual acquaintance or recognition" (Bourdieu 1986, p. 248) and (b) "social obligations ('connections'), which is convertible, in certain conditions, into economic capital and may be institutionalized in the form of a title of nobility" (Bourdieu 1986, p. 243). These definitions offer utility to understanding inequality in classrooms when certain groups cluster at differing points of advantaged positions (Lin, 2000). The concept of capital, particularly in terms of social relationships and linguistic ability, both embodied forms of cultural capital that potentially mediate an individual's participation in classroom settings, are useful in understanding inequitable outcomes among students.

Linguistic capital, an embodied form of cultural capital, involves the mastery of language and its relations. As linguistic capital represents an aspect of cultural capital, an individual's discourse (i.e., language use, accent, self-presentation) are mediated by their cultural background and other historical events such as one's upbringing or previous educational experiences, all of which from a constructivist viewpoint, shape their ways of being and communicating (i.e, primary discourse).

Antecedent Influences and Cultural Capital

The concept of cultural capital is useful in explaining differences among students entering classrooms from a range of sociocultural backgrounds (e.g., transfer students versus regular-admit learners). Students with background experiences that are congruent with institutional culture (e.g., regular-admit students) acquired through practices embedded in university physics classrooms, particularly linguistic practices, are more likely to be perceived as successful students by faculty or unsocialized learners. Bourdieu and Wacquant (1992) argued that legitimate language (e.g., discipline-specific discourse), which is a form of cultural capital in classrooms, is unequally shared or monopolized by in-groups versus out-groups. In the case of upper-division physics courses, this suggests that content knowledge, discipline-specific language, or other useful practices vary across social groups, providing an advantage. Students who enter classrooms possessing relatively advanced levels of social and linguistic capital can transform this capital into instrumental relations that reinforce power bases, which further strengthens group members' social capital, and in turn, the ability to transmit valued resources such as academic reward (Stanton-Salazar & Dornbusch, 1995). The extent of students' linguistic capital reveals itself through classroom interactions. In classrooms or other contexts, the movement from limited to full participation is aided through the process of participating in active learning processes (e.g., free dialogue or debate) within learning communities (Lave & Wenger, 1991; Lemke, 1990).

Social Capital and Inequity in Classrooms

Social capital (i.e., possession of social relationships) represents a psychosocial factor that influences and is influenced by other factors such as, but not limited to, institutional culture, individual or group background, institutional teaching practices, and individual psychosocial factors (e.g., one's beliefs about their content ability, motivation, skills, identity, self-efficacy, etc.) Bourdieu (1986) provided a foundational understanding of differences in the acquisition and returns associated with social capital among individuals or groups of varying social affiliations.

Later, Lin (2000) expanded on Bourdieu's theory of social capital by presenting two principles. The first principle asserts that inequality of social capital occurs when groups cluster at disadvantaged socioeconomic positions. The general tendency is for social groups to associate with those who share characteristics (e.g., background, ability, identity, other markers of difference) based on communal standing. According to this principle, historical and institutional constructions bring about and reinforce unequal opportunities to members of different groups. The second principle of homophily assumes a tendency for people to seek out or be attracted to those with similar characteristics.

Bourdieu (1986), and then later, Lin (2001) offered a rational explanation of how individuals or groups seek to gain power based on differences in social capital in communal settings. Differences in antecedent individual or institutional psychosocial influences (e.g., previous educational experience, family background, relationships, power imbalances in university learning spaces, ability-related self-concept, individual's expectations for successful task completion, the value individuals place on completing tasks, instructional pedagogy practices, and ability to engage in discipline-specific discourse) predispose the way students think, act, or engage within classrooms. In turn, social affiliations and participation in educational activities shape students' motivation, critical thinking skills, personal character, and academic abilities (Gasiewski, Eagan, Garcia, Hurtado, & Chang, 2011). Power imbalances may lead to the isolation of individuals or groups in learning spaces, and isolated individuals may not engage in object-oriented activity which in turn, may fail to produce suitable conditions for movement within the Zone of Proximal Development towards autonomy.

Several studies sought to understand the role of various forms of cultural or social capital by highlighting the importance of classroom interactions, faculty interactions (i.e., research with faculty), supportive learning environments, effect mentoring on the ability to cope with problems of self-efficacy, dispositions toward studying STEM, lifelong learning, and one's ability to convert institutionalized cultural or social capital in the labor market (Mayhew, Wolniak & Pascarella, 2007; Moser, 2012; Starobin, Jackson, & Laanan, 2016; Walpole, 2003). Members of groups possessing social capital enjoy access to a larger quantity of and diverse variety of resources. Groups who leverage differential access to these resources will often act to reproduce and perpetuate inequality in learning outcomes (Collins, 1993).

Linguistic Capital and Inequity in Classrooms

Linguistic ability, a sociocultural factor that represents an antecedent influence on classroom interactions, originates within what Bourdieu (1986) attributes to family structures and practices. Linguistic ability facilitates individual and group cultural features such as the mastery of language and relations (e.g., social capital), an embodied form of cultural capital. Further, linguistic capital represents a person's means of communication and self-presentation, acquired from one's cultural exposure. For these individuals, the embodiment of cultural influences, emboldens what Bourdieu referred to as habitus (i.e., habits, skills, and dispositions), which may predispose their actions (e.g., language) or other ways of being. In cases where there is congruence between individuals' or groups' language and that of the discursive practice (e.g., scientific, mathematical, or other relevant discourse), an individual or group will most likely have greater access to knowledge and other forms of capital represented in and through such practices. From this viewpoint, language constitutes a tool within the constellation of practices that comprise and contribute to class-based social stratification in classrooms.

Bourdieu, Passerson, and de Saint Martin (1994) proposed that class-based language patterns contribute to "serious and insidious" implications on judgments of pupils' quality and extent of discipline-specific expression by other persons in classrooms (e.g., teacher, other pupils) (p.40). An individual's habitus (i.e., ingrained habits, skills, dispositions) has a substantial impact on a learner's ability to make sense of or engage in discursive practice and subsequent capacity to accomplish full participation within learning communities. Educational institutions value students' ability to participate or become involved in the use of discipline-specific language and devalue the use of vernacular. In cases where students fail dialogically to develop discipline-specific vocabulary, their adoption of ways being consistent with that of their learning communities is constrained, potentially contributing to lower levels of persistence and higher levels of student attrition.

Sociocultural Factors and Attrition from Higher Education STEM Programs

Many studies report factors associated with attrition from STEM majors. However, few studies have focused on community college transfer students and the unique factors that predict their educational outcomes (Wang, 2009). Broad research at the undergraduate level of study reveals that "poor teaching" and "a lack of student-faculty interaction" represent factors that lead to attrition (Seymour & Hewitt, 1997; Watkins & Mazur, 2013). A study of STEM attrition rates conducted by the National Center for Educational Statistics showed that one-third of students pursuing STEM related associate's degrees and one-fifth of students pursuing STEM related bachelor's degrees left their degree program by changing majors or by leaving college prior to degree completion (Chen, 2015, p. 15). The NCES quantitative study revealed that attrition for students pursuing either associate or bachelor's degrees major switching was correlated with (a) the intensity of first-year courses; (b) the level of math taken during the first year; and (c) level of success in STEM courses. Dropping out of college without earning a degree was correlated to (a) low grade point average and (b) high levels of withdrawing from, or failing courses for both bachelor's and associate's STEM entrants.

While the NCES study offers utility by providing insight about attrition rates based on various individual and institutional sociocultural factors, this study fails to provide context-specific data about student socialization higher educational experiences (i.e., discourse appropriation) at two-year, four-year, or transfer-receiving institutions.

Sociocultural Factors and Movement in the Zone of Proximal Development

Activity Theory offers a holistic view of human activity as a systematic social phenomenon (Engeström, 1996). In this study, Activity Theory serves as a useful framework that allows practitioners to consider how a variety of sociocultural factors alter human activity (e.g., participation in learning communities). I will focus on how mediating factors within the physics classroom or co-curricular settings alter transfer students' social language use or other activities while enrolled in upper-division physics courses. Some examples of mediated action that potentially alter transfer students' social language use include but are not limited to (a) pedagogy methods that physics instructors employ (i.e., activity structure), and (b) student behavior (e.g., social language use, use of other semiotic tools or resources such as group seating, problem sets, other relevant interactions). Activity Theory, or other systems models such as Eccles et al.'s (1983) causal and developmental model, that relate sociocultural factors and object-oriented activity, provides a method for understanding and analyzing a phenomenon, finding patterns, making conclusions based on evidence, and describing phenomena using context- or discipline-specific communication methods. Activity Theory is useful in explaining how social artifacts (e.g., pedagogy techniques, student language, etc.) and social organization (i.e., relations between individuals or groups) bring about social action. The complex and interrelated nature of components within learning spaces make

Activity Theory a practical choice for gaining an understanding of the socialization process of transfer physics majors in upper-division physics classrooms.

Lemke (1990) asserted that classroom instructors who employ teacher-centered pedagogy approaches such as monologue, constrain the free exchange among classroom participants to pace lessons and to manage student behavior. For example, the use of monologue (i.e., lecture) or the ubiquitous triadic dialogue involves the instructor initiating questions to pupils, pupils' responses to teachers, followed by evaluative responses by the instructor to provide feedback related to pupil responses. Triadic dialogue or monologue represent a sociocultural influence or artifact that contributes to class-order systems within instructional settings by limiting participation to select learners and constraining other students' participation. Limiting active learning classroom activities hampers classroom participants' ability to connect relevant concepts, exercise skills, or develop discipline-specific language.

In contrast, Lemke (1990) asserted that active learning activity structures such as debate or free-dialogue learning processes represent a sociocultural influence or artifact that reduce power imbalances, giving voice to a larger number of students in classrooms, and afford classroom participants with the potential for higher levels of higher-order thinking. Dialogic based interactions allow learners to establish connections between concepts (i.e., thematic patterns) and reveals learners' linguistic competence (Lemke, 1990). Incorporating pedagogy methods that encourage dialogue or debate among all classroom stakeholders potentially allow for interactions composed of higher levels of abstraction and provide an opportunity for the instructor to gauge a student's ability to employ instructional activities that maximize students' opportunities to acquire discipline-specific language competency and conceptual understanding.

Instructional methodology plays a significant role in knowledge retention and transfer. Classroom instructors must employ teaching strategies to encourage student dialogue to observe and assess conceptual understanding and language development within classrooms (Gee, 1990; Lemke, 1990). According to the constructivist model, learning occurs when the individual is assisted by social others such as a student-centered learning process where an individual with a higher skill set assists the student in attaining the skill he or she is trying to master, until assistance is no longer needed for that task (Burkitt, 2006). As stated in chapter one, Anderson and Bloom's (2014) Taxonomy, the most widely accepted hierarchical arrangement, views thinking skills on a continuum starting with remembering (i.e., low-level thinking) involving recognizing and recalling, and increasing complexity to creating knowledge (i.e., high-order thinking). Critical, constructive, or creative thinking involves using increasingly complex cognitive processes. For example, increasingly complex thinking may involve critically analyzing newly acquired knowledge, followed by synthesizing these concepts to construct thematic patterns. From a constructivist point of view, the actions of synthesizing concepts to form thematic patterns while engaging in self-talk or interacting with others involves the transformation of information or ideas.

Transformations occur when individuals, assisted by others, or by interacting with material semiotic resources, combine facts, explain, hypothesize, synthesize, or arrive at some conclusion or interpretation (Anderson & Bloom, 2014). Engaging in the process of increasingly complex thinking allows students to solve problems, gain understanding, make meaning of, and appropriately articulate physics phenomena. Across all subject areas, instructors who pose higher-order questions encourage students to work collaboratively and make explicit statements or accounts that clarify their understanding of how concepts are connected or how new knowledge is created; through this process, learning is enhanced (Ramos, Dolipas, & Villamor, 2013).

Vygotsky's (1978) notions are important for providing a conception of sociocultural processes and allude to the dynamics of power imbalances that lead to class order systems in classrooms. In addition to sociocultural processes, the concept of class is necessary to understand differential learning in classroom spaces. The construct of social classes offers insight to understand how perceived differences between individuals or groups are regulated and reinforced through classroom stakeholder interactions, contributing to differentiated student experiences. Lastly, class order systems in classrooms, an economy of class, produces and reinforces a hierarchy of privilege among classroom participants. Bourdieu (1986) asserted that antecedent factors predispose individual or group members' accumulation of knowledge, behaviors, and skills needed in higher education and beyond. From a Vygotskian standpoint, these antecedent factors also influence student socialization within learning communities. According to these viewpoints, these interactions represent essential factors in creating a Zone of Proximal Development needed for language development, conceptual understanding, or other forms of learning.

Socially Constructed Identities or Ways of Being and Socialization

Similar to Lave and Wenger, Gee (1990) differentiated discourses (i.e., use social language use, critical thinking, and other ways of being) acquired from an individual's primary socialization as members of particular sociocultural settings, solidifies one's social identity through the participation in apprenticeships within communities of practice such as school communities, professional organizations, or other peer groups. Discourses (i.e., use of social language or other ways of being) associated with practices beyond one's primary socialization connected to the outside communities are mastered through *acquisition* rather than *learning* (Gee, 1990). Gee (1990) argued that discourses are mastered through acquisition, a process involving practice or trial and error within social groups without formal teaching, compared to learning, a process that knowledge is gained through exposure to teaching (i.e., show or explaining how to carry out tasks). Classroom or co-curricular interactions that encourage dialogue within classrooms are most often determined through instructors' choice of activity structure (e.g., monologue, triadic dialogue, free dialogue, debate, etc.) that in part regulates the quantity and quality of student interaction that promotes discourse appropriation and content learning (Lemke, 1990; Harlow & Otero, 2006).

Qualitative Research Sheds Light on Stakeholder Perspectives and Activities

Qualitative inquiry emphasizes classroom stakeholders' lived experiences and are well suited for unearthing the events and processes that alter transfer physics majors' social language use and other activities within upper-division physics classrooms at transfer-receiving institutions. According to Perna and Thomas (2006), across all disciplines, the majority of studies investigating student success rely principally on quantitative measures. While data are generalizable, studies enlisting quantitative methods may fail to provide a context-specific understanding of student experiences. The reliance on aggregate quantitative measures to drive organizational decision-making teaches researchers much about the majority of learners, but little about other students at the margins (Stage, 2000). Fully understanding the challenges transfer physics majors face defies descriptions or predictions made through the vast number of non-specific quantitative studies. Transfer physics majors' distinctive and idiosyncratic needs require local exploration using qualitative methods to gain an understanding of these populations' educational and socialization experiences.

Chapter III

Methodology

In this chapter, I provide a discussion of the inquiry design. This discussion will address the purpose of the study, the research questions, and the rationale for qualitative methodology. The next portion will discuss the criteria for participant selection, data collection procedures, data analysis methods, and the process to ensure the reliability and the validity of the data and interpretations.

Purpose Statement

The purpose of this study was to gain an understanding of how transfer physics students' participation in educational activities was influenced by a host of individual psychosocial factors, such as their beliefs about their own capacity to study physics, expectations for success in physics coursework, value beliefs related to studying physics, unique past educational and transitional experiences, institutional perceptions, perceptions of faculty and peers, how transfer students experienced belonging as physics majors, their perception about the meaning of socialization, and how they experienced socialization. Additionally, this study revealed how institutional factors such as practitioners' teaching and the promotion of co-curricular activities influenced students' participation in educational activities.

This study employed a purposeful sampling of transfer and regular admit physics students, as well as instructors within upper-division physics classrooms. Data were collected primarily from video and audio recordings, along with the creation of detailed field notes (using the Smith et al. (2013) Classroom Observation Protocol for Undergraduate STEM instrument) of participant interactions within physics classrooms, student surveys, and student interviews to gather data related to the socialization of transfer physics majors. I transcribed the audio recordings using the verbatim principle, followed by coding and analysis to identify emerging thematic patterns associated with instructor-student or student-student classroom interactions in upper-division physics classrooms where transfer students were enrolled. Additionally, comprehensive field notes were used to capture contextual information allowing for a rich description of the classroom environment. Survey data and student interview transcripts enriched the understanding of individual psychosocial factors and other unforeseen student perspectives.

For the last 25 years or so, physics education practitioners have sought to develop empirical methods to evaluate what students learn about physics under various modes of instruction (McNeil, n.d.). The most significant finding of this body of research has revealed that the traditional lecture model of instruction is ineffective at achieving learning goals for physics students (Gatch, 2010; Lowe, 2011). An abundance of physics educational research demonstrates that pedagogical methods that promote conceptual understanding and the formation of thematic patterns across the content mediated through interactive content (e.g., minds-on, hands-on) yield feedback through dialogue with peers or instructors (Lemke, 1990). While frameworks discussed in this and previous chapters are generalizable and applicable to understanding how individual and institutional sociocultural factors influence students' participation in classroom or co-curricular activities or experience socialization, additional research was needed to grasp the context-specific, individualized needs of the transfer physics student population. Further, this study will add to the growing body of knowledge related to the socialization of transfer students within STEM classrooms at transfer receiving institutions. Lastly, it is hoped that the results of this inquiry will create a greater consciousness of how individual sociocultural factors impact students' participation in classroom or co-curricular activities impact their socialization, or the adoption of physics-related discourses.

Research Questions

1. How do regular-admit physics students, transfer physics students, and the physics course instructor describe personal beliefs related to their own or others' (a) physics content ability; (b) expectations for success in physics studies; and (c) how values attached to the value they place on their physics studies (i.e., utility of, importance of, and interest in) change as a result of participation in upper-division physics coursework?

a. How do ability beliefs, expectations for success in physics coursework and the values students attach to physics studies influence students' participation in classroom or co-curricular activities?

2. How do individuals or groups of transfer physics majors or the physics instructor describe their own or others' socialization experiences related to participation in upper-division physics classrooms at transfer receiving institutions?

3. In what ways do transfer physics majors enrolled in upper-division physics courses at Grand Lakes University interact when participating in classroom activities?

a. What are the larger or main activities (or sets of activities) occurring within upper-division physics classrooms at Grand Lakes University?

b. What upper-division physics classroom sub-activities comprise this or other activities?

4. To what extent do transfer physics majors enrolled in upper-division physics courses at Grand Lakes University engage in social language related to physics or other related disciplines?

a. What discipline-specific content-based social languages are relevant (i.e., closely related to physics or other related discourses) or irrelevant (i.e., not connected to physics or related discourses)?

5. How is transfer students' at Grand Lakes University use of physics-related language or classroom activities developed over time within upper-division physics classrooms?

a. How do individuals or groups of transfer physics majors adapt social language use throughout their experiences within their initial upper-division physics course?

b. How does transfer physics majors' use of social language or activities become stabilized or transformed?

Assumptions and Rationale for Qualitative Methodology

Qualitative research offers a source of well-grounded, richly described explanation of processes within local contexts (Miles & Huberman, 1994). Qualitative researchers engage in an intentional process of explicitly communicating rationales for the instructional design to ensure the trustworthiness of inquiry (Lincoln & Guba, 1985). Creswell and Plano Clark (2018) and Rubin and Rubin (2005) assert that research instruments are based on assumptions that differ within each paradigm belief (e.g., epistemology, ontology). Within the qualitative methodology, the researcher serves as an instrument in situ collecting data through multiple measures to understand and analyze phenomena (Rossman & Rallis, 2012). Qualitative researchers engage in an inductive data analysis through iterative coding, providing a systematic process for the discovery of emerging phenomenological themes (Patton, 2001). Since little is known about transfer physics majors' socialization into upper-division physics courses at Grand Lakes University, a qualitative research design is appropriate for this research. This project looked at individual and institutional sociocultural factors that influence their achievement-related behaviors in the classroom and co-curricular settings, which mediate their socialization as physics majors.

Since I am interested in how individuals and groups of students describe their self-concept related to ability, the value they attach to participation in physics studies, their previous educational experiences, their transition experiences, their perceptions of the institution and the physics department, their perceptions of their peers and physics faculty, how they describe the meaning of socialization, or how they experience socialization, their sense of belonging, and the use language or how behaviors mediate language use in social settings, a qualitative methodology is applicable for this study. Qualitative methodologies using multiple, triangulated approaches and measures are useful in understanding human behavior and the informant's perspectives.

Multi-method qualitative research methods enabled the study of complex entities and phenomena in a holistic manner (Roller & Lavrakas, 2015). The use of multi-method qualitative methodologies allowed for the investigation of transfer students' complex, multifaceted educational and socialization experiences. The need to fully address the research aims (i.e., exploring the life experiences of individuals, understanding the intrinsic nature of a variety of experiences, developing an in-depth analysis of individual and multiple students' experiences and activities, and the study of spoken language in classroom contexts) warranted the use of a multi-method qualitative approach to inquiry. Working under the constructivist worldview required the investigation of a large number of sociocultural variables that all mediated participation in educational activities in unique ways for individual students or for groups with shared identities (e.g., transfer physics majors). Understanding how individual and institutional variables mediated achievement-related behavior in the classroom or co-curricular settings called for the use of a variety of research instruments including student surveys, student and instructor interviews, and field observation instruments. The emergent nature of the data and findings provided by each instrument, shaped my approach to inquiry. For example, students engaged in extensive storytelling while describing their previous experiences studying physics, their transitions to Grand Lakes University, and their socialization experiences at Grand Lakes University. The findings related to student storytelling were best communicated using qualitative narrative research approaches. Next, during interviews, the students described the importance of a sense of belonging within the physics major, the meaning of socialization as a physics major, and how they experienced socialization as a physics major. These interviews revealed how individuals interpreted the meaning of experiences by describing the meaning of socialization, and the importance of experiencing belonging, that was characteristic of a qualitative phenomenological approach to inquiry. Third, the study of classroom participants' social interactions in terms of interactional discourses, use of discipline-specific social language, and the nature of critical thinking processes was accomplished through the use of qualitative field study-based discourse analysis approaches to inquiry. Last, the cross comparison of aggregate survey, interview, and observational data of groups of transfer students employed what Creswell (2013) described as a collective, or multiple case study, provided an understanding of how various individual and institutional sociocultural factors that mediated transfer students' participation in classroom and co-curricular activities, socialization activities, and the adoption of physics-related discourses.

A disaggregated comparative analysis of individual student's responses across various instruments (e.g., individual survey data, individual student portraits/vignettes, disaggregated observational data) that bound inquiry at the individual student level, and incorporated the narrative and phenomenological approach findings was characteristic of an intrinsic case study. Although complex and time consuming, the multi-method approach enabled a deeper immersion into the complex research objectives and subject matter related to an extensive array of idiosyncratic and interconnected sociocultural variables connected to transfer students' educational experiences.

In this study, I employed qualitative research design using multi-method qualitative research approaches that focused on (a) written or spoken language as a semiotic symbol that conveys or helps individuals make meaning in social settings; (b) activities, interactions, or participant actions that potentially enact identities associated with individuals discourses; (c) survey data that illuminated student perspectives related to physics content ability belief, expectations of course experiences, and task-value as related to physics content knowledge gained during coursework; (d) student interview data that captured perspectives of transfer physics majors socialization process; and (e) instructor interview data provided information about the instructor's beliefs about student expectations for success, student motivations for studying physics, students' physics-related linguistic ability, and students' interactional tendencies in the classroom or co-curricular settings. Further, this design (using multiple measures such as the Smith et al. (2013) COPUS instrument to characterize classroom actions and interactions, survey, and focus group data) permitted examination of the corresponding language use, actions, beliefs, perspectives, and other interactions among classroom participants (e.g., instructors, students), mainly transfer physics majors within, and as related to the instructional setting. These approaches and definitions of discourse are useful for engaging in social research from the interpretive and critical perspectives. For this qualitative study, I collected data as a non-participatory observer in classrooms, by administering student surveys, and then by using semi-structured interviews during student and course instructor interviews.

Strengths and Limitations of Qualitative Methods

Atieno (2009) asserted that qualitative methods help researchers engage in the systematic management of data "without destroying the complexity of the context" (p. 16). As stated in Chapters I and II, an excessive number of quantitative studies sought to determine relationships between individual and institutional antecedent sociocultural influences. Qualitative research using a multi-method approach provided a rich, context-specific understanding of students' classroom experiences and other relevant perspectives related to student socialization.

Setting

I conducted this qualitative research study at a university located in the mid-Atlantic region of the United States. Grand Lakes University is a medium-sized public undergraduate and graduate institution situated in a suburban environment. In addition to the main campus, the university operates several satellite campuses. The total student population is 19,000 students, which includes 16,000 undergraduate students, 2,000 graduate students, and 1,000 professional or medical students ([Grand Lakes University (pseudonym)] Fast Facts 2018-2019, n.d.). Grand Lakes University was chosen due to a large population of transfer physics majors. On average, 30% – 50 % of all physics majors at Grand Lakes University begin their undergraduate studies at other institutions, presumably community colleges before transferring to study physics ([Grand Lakes University (pseudonym)] Fast Facts 2018-2019, n.d.). Further, Grand Lakes University was chosen due to a large number of physics students (N = 175 physics majors).

Grand Lakes University accepts 71% of all annual undergraduate applicants. Since many of the satellite community colleges in the Grand Lakes University network are considered open enrollment institutions, this contributes to Grand Lakes University accepting a large number of transfer physics majors (e.g., 30-50% of all physics majors). The rate of transfer was encouraged by the [(2008) *Comprehensive State-wide Transfer Agreement,]* that determines articulation or enrollment agreements between two-year community colleges and four-year public universities within the state where this study was conducted. At Current average class sizes at Grand Lakes University are 20 students, with a faculty to student ratio of 17:1, and the mean grade point average of all students enrolled at Grand Lakes University is 3.57 on a 4-point scale ([Grand Lakes University (pseudonym)] Fast Facts 2018–2019, n.d.; [Grand Lakes Website], n.d.).

Several major and minor degree pathways account for the enrollment within upper-division physics courses at Grand Lakes University: minor degrees pull from students pursuing a variety of degrees, including but not limited to, engineering, mathematics, computer science, chemistry, and biochemistry, and majors most often include students pursuing a bachelor's of science (BS) degree in physics and biophysics. The bachelor's degree in physics requires 120 semester hours, 20 student hours which are composed of introductory physics courses (e.g., 100 and 200 level courses), 29 semester hours of upper-division physics courses (e.g., 300 level or above), and 11 semester hours are dedicated to restricted electives from a variety of STEM subject areas (e.g., 100, 200, and 300 level courses) (Academic Program Guide for Physics BS at Grand Lakes University [pseudonym], 2018). Additionally, Grand Lakes University offers a bachelor's of arts degree (BA) which requires 120 semester hours, 16 student hours which are composed of introductory physics courses (e.g., 100 and 200 level courses), 25 semester hours of mid-level and upper-division physics courses (e.g., 300 level or above. (Academic Program Guide for Physics BA at Grand Lakes University [pseudonym], 2018).

This site was chosen for several reasons. First, Grand Lakes University has one of the largest enrollments of physics majors in North America. Second, depending upon the year, roughly one-third to one-half of all physics majors transfer from other institutions to study physics at Grand Lakes University. Third, the large population of physics majors enrolled at Grand Lakes University allows for the potential collection of data across several upper-division physics courses, ensuring the opportunity to satisfy quality criteria for qualitative research by employing strategies to ensure the trustworthiness of data. Collecting data within upper-division physics classes offered rich data, increasing the understanding of transfer physics majors' social language use, relevant classroom learning activities, beliefs, values, or other student perspectives related to socialization experiences uncovered during the inquiry. Lastly, a wider sampling collects larger numbers and provides a greater depth of critical analysis of alternative explanations that are principles generally sought in order to enhance content validity (Long & Johnson, 2000). Miles and Huberman (1994) recommend emphasizing sufficient action to obtain a comprehensive understanding of a phenomenon or situation by continuing data collection until no further new or substantive information is revealed.

Participants

I sought approval from the Institutional Review Board (IRB) to conduct this investigation. After the IRB granted approval, I began participant recruitment, selection, and data collection. The targeted population for this study included transfer physics majors who transferred to Grand Lakes University within the 2019-2020 academic year. The population identity was confirmed through survey responses that indicated the year and semester (e.g., fall semester, spring semester) that they began their physics studies at Grand Lakes University. For this study, 16 students (9 regular admit; 7 transfer physics majors) and 1 course instructor associated with a single course section of the entry-level upper-division physics course that transfer students participate in during their first academic semester were approached for participation in this qualitative study. Seven transfer students (all male students), six regular admit students (1 female and 5 male students), and one course instructor agreed to participate in the classroom observation and survey portion of this study, representing an 82% participation rate. Several participants (1 transfer student and 2 regular-admit students did not complete the post-survey, nor did 1 student, transfer student Tyson, respond to solicitation for participation in the individual student interviews).

These participants most likely entered the study with varied experiences and backgrounds that may lead these individuals or groups to possess different levels of social capital, linguistic ability, disciplinary affordance with material or nonmaterial semiotic resources, ability, values, or task-values related to physics content knowledge. I speculate that differing levels of student socialization may be attributed to antecedent sociocultural factors such as family background, previous educational experiences (e.g., interactions with faculty in introductory physics courses or learning community courses at Grand Lakes University), institutional practices, or other unknown factors. At Grand Lakes University, the vast majority of transfer physics majors attended community colleges before enrolling as physics majors. Working under the assumption that transfer students represented 30-50% of the total course enrollment, a minimum of six and a maximum of ten transfer physics students could potentially participate in individual transfer student interviews. Additionally, upper-division physics were taught by either one or two faculty members for the lecture and laboratory portions of the classes. Therefore, I solicited one faculty member, the course lecturer, for participation in interviews to gather instructor perspectives related to students' socialization experiences.

Purposeful Qualitative Sampling

Qualitative data collected over a sustained period was accomplished by first, identifying participants who are relevant to understanding a problem or issue related to the study. Second, by the researcher engaging in a lasting presence while working in the field with participants, investing sufficient time to become familiar with the setting and context so as to build trust and gather sufficient and rich data of lived experiences, events, and processes (Miles & Huberman, 1994). Patton (2001) recognized purposeful sampling as a technique used as an efficient means to identify and select information-rich cases within a qualitative inquiry. According to Creswell and Plano Clark (2018), purposeful sampling involves intentionally selecting participants based on who has or will experience the central phenomenon. In this study, I focused on collecting and analyzing data related to a variety of individual and institutional sociocultural factors that mediated participation in educational activities and further mediated student socialization. Individual factors investigated within this study included students' psychological beliefs regarding self-concept related to abilities, the value students placed on participating in physics-related educational activities, their perceptions of their peers and course instructors, and their sense of belonging as physics majors at Grand Lakes University. Institutional factors investigated in this study included practitioner behaviors including pedagogy and the facilitation of activities to promote student curricular and co-curricular activities. In this study, I used what Creswell and Plano Clark (2018) describe as a homogenous sampling composed of physics majors enrolled in or faculty members teaching upper-division physics courses.

While the student composition for the sample was uniform, variation in students' beliefs and values, or other factors, may have led to variation in student interactions, and the corresponding use of discipline-specific social language or other activities. Upper-division physics courses at Grand Lakes University are taught by instructors who may be a full-time university professor, full-time lecturer, or part-time adjunct instructor; the course enrolls a maximum of 20 undergraduate students, mostly students pursuing physics majors or minors. I conducted this research study in a single physics course, of the two *[entry-level upper-division physics]* courses offered, that was taught by one tenured faculty member from the physics department and involved the participation of seven transfer student physics majors and six regular-admit students. I chose to observe this single section of the entry-level upper-division physics course due to the number of transfer and regular-admit physics students enrolled in the class. While collecting data for this study, I sampled five 75-minute classes to gather approximately 14 hours of classroom interaction data (e.g., lecture and group work). After screening the participants based on matriculation status as a part of conducting a purposeful sampling, data were collected using instruments including surveys, interviews, and classroom observations. These data involved (a) capturing video and audio recordings of student interactions (i.e., student-instructor, student-student); (b) making written recordings of contextual observations in field notes at two-minute intervals using the Smith et al.'s (2013) COPUS instrument (attached in Appendix A); (c) administering pre- and post-surveys which provided information needed to screen participants to identify their matriculation status, the length of time the participants had been studying at the Grand Lakes University campus, their students' ability beliefs, expectations for success, and the value students attached to participation in physics coursework using Wigfield and Eccles (2000) Ability Beliefs and Subjective Task Values survey instrument (attached in Appendix B); (d) conducting semi-structured individual interviews using a modified version of the Weidman and Stein (2003) interview questionnaire (attached in Appendix C) to gather perspectives related to socialization; and (e) conducting faculty interviews using an interview questionnaire (attached in Appendix H). I coded the observational and focus group data to identify emerging themes related to (a) transfer students' interactions,

actions, and responses or (b) phenomena indirectly related to transfer students' experiences.

Solicitation of Participants

This study included regular-admit physics majors, transfer physics majors, and faculty participants. Both students and faculty participated in the classroom observation component of the study (capturing video and audio recordings of student interactions (i.e., utterances) *and* making written recordings of contextual observations in field notes at two-minute intervals using Smith et al.'s (2013) COPUS instrument (attached in Appendix A). Regular-admit and transfer physics students enrolled in one upper-division physics course completed the Wigfield and Eccles (2000) Ability Beliefs and Subjective Task Values survey instrument (attached in Appendix B) twice, during weeks two and twelve of the academic semester. Transfer physics majors participated in individual interviews using a modified version of the Weidman and Stein (2003) interview questionnaire (attached in Appendix C) to gather perspectives related to socialization. Lastly, the physics course instructor participated in an individual interview using an interview questionnaire via email and the administration of in-person follow up questions in the within the physics classroom (attached in Appendix H).

The use of multiple data collection instruments, administered to a variety of participants, necessitates multiple solicitations and acquisition of multiple consents for each portion of the study. For the classroom observation and survey portion of the study, I solicited student and faculty participants in person (Solicitation forms are presented in Appendix E-G) within the lecture portion of the upper-division physics course (see solicitation script and consent form attached in Appendix E). I solicited nine transfer physics majors, seven of whom participated in the classroom observation and completed surveys, five of whom participated in individual interviews using a modified version of the Weidman and Stein (2003) interview questionnaire via email solicitation (instrument and solicitation script attached in Appendix C). Lastly, I solicited the faculty member via email to participate in individual interviews using an interview questionnaire and solicitation script (attached in Appendix H).

Data Collection and Instrumentation

I observed several factors and completed comparative analyses across several areas including but not limited to (a) the type of instructional methods the faculty member employed when disseminating physics content; (b) connections between the types of instructional pedagogy (i.e., activity structure) and the extent of interactions among physics students; (c) social language use between students in upper-division physics classrooms; (d) pre- and post-surveys of students' ability beliefs, expectations for course experiences, and task-value beliefs related to physics coursework; (e) gathering the perspectives of transfer physics majors' previous educational and socialization experiences by posing semi-structured questions within individual interviews; and lastly, (f) gathered the faculty member's beliefs related to transfer students' abilities, motivations for studies, and participation rates while enrolled in upper-division physics courses at Grand Lakes University.

Informed Consent

Before collecting data associated with any of the previously mentioned instruments, I presented and explained an informed consent form to all study participants. Additionally, I described the purpose of the study and methods of data collection to participants (e.g., students, faculty instructors) and provided opportunities for the participants to ask questions. Participation was voluntary, and participation or refusal to participate did not impact participation or the assessment of coursework, employment, or any other relationships with the university. To ensure confidentiality and to minimize coercion of any participant by the researcher or other participants, I informed individuals that they could turn in unsigned consent forms if they did not wish to participate in this study. Since I collected the participation consent forms prior to engaging in data collection, no other participants knew if others chose not to participate in this study. Data associated with unwilling participants was not included in the analysis or dissemination of research findings.

Additionally, I defined and described any risks associated with participation, and that there were no monetary or grade-based awards or incentives for participating. Once participants agreed to participate in any portion of this research study (e.g., classroom observations, surveys, and individual interviews), they signed the informed consent form associated with each and every portion of the study. I provided a copy of the form for their personal records. I stored electronic or paper-based data in a secure location, such as a locked filing cabinet or on a secure computer (i.e., password-protected) in my office at Grand Lakes University. A pseudonym was assigned to participant data *and* school logos or facial features were digitally masked when disseminating findings (i.e., publication of data and findings) to protect the participants' privacy and confidentiality.

Classroom Observations and Surveys

During the classroom observations, five classroom sessions were audio and video recorded and transcribed verbatim. Additionally, detailed field notes were used to record interactions in the classroom setting. Data related to student-instructor interactional patterns emerged during large and small group settings. First, the total number of teacher and student-initiated interactions were tallied. Next, the frequency of student and instructor on-topic utterances were coded and analyzed to identify the distribution (i.e., extent) and development of social language (i.e., physics-related language use) at the group and individual level. Last, to identify the extent and development of critical thinking in problem solving contexts I used Thompson's (2018) modified version of the critical thinking metrics of Garrison (1992) and Newman, Webb & Cochrane (1995) to code and analyze both students, and in limited instances, instructor verbal interactions. The classroom data provide insight into the class instructor's, groups of students', and individual student's actions or interactions, which often represent the manifestation of myriad sociocultural influences. The classroom observation revealed that the frequency of student-instructor and student-student interactions varied across participants in small and large group settings. Furthermore, the distribution, development, and adaptation of students' use of discipline-specific social language varied across students throughout the academic semester.

Data collection occurred through the use of video and audio data intended to capture instructor-student and student-student interactions within upper-division physics classrooms. The use of observations recorded in field notes at 2-minute intervals (using the COPUS instrument), pre- and post-surveys administered on paper within the lecture portion of physics classes (unwilling participants turned in blank surveys), individual interviews with transfer students to capture perspectives related to student socialization experiences, and last, individual faculty member email-based survey and follow-up interview questions to gather instructor perspectives related to transfer physics majors enrolled in upper-division physics courses. I entered the field at the beginning of the spring semester of the 2019-2020 academic year to capture aspects of the socialization process transfer students experience at the transfer receiving institution. The initial research plan involved performing ten classroom field observations throughout the span of an academic semester; however, a shift from in-person to online remote-learning structures due to the onset of the COVID-19 pandemic during the eighth week of the academic semester hampered my ability to perform classroom observations. For the remainder of the semester, the course instructor conducted the class meetings using video conferencing software, hampering my ability to observe student-student interactions in the remote learning setting. Fortunately, a large amount of classroom observation data was collected during the initial five weeks of the in-person class meetings, allowing for the characterization of classroom interactions and social language use dynamics (i.e., distribution, development, and adaptations in physics-related conversations) within small group settings. Typically, during normal circumstances, each upper-division physics course at Grand Lakes University meets twice weekly for a period of 75 minutes. The [upper division physics] course required a weekly 75-minute supplemental instruction class meeting beyond the two 75-minute classes, and the [entry-level upper-division physics] course had a laboratory requirement, meeting once weekly for a period of 180 minutes.

I prioritized collecting data in the [entry-level upper division physics] course, the first course transfer physics majors traditionally enroll within after matriculating as physics majors at Grand Lakes University. Additionally, of the two [entry-level upper division physics] offered during the academic semester, I chose to conduct this research study in the section that enrolled the largest number of transfer students (9 transfer physics majors and 7 regular-admit students; 5 regular-admit students pursuing physics majors and 2 regular-admit students pursuing physics minors). I collected data during the period of time associated within a single semester. I employed verbatim transcription methods of audio recordings to capture data related to participant interactions during classroom instruction and during individual student interviews. I collected classroom observational data over the period of the on-campus class meetings to prolong the engagement and account for possible changes in the dynamic and potentially time-changing nature of the participants' social language use or relevant classroom activities. I administered the initial (paper-based pre-survey) to all students enrolled in the upper-division physics class at the beginning of the semester (around week two of the semester), and an electronic-based post-survey prior to collecting student interview data (around week twelve) of the sixteen-week semester.

Next, I collected additional data in the form of field notes (at two-minute intervals during class) related to the class environment (e.g., description of the learning space, seating arrangement, whether or not interaction occurred, etc. using the COPUS instrument, a STEM specific observation tool used to characterize classroom interactions and activities) to supplement voice transcripts. The field notes consisted of detailed descriptions of the environment and participant interactions, as well as researcher comments, including insights and questions regarding meanings of observations (Larrabee, 2009). Audio, video, and observational transcripts played an important role in providing detailed descriptions and an audit trail to increase the dependability and confirmability of data related to participants' social language or other relevant activities or interactions (Geertz, 1973; Lincoln & Guba, 1985).

Student Interviews

I collected data through the use of individual student interviews composed of transfer physics majors, which allowed for the cross-comparison of transfer students' perspectives relative to their experiences related to socialization after transferring from another institution (presumably a community college, or four-year university), within upper-division physics classrooms at Grand Lakes University. Student perspectives related to these topics provide an understanding of factors that mediate behaviors and their motivations for physics studies. The questionnaire was adapted to reflect transfer students' physics-related or other relevant educational experiences prior to attending Grand Lakes University, while transitioning to Grand Lakes University from transfer-sending institutions, and during their initial academic semesters at Grand Lakes University.I collected audio and video data, written field notes, and then transcribed the student interview data after probing students about their experiences within upper-division physics courses. According to Morgan (1994), student interviews "draw upon respondents' perspectives related to attitudes, feelings, beliefs, experiences, and reactions in a way which would not be feasible using other methods (e.g., observations, surveys).

Faculty Interviews

I collected data along with written field notes while using an interview questionnaire (administered via email) to gather the course instructor's beliefs about transfer students' physics related abilities, their expectations for successful completion of physics coursework, their motivations for participation in physics coursework, their use of physics-related social language, and their general interactions in the physics classroom or co-curricular settings. The previously mentioned variables represent important factors that influence the process where individuals or groups of physics majors participate in educational activities that assist in adopting ways of being, consistent with that of socialized physics majors within the academic community.

Student Interview and Faculty Interview Venue

The transfer physics major interviews were conducted via telephone questions from the Physics Education Research laboratory space, a private, quiet, and distraction free location intended to ensure participant privacy and place participants at ease. The faculty interview was initially conducted via email and followed by in-person a limited number of follow-up questions in a private setting. After I explained the interview procedures and gathered informed consent, I provided the transfer student participants and individual faculty interview participant with an opportunity to generate a variety of opinions and ideas in a time-frame designed not to exceed 90 minutes using a set of carefully predetermined interview script and questionnaire (see questionnaire in Appendix C and the faculty interview questions in Appendix H). In addition to collecting audio for the individual interviews, I compiled field notes comprised of direct observations, personal inferences related to participant responses, interview notes (e.g., information about participants and interview venue), or personal feelings or emotional reactions to responses, significant participant interactions or actions, or other relevant information related to participant responses.

Data Analysis

I organized the data analysis by labeling information according to type of media (e.g., video, audio transcripts, field notes, analytical memos, survey data, etc.), date and location collected. These data sources included transcripts from classroom interactions, field notes from classroom observations, survey data, and discussions from student interviews. When possible, I transcribed audio recordings verbatim using secure, password-protected automatic transcription software. After transcribing the audio data, I promptly read the data (e.g., transcripts and field notes) to gain a general understanding of its meaning. After I transcribed and reviewed the data, I engaged in data coding, using open or process coding schemes, followed by pattern coding to identify emerging themes in the data. I collected data, continuing the process until saturation, when I could no longer obtain information to enrich the findings, or when additional coding was no longer feasible (Fusch & Ness, 2015).

When analyzing data in discourse analyses, Gee (1999) recommends looking for patterns or links within and across utterances in order to form hypotheses related to the meaning of the verbal and nonverbal language that build an understanding of individual or group members' worldview, identity, or relationships. Before analyzing, I organized the speech data into single lines. A series of lines containing informationally salient topics consisted of stanzas about “one important event, happening, or state of affairs at one time and place, or it focuses on a specific character, theme, image, topic, or perspective” (Gee, 1999). Lastly, themes associated within and across stanzas provided thematic information that revealed large scale higher-order organization of participant utterances or thoughts called a macrostructure. Nonverbal actions and interactions were characterized at two-minute intervals using Smith et al.'s (2013) COPUS instrument (found in Appendix A). In addition to temporal descriptions of activities, I recorded other salient material aspects (e.g., classroom arrangement, movement, use of semiotic resources) in my field notes. I coded transcript data containing participant speech and the classroom observational data collected using the COPUS instrument (supplemented with field notes) using multiple coding cycles.

I analyzed transcripts and field notes using multiple coding cycles that allow researchers to index or map data relevant to a particular point to make sense of phenomena. In qualitative inquiry, a code "is most often a word or short phrase that symbolically assigns a summative, salient, essence-capturing, and/or evocative attribute for apportion of language-based or visual data" (Saldaña, 2013, p. 3). During the first coding cycle, transcripts and field notes from classroom interactions, focus groups, and classroom observations were coded using process coding that highlights the routines and rituals of human life, typically involving labeling codes using gerunds, which are words or phrases that denote action. The initial coding cycles (e.g., open, process, etc.) involved the assignment of descriptive, low-inference labels to data that provided the bases for later coding cycles. After assigning codes during the first coding cycle, I developed and compiled a codebook for the purpose of creating a set of coding standards (e.g., "the code, a brief definition, a full definition, guidelines for when to use the code, guidelines for when not to use the code, and examples") as a part of the audit trail or for use within future research projects (Saldaña, 2013).

Later coding cycles offered interpretive, although data-driven, focus on a process of meta-coding, aggregating the initial codes into a smaller number of more meaningful units, lessening the abstraction of data. In pattern coding, “inferential codes” are used to “identify an emergent theme, configuration, or explanation” (Saldaña, 2013, p. 210). Pattern coding applies to the qualitative analysis of classroom participant actions or interactions in upper-division physics courses, as this iterative coding process (i.e., process followed by pattern coding) served as a means to uncover patterns including, but not limited to, (a) the relationship between instructional pedagogy and student interactions mediated through language; (b) transfer physics majors’ social language use; (c) relevant educational activities of transfer physics majors; and (d) student perspectives regarding transfer students’ educational or socialization experiences gleaned from student interview data. Additionally, since the statistical significance was low, I did not report inferential statistical findings from survey data and did not report inferential statistical analysis (i.e., Chi-Square, ANOVA, MANOVA) of survey data.

During the analysis process, I composed analytical memos to account for preliminary assumptions, biases, reflexivity, and reactivity that may have impacted the trustworthiness of the research data or findings. Analytical memos are brief prompts for reflection to document personal relationships with the participant or phenomena, code choice for operational definitions, emergent patterns within data, problems encountered during the study, tentative answers to research questions, or anything significant to the study (Saldaña, 2013).

Trustworthiness

Rossman and Rallis (2012) argued that the trustworthiness of qualitative research is judged on standards including whether a study (a) is conducted according to norms for acceptable and competent research standards; (b) adheres to ethical standards, (c) is sensitive to the politics of the topic and the setting, and (d) is open for the inspection and critique by others. According to Lincoln and Guba (1985), research is trustworthy when measures are taken to ensure and address the credibility, transferability, dependability, confirmability, and reflexivity.

Credibility

Credibility refers to the confidence that can be placed in the truth of research findings (Korstjens & Moser, 2018). Strategies to ensure credibility include prolonged engagement, persistent observation, triangulation, and member checking (Korstjens & Moser, 2018). I aimed to increase the credibility of this study by prolonging my engagement with field participants (a) investing sufficient time to become familiar with the context and setting; (b) interacting with the data sufficiently to code, categorize, and identify emerging thematic patterns; (c) and lastly, test for misinformation within the data or findings. Persistent observation was accomplished by conducting multiple observations within the field, as such observations allow for the identification of salient characteristics or elements under the study that was investigated. Triangulation enhanced the quality of the study by gathering data through different data collection methods (e.g., audio transcripts, field notes, survey data, student and faculty interview data, analytic memoing). Persistent observation allowed for the deep focus on salient characteristics or elements within student discourses. Lastly, member checking involved providing the study participants with data, interpretations, and conclusions from whom the data originated to determine the representativeness of the data and findings.

Dependability

Dependability includes the aspect of consistency (Lincoln & Guba, 1985). I established dependability by transparently describing the research steps taken from the start of research through the development and communication of findings. I documented the research steps by maintaining records (i.e., audit trail) of the research path throughout the study. Additionally, the documentation process ensured that the chosen analytical methods were aligned with accepted standards for qualitative research designs.

Confirmability

Confirmability concerns the neutrality of research findings (Korstjens & Moser, 2018). I ensured confirmability, similar to dependability, using an audit trail. My research audit trail involved documenting a complete set of notes (e.g., analytic memo) regarding decisions made throughout the research process (e.g., the rationale for research methodology, sampling, coding, methods for determining the trustworthiness of data, data management, etc.) (Saldaña, 2013). The previously mentioned measures enable any auditor to study the transparency of the research path (Lincoln & Guba, 1985).

Transferability

Transferability concerns the aspect of applicability or generalizability of research findings to similar contexts, settings, or populations (Korstjens & Moser, 2018). I engaged in persistent observations that allow deep understanding by providing a detailed description of the salient characteristics of the elements of the participants and the research processes to allow consumers to assess whether my research findings are applicable to their own setting.

Reflexivity

Qualitative research involves acknowledging my role in the process of collecting, analyzing, and reporting data and findings, and my preconceived explicit and implicit assumptions I brought to the research (Mauthner & Doucet, 2003). To address my reflexivity, I supplemented my interview and observational data and findings with reflexive notes in the form of a research diary. Additionally, my reflexive notes included my subjective responses (e.g., critical findings, both in participant responses and observer reactions).

Special Considerations Related to Discourse Analysis

In addition to the above measures, Gee (1999) asserted that the validity of discourse analysis is not constituted by arguing as to how the data reflects reality, but acknowledges that (a) the reality imposed within the analysts' interpretation that constructs the reality of situations and (b) that language and situations are reflexive in nature, assuming each make the other meaningful. Further, Gee (1999) asserted that the validity of a discourse analysis study is open to ongoing discussion or scrutiny. According to Gee (1999), the validity of a discourse analysis is based on elements including convergence, agreement, coverage, and linguistic details. In terms of coverage, a discourse analysis is more or less valid based upon the amount of data that observations provide regarding semiotic, activity, material, political, and sociocultural aspects of social situations. Agreement involves collecting data that show repeated activity across the participant sampling associated with the above aspects of social situations, and represents a convincing qualitative study using discourse analysis methods. An analysis that covers or includes multiple data sources and types (e.g., observation, interview, and survey data) that allowed me to account for adaptations in social behavior. Lastly, the validity of analysis was tied to the details of the linguistic structure of conversations that emerged from the participant communities' use of social language or description of phenomena.

Roles of Researcher and Collaboration with Participants

Rossman and Rallis (2012) recognize that qualitative research offers a broad approach to study social phenomena. Further, qualitative methodologies allow for data gathering techniques that allow practitioners to observe the dynamic and social nature of social systems. Participant observations represent the hallmark of anthropological and sociological research (Kawulich, 2005). Marshall and Rossman (1989) define observation as "the systematic description of events, behaviors, and artifacts in the social setting chosen for study" (p.79). My personal biases will influence the research design and interpretation. Within qualitative inquiry, data are mediated directly through the researcher, a human research instrument, rather than focusing solely on the collecting data through the use of polls, questionnaires, and surveys, or by manipulating pre-existing statistical data using computational techniques (Miles & Huberman, 1994). Since my relationship or proximity to the settings and problem inevitably will influence aspects of the research design, analysis, and findings, I must explicitly address any personal assumptions or biases I hold regarding the research topic.

My experiences as a transfer physics major, a physics teacher working in high school classrooms, a mentor facilitating professional development for individuals pursuing physics teaching endorsements (i.e., requirements for certification), a physics laboratory lecturer within the higher education setting, and a student at the undergraduate and graduate levels studying physics and other topics, I recognize and believe that classroom processes, specifically activity structures related to instruction, alter students' socialization and learning experiences. My personal disposition and worldview of student socialization are heavily influenced by theoretical frameworks that help create mental models to understand sociocultural phenomena. A constructivist theory informs my understanding of the socialization process of transfer physics majors, along with the concept of social capital, which is informed and mediated by my experiences within classrooms and through studying the literature. According to Creswell and Plano Clark (2018), constructivism is an interpretive framework where individuals seek to understand their world and make meaning of their experiences through interactions with self and others. Intentionality, in instructional design within classrooms is necessary to facilitate interactions with oneself (e.g., self-reflection, self-talk) and among social others (e.g., dialogue), helping a diverse subset of learners gain a disciplinary affordance of language or other discipline-specific semiotic resources that allow learners to learn within the natural sciences (Lemke, 1990). Ideally, practitioners should engage in ongoing reflection, to consider how individual and institutional antecedent sociocultural influences impact student experiences (Osterman and Kottkamp, 2004).

My interest in this topic is multifaceted. Through my experiences, while learning physics during my undergraduate studies and a long-term career teaching high school physics, I understand the importance of instructional design to promote student interaction, particularly in using active learning teaching strategies that incorporate dialogue that exercise and make students' higher-order thought processes explicit. Additionally, as an instructional coordinator, I advocate and encourage the use of a variety of semiotic resources within instructional settings to assist faculty and other practitioners in facilitating students' understanding and encourage learning processes at higher levels of cognitive complexity.

Acting in a non-participatory role throughout the duration of upper-division physics courses (e.g., the semester), I compiled thick, detailed descriptions from observations that deeply focused on and captured salient characteristics of the phenomenon. When clarification of data was needed, I included student and faculty participants in the verification of the analysis and the interpretation of data through a process of member checking (Miles & Huberman, 1994; Lincoln & Guba, 1985; Rossman & Rallis, 2012). Involving participants in the investigation when I engaged in the member checking process helped create a deeper understanding of classroom processes and increase the trustworthiness of the research process (Miles & Huberman, 1994; Lincoln & Guba, 1985).

Ethical Considerations

Ethical considerations and the relationships between the researcher and the participants impact the trustworthiness of inquiry (Miles & Huberman, 1994; Patton, 2001; Rossman & Rallis, 2012; Salloch, Wäscher, Vollmann, & Schildmann, 2015). Assuring the rights and privacy of participants is of the highest importance. Prior to conducting any research, I sought approval from my dissertation committee and acquired IRB approval. Following participant recruitment and selection, I explained the purpose of the study, the data collection methods, and my role as a non-participatory observer. I explained any known benefits or risks associated with participation, how confidentiality and privacy was maintained, and conveyed the scope and sequence of the study. After explaining the previously mentioned aspects of the study, I asked and addressed questions the participants posed related to participation in the study. I maintained confidentiality and minimized coercion of any participant by the researcher or other participants by informing individuals that they could turn in unsigned consent forms if they did not wish to participate in the study. Since I collected the participation consent forms prior to engaging in data collection, no other participants knew if other students chose not to participate in this study.

Summary

I designed the multi-method qualitative inquiry described in this chapter to gain an understanding of transfer physics majors' socialization experiences (e.g., use and adaptation of social language, relevant activities or interactions, attitudes or beliefs regarding ability, expectations, perceived utility of content knowledge, or other perspectives related to socialization) while participating in upper-division university physics classrooms or co-curricular activities at Grand Lakes University. The use of multi-method qualitative research approaches to inquiry shed light on the complex relations among individual and institutional sociocultural factors that influence students' participation in classroom or co-curricular activities. Participation in these achievement-related behaviors also play an important role in transfer physics majors' socialization or their adoption of ways being similar to that of physics majors. Further, I discussed the reciprocal relationship between how the research and researcher impact one another and defined my personal assumptions and experiences related to the phenomenon. Lastly, I discussed steps I will take to protect the integrity of the research and the safety and privacy of the participants.

Chapter IV

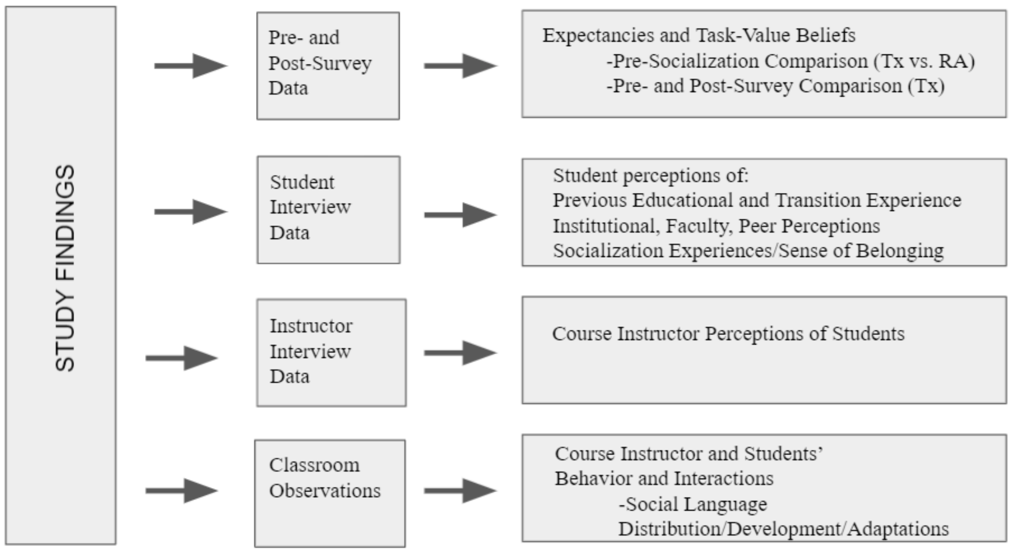
Findings Related to Psychosocial Influences

The purpose of this study was to gain an understanding of how transfer physics students' participation in educational activities was influenced by a host of individual psychosocial factors, such as their beliefs about their own capacity to study physics, expectations for success in physics coursework, value beliefs related to studying physics, unique past educational and transitional experiences, institutional perceptions, perceptions of faculty and peers, how transfer students experienced belonging as physics majors, their perception about the meaning of socialization, and how they experienced socialization. Additionally, this study revealed how institutional factors such as practitioners' teaching and the promotion of co-curricular activities influenced students' participation in educational activities.

The data in this study revealed insights about students' beliefs related to psychosocial factors (student survey, student interview data in this chapter), followed by attitudinal and behavioral data (classroom observations presented in Chapter V) that provide information about the course instructors' attitudes about transfer students, and the student and instructor activities and interactions in classroom settings. The data sources for this study included: Pre- and post-survey data instruments, administered at weeks two and twelve of the academic semester, that allowed for the measurement of potential changes of students' expectations for coursework outcomes, ability in physics content, and the value of physics coursework in terms of internal and external motivation factors. Next, transfer student interviews provided rich descriptions of their perceptions of and attitudes related to previous and current educational experiences, transition experiences, institutional perceptions, perceptions of faculty and peers, and the importance and meaning of socialization experiences and sense of belonging as physics students. Third, an instructor survey with a follow-up interview provided insight into the instructor's beliefs about transfer students': expectations for success in physics coursework, motives for participation in physics coursework, interactions in classroom and co-curricular settings, and physics related language use. Finally, in a separate chapter (Chapter V) I present classroom observations that allow for the observation of student and instructor activities and interactions which mediate students' achievement-related behaviors or other socialization activities. Figure 4 illustrates the presentation of the connections between the study findings and the research instruments.

Figure 4

Visual Representation of the Research Findings



Research Questions

The following research questions guided this study.

1. How do regular-admit physics students, transfer physics students, and the physics course instructor describe personal beliefs related to their own or others' (a) physics content ability; (b) expectations for success in physics studies; and (c) how values attached to the value they place on their physics studies (i.e., utility of, importance of, and interest in) change as a result of participation in upper-division physics coursework?

a) How do ability beliefs, expectations for success in physics coursework and the values students attach to physics studies influence students' participation in classroom or co-curricular activities?

2. How do individuals or groups of transfer physics majors or the physics instructor describe their own or others' socialization experiences related to participation in upper-division physics classrooms at transfer receiving institutions?

3. In what ways do transfer physics majors enrolled in upper-division physics courses at Grand Lakes University interact when participating in classroom activities?

a) What are the larger or main activities (or sets of activities) occurring within upper-division physics classrooms at Grand Lakes University?

b) What upper-division physics classroom sub-activities comprise this or other activities?

4. To what extent do transfer physics majors enrolled in upper-division physics courses at Grand Lakes University engage in social language related to physics or other related disciplines?

a) What discipline-specific content-based social languages are relevant (i.e., closely related to physics or other related discourses) or irrelevant (i.e., not connected to physics or related discourses)?

5. How is transfer students' at Grand Lakes University use of physics-related language or classroom activities developed over time within upper-division physics classrooms?

a) How do individuals or groups of transfer physics majors adapt social language use throughout their experiences within their initial upper-division physics course?

b) How does transfer physics majors' use of social language or activities become stabilized or transformed?

Summary of Upcoming Findings

As will be seen in this chapter, transfer physics students' participation in classroom and co-curricular activities were mediated by their: ability and motivational beliefs related to physics studies, course instructor's teaching approach and beliefs about students, educational experiences such as previous educational experiences studying physics, transitional experiences, perceptions of the university and the physics department, their relationships with professors and/or classmates, students' interpretations of the meaning of socialization, how they experience socialization, the importance students place on belonging as physics majors, and how they experience belonging as physics majors.

As a whole, transfer students possessed positive motivational beliefs, expectations for success in their physics studies, and beliefs about their capacity to complete physics coursework. These findings were consistent with classroom observational data as the majority of transfer students regularly participated in classroom activities and experienced physics-based language development over the time of their participation within the observed physics course. However, when disaggregated at the individual level, one student's motivational beliefs may have contributed to low levels of participation in classroom activities. Interestingly, some of the students who expressed lower expectations of succeeding when learning new physics content also displayed disproportionately high levels of classroom participation (discussed in detail in Chapter V), perhaps to compensate for lower ability beliefs.

The course instructor activities and beliefs also mediated transfer students' educational experiences. Also, the instructor indicated that he believed transfer physics majors' previous physics classes at other institutions failed to prepare them for advanced physics courses. The course instructor believed that these students also possessed external motivations connected to grades or occupational outcomes in relation to studying physics. Despite the course instructor’s belief in the value of collaborative interaction in classroom settings, the course instructor employed teaching techniques for a large portion of the class meeting time that constrained student interactions. However, as discussed later in Chapter V, significant findings in this study revealed that in circumstances where the course instructor encouraged group work, transfer and regular-admit physics students participated in extensive conversations using physics-based language and critical thinking while evaluating problem-solving processes.

The study results also revealed that transfer students’ motivational beliefs and academic advisors’ activities mediated their participation in physics-related co-curricular activities. Inconsistent with positive motivational beliefs in their survey responses, three of the five transfer students made statements during individual interviews that they did not attend, or did not find value in university- and department-hosted student orientation events. Two of the three students placed value on relationships with students outside of the physics major or rarely interacted with other physics students outside of class. On the other hand, one student who attended the orientation events, stated that he gained information that led to regular participation in co-curricular activities. This student attributed participation in co-curricular activities to his increased sense of belonging as a physics major and increased motivation for his physics studies.

Data collection took place at Grand Lakes University (pseudonym), a mid-sized public university located in the mid-Atlantic portion of the United States. Participants in this study included transfer students (assigned pseudonyms beginning with the letter "T"), regular-admit students (assigned pseudonyms beginning with the letter "F"), and a course instructor who taught the observed upper-division physics course connected to this study. The original research plan included collecting classroom observation data throughout ten class periods, however the shift from in-person to remote instruction, due to the COVID-19 pandemic, constrained and limited data collection in the classroom. Fortunately, large amounts of data were collected during the in-person class meetings, providing adequate data to characterize the participants' classroom interactions.

Student Survey Data

According to Eccles et al., (1983) students' achievement and participation in beneficial educational activities are predetermined by two factors: expectancies and subjective task values. Within this study, expectancy survey data was specific to individual's beliefs about their expectations for future success and content-ability in physics coursework. Expectancies are related to self-efficacy and self-concept. Self-concept involves individual beliefs about one's ability based on previous experiences. Self-efficacy is the belief that individuals have about their ability to complete academic or other related tasks.

Subjective task values corresponded with students' motivations for participation in educational activities. Student surveys provided data related to three subcategories of subjective task values. These categories included utility, attainment, and intrinsic interest. Utility value responses assisted in determining the relevance of physics studies to students' current future academic or professional goals. Attainment value responses signified students' importance of studying physics and their identity as physics majors.

Intrinsic interest value survey responses provided information about students' enjoyment or interest in physics studies.

In this section, I present survey data including (a) a comparison of transfer and regular-admit physics student expectancy and subjective task value beliefs at the beginning of their immersion in upper-division physics coursework, and (b) a comparison of transfer student survey results before and after transfer students' participation in socialization activities including upper-division physics coursework or other related co-curricular activities across the span of an academic semester.

First, the survey results served as a baseline comparison of socialized (e.g., regular-admit) and unsocialized (e.g., transfer) students' beliefs regarding their expectations for success, physics content ability, or perceived value they attached to their physics studies. The comparison of seven transfer and six regular-admit student survey responses assumed that regular-admit students were previously socialized as physics majors, as they had participated in physics coursework or other educational activities for multiple semesters at Grand Lakes University. Six of the seven transfer student participants who completed surveys were new, presumably unsocialized students, having transferred to Grand Lakes University during the current academic year and were participating in their first upper-division physics course after entering into the physics program.

Second, a comparison of survey data of six of the seven transfer student participants who completed the pre- and post-surveys administered in weeks two and twelve of the academic semester allowed for the evaluation of potential alterations in transfer students' expectations for success in physics coursework, physics-content ability beliefs, or value attached to physics studies, as a result of participation in physics coursework or other socialization activity across the span of the academic semester. Next, I present the baseline comparison of transfer and regular-admit students' expectancy and subjective task value beliefs.

Transfer and Regular-Admit Students' Baseline Expectancy and Value Beliefs

The aggregate baseline survey results (see Table 1) comparing students revealed small differences between the six regular-admit and seven transfer students' expectations for success, content ability, or value beliefs about physics studies, prior to participation in upper-division physics coursework. These results suggested positive student motivations generally support regular-admit and transfer students' achievement-related behavior, measured through participation in classroom activities or interactions, or through descriptions of individual's participation in co-curricular activities connected to the physics department or activities as related to studying physics at Grand Lakes University. This was important because expectancy or subjective task value survey responses were useful in assessing an individual's beliefs and values that influence student goals and achievement-related behavior. Students who hold lower expectations for course related success, and do not find value in physics coursework may also hold negative task-related perceptions, or may not participate in classroom or co-curricular activities.

When viewed at the aggregate level, the transfer students responded with positive responses about their expectations for success, their content ability beliefs, and the value they placed on their physics studies. However, when disaggregated at the individual expectancy question level and at the individual student level, a transfer student, Tyson reported low (i.e., below neutral Likert responses) in terms of his perceived ability in physics compared to other subjects, and in comparison, with other students. Additionally, Tyson's survey results revealed that although he believed that being good in physics was important, he was undecided if he found enjoyment in physics coursework. In addition to holding negative ability beliefs, Tyson did not participate in teacher- or student-initiated interactions in large and small group settings, nor did he collaborate with other students during group discussions centered on problem solving. Although Tyson successfully completed the course, he did not respond to solicitations for individual student interviews to clarify his responses, nor did he complete the post-survey. Albeit unconfirmed with other measures, Tyson's motivational beliefs may have mediated his classroom interactions or participation in other aspects of this research study.

A comparison of individual baseline transfer students' survey responses related to: (a) their general expectations for successfully completing physics courses during the upcoming academic semesters and (b) their beliefs about their ability to learn new things in their upcoming courses— revealed interesting differences in responses. When asked how well they expected to do in physics, aggregate survey data revealed that six of the seven transfer students expected to perform above average. One respondent (Tyson) reported a neutral response, stating that he did not expect above or below average outcomes for his physics studies. However, when asked how well they would respond to learning something new in physics, the responses shifted as four of seven respondents (Theodore, Tyson, Trenton, and Thatcher) predicted average abilities (i.e., neutral responses), two students believed they would be good, and one student believed that they would be very good at learning new physics content. Interestingly, the transfer student respondents expressed lower ability beliefs about learning new physics content in comparison to regular-admit physics students. These findings potentially indicate uncertainty of transfer students' beliefs about successful course outcomes and potentially reveal that many students possess decreased levels of self-efficacy in relation to upcoming physics course experiences (i.e., their upper-division physics coursework).

There were also differences in students' survey responses about the perceived utility of applying physics knowledge for tasks outside of their coursework or within the academic major**;** most students held positive beliefs regarding the utility value for their physics studies. However, when asked about the usefulness of physics in relation to other subjects, the survey data revealed two dominant responses (i.e., a bimodal response distribution), as four of the seven transfer students stated that physics knowledge is very important or important, where the remaining three respondents found the relative utility of physics content knowledge as moderately or slightly important. These findings indicated that some students potentially fail to see the relevance of physics content knowledge in relation to other, or future topics. These findings are significant as Bong (2001) asserted that student expectations for success and beliefs related to the value that is placed on their physics studies predicted future intentions related to participation in related coursework. These findings related to decreased expectations for successfully learning new material or decreased value attached to the utility of physics studies that have important implications for research, policy, and educational practice. The baseline comparison of transfer student and regular-admit survey responses are displayed in Table 1.

Table 1

Baseline Comparison of Transfer Student and Regular-Admit Survey Responses

How well do you expect to do in physics this year?	Very High	Above Average	Average	Below Average	Very Low
Transfer Student	0/7	6/7	1/7	0/7	0/7
	0%	86%	14%	0%	0%
Regular-Admit	3/6	1/6	2/6	0/6	0/6
	50%	17%	33%	0%	0%

How good would you be at learning something new in physics?	Very Good	Good	Acceptable	Poor	Very Poor
Transfer Student	1/7	2/7	4/7	0/7	0/7
	14%	29%	57%	0%	0%
Regular-Admit	1/6	5/6	0/6	0/6	0/6
	17%	83%	0%	0%	0%

How good in physics are you?	Very Good	Good	Acceptable	Poor	Very Poor
Transfer Student	0/7	5/7	2/7	0/7	0/7
	0%	71%	29%	0%	0%
Regular-Admit	1/6	2/6	3/6	0/6	0/6
	17%	33%	50%	0%	0%

If you were to list all the students in your class from the best to the worst in physics, where would you put yourself?	Much Better	Somewhat Better	The Same	Somewhat Worse	Much Worse
Transfer Student	0/7	4/7	2/7	1/7	0/7
	0%	57%	29%	14%	0%
Regular-Admit	1/6	2/6	2/6	1/6	0/6
	17%	33%	33%	17%	0%

Compared to most of your other school subjects, how good are you in physics?	Much Better	Somewhat Better	The Same	Somewhat Worse	Much Worse
Transfer Student	1/7	5/7	0/7	0/7	1/7
	14%	71%	0%	0%	14%
Regular-Admit	1/6	3/6	2/6	0/6	0/6
	17%	50%	33%	0%	0%

In general, how useful is what you learn in physics?	Very Important	Important	Moderately Important	Slightly Important	Not Important
Transfer Student	4/7	1/7	1/7	1/7	0/7
	57%	14%	14%	14%	0%
Regular-Admit	3/6	2/6	1/6	0/6	0/6
	50%	33%	17%	0%	0%

Compared to most of your other activities, how useful is what you learn in physics?	Very Important	Important	Moderately Important	Slightly Important	Not Important
Transfer Student	3/7	1/7	1/7	2/7	0/7
	43%	14%	14%	29%	0%
Regular-Admit	2/6	2/6	2/6	0/6	0/6
	33%	33%	33%	0%	0%

For me, being good in physics is	Very Important	Important	Moderately Important	Slightly Important	Not Important
Transfer Student	2/7	4/7	1/7	0/7	0/7
	29%	57%	14%	0%	0%
Regular-Admit	4/6	2/6	0/6	0/6	0/6
	67%	33%	0%	0%	0%

Compared to most of your other activities, how important is it for you to be good at physics?	Very Important	Important	Moderately Important	Slightly Important	Not Important
Transfer Student	1/7	4/7	2/7	0/7	0/7
	14%	57%	29%	0%	0%
Regular-Admit	0/6	3/6	3/6	0/6	0/6
	0%	50%	50%	0%	0%

In general, I find working on physics assignments interesting [fun].	Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree
Transfer Student	3/7	1/7	3/7	0/7	0/7
	43%	14%	43%	0%	0%
Regular-Admit	2/6	3/6	1/6	0/6	0/6
	33%	50%	17%	0%	0%

How much do you like doing physics?	Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree
Transfer Student	2/7	4/7	1/7	0/7	0/7
	29%	57%	14%	0%	0%
Regular-Admit	2/6	4/6	0/6	0/6	0/6
	33%	67%	0%	0%	0%

Next, I present the cross-cross comparison of transfer students' pre- and post-survey findings related to expectancy and subjective task value responses across the span of an academic semester.

Changes in Transfer Student Expectancy and Value Beliefs

The next portion of the chapter presents pre- and post-survey findings of six of the seven transfer student participants' (minus Tyson who did not complete the post-survey) expectations for success in physics coursework, physics-content ability beliefs, and values beliefs related to physics studies across the timespan of their participation in their first upper-division physics course at Grand Lakes University. The distribution of transfer students' pre- and post-survey results (see Table 2) varied across the expectancy and subjective task domains. In general, the aggregate survey results revealed slight increases in beliefs related to expectations of success in their physics course studies. Next, aggregate survey results revealed positive shifts in transfer students' beliefs as related to ability in physics, physics ability compared to other subjects and student's physics ability compared to other students. The survey responses about students' beliefs related to the value students placed on the domains such as the usefulness of, importance of, and interest in physics coursework varied across domains and across individual students.

The aggregate subjective task survey data revealed decreases in the transfer student respondents' beliefs regarding the usefulness and interest in physics coursework, or other related activities. The survey findings revealed stable responses in terms of students' beliefs related to the importance of studying physics in comparison to other educational activities. These findings indicated that student experiences throughout the academic semester may mediate individual students' perceived value of physics studies. For example, transfer several students did not place value on social relationships with their physics student peers, which seemed to impact their awareness of physics-related co-curricular activities. Also, another transfer student mentioned that he did not feel that his physics studies were relevant to his occupational goals. This student intended to pursue an engineering degree, however, he was declined admission to the Grand Lakes University engineering program. According to this student, these circumstances impacted his social and academic working relations within the physics department setting.

When viewed at the individual level, transfer student Trenton reported slight decreases in beliefs related to future course outcomes and large decreases in his perceived physics content ability regarding physics studies. As related to his reported value in studying physics, Trenton reported slight decreases in his perceived importance of physics coursework and large decreases in the perceived usefulness and interest in pursuing physics studies. These findings are significant as attainment values related to an individual's conception of identification with, or competence in a given domain (Wigfield, 1994). Wigfield's (1994) assertion suggests that students who recognize the importance of performing tasks (i.e., engaging in physics studies) will maintain motivations to set and establish goals through appropriate achievement-related choices. The remaining five transfer physics participants maintained stable and positive beliefs (i.e., neutral or greater Likert-based responses) related to the value they placed on studying physics. These findings indicate other transfer student participants initially possessed, and maintained positive motivational beliefs that supported their physics studies across the span of the observed semester.

The pre- and post- survey results are important in revealing individual and groups of physics students' expectations related to their belief that they can succeed in physics coursework, beliefs about their own physics ability, and beliefs about the value they placed on physics such as the usefulness of, importance of, and interest in physics studies. These findings indicate that most students possess motivations that support their physics studies. However, factors that mediate student experiences should be viewed at the individual level, using multiple, triangulated measures to provide a clearer picture of complex socialization processes. Disaggregated survey responses for individual student survey responses are presented in Appendix J23. The transfer student pre- and post-survey responses are displayed in Table 2.

Table 2

Comparison of Transfer Student Pre- and Post- Survey Responses

How well do you expect to do in physics this year?	Very High	Above Average	Average	Below Average	Very Low
Transfer Student (Pre-)	0/6	6/6	0/6	0/6	0/6
	0%	100%	0%	0%	0%
Transfer Student (Post-)	2/6	2/6	2/6	0/6	0/6
	33%	33%	33%	0%	0%

How good would you be at learning something new in physics?	Very Good	Good	Acceptable	Poor	Very Poor
Transfer Student (Pre-)	1/6	2/6	3/6	0/6	0/6
	17%	33%	50%	0%	0%
Transfer Student (Post-)	2/6	2/6	0/6	0/6	
	33%	33%	33%	0%	0%

How good in physics are you?	Very Good	Good	Acceptable	Poor	Very Poor
Transfer Student (Pre-)	0/6	5/6	1/6	0/6	0/6
	0%	83%	17%	0%	0%
Transfer Student (Post-)	2/6	3/6	1/6	0/6	0/6
	33%	50%	17%	0%	0%

If you were to list all the students in your class from the worst to the best in physics, where would you put yourself?	Much Better	Somewhat Better	The Same	Somewhat Worse	Much Worse
Transfer Student (Pre-)	0/6	4/6	2/6	0/6	0/6
	0%	67%	33%	0%	0%
Transfer Student (Post-)	2/6	1/6	3/6	0/6	0/6
	33%	17%	50%	0%	0%

Compared to most of your other school subjects, how good are you in physics?	Much Better	Somewhat Better	The Same	Somewhat Worse	Much Worse
Transfer Student (Pre-)	1/6	5/6	0/6	0/6	0/6
	17%	83%	0%	0%	0%
Transfer Student (Post-)	2/6	4/6	0/6	0/6	0/6
	33%	67%	0%	0%	0%

In general, how useful is what you learn in physics?	Very Important	Important	Moderately Important	Slightly Important	Not Important
Transfer Student (Pre-)	4/6	1/6	0/6	1/6	0/6
	67%	17%	0%	17%	0%
Transfer Student (Post-)	2/6	1/6	2/6	1/6	0/6
	33%	17%	33%	17%	0%

Compared to most of your other activities, how useful is what you learn in physics?	Very Important	Important	Moderately Important	Slightly Important	Not Important
Transfer Student (Pre-)	3/6	1/6	1/6	1/6	0/6
	50%	17%	17%	17%	0%
Transfer Student (Post-)	2/6	2/6	1/6	1/6	0/6
	33%	33%	17%	17%	0%

For me, being good in physics is	Very Important	Important	Moderately Important	Slightly Important	Not Important
Transfer Student (Pre-)	2/6	3/6	1/6	0/6	0/6
	33%	50%	17%	0%	0%
Transfer Student (Post-)	3/6	1/6	2/6	0/6	0/6
	50%	17%	33%	0%	0%

Compared to most of your other activities, how important is it for you to be good at physics?	Very Important	Important	Moderately Important	Slightly Important	Not Important
Transfer Student (Pre-)	1/6	4/6	1/6	0/6	0/6
	17%	67%	17%	0%	0%
Transfer Student (Post-)	2/6	3/6	1/6	0/6	0/6
	33%	50%	17%	0%	0%

In general, I find working on physics assignments interesting [fun].	Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree
Transfer Student (Pre-)	3/6	2/6	1/6	0/6	0/6
	50%	33%	17%	0%	0%
Transfer Student (Post-)	1/6	4/6	1/6	0/6	0/6
	17%	67%	17%	0%	0%

How much do you like doing physics?	Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree
Transfer Student (Pre-)	2/6	4/6	0/6	0/6	0/6
	33%	67%	0%	0%	0%
Transfer Student (Post-)	1/6	3/6	2/6	0/6	0/6
	17%	50%	33%	0%	0%

A detailed report featuring a disaggregated analysis of each survey question is presented in Appendix J. Individual student interview data presented in the next portion of the chapter provides detailed information about five of the transfer physics students' experiences studying physics. As communicated in a series of individual student portraits, these conversations provided additional insight about the nature of their expectancies and subjective task value related survey responses, and how these beliefs mediate transfer students' physics studies and other socialization experiences.

Student Interview Data

The transfer student interview responses are based on replies to questions from the use of a modified version of Deluca's (2017) semi-structured interview questions derived from Weidman and Stein's (2003) *Doctoral Student Socialization Questionnaire*. The adapted questions were designed to elicit transfer students' descriptions of: previous educational and transition experiences, perceptions of the transfer receiving institution at the university and physics department level, perceptions of faculty and peers, socialization experiences and activities, and last, students' sense of belonging.

Previous Experiences

An individual's past educational experiences represent mediating factors for their motivations, goals, and achievement-related behaviors (Bourdieu, 1986; Eccles et al.,1983). Transfer students' previous educational experiences (e.g., outcomes, interactions) influenced their decisions to pursue physics studies at Grand Lakes University. Transfer students Thatcher, Trenton, Tucker, and Theodore cited positive experiences, and Tyrell cited negative experiences that encouraged their pursuit of advanced physics studies. All of the transfer student participants described studying physics prior to enrolling at Grand Lakes in both the secondary and post-secondary level. Several transfer students attributed experiences with instructors from previous physics classes as a motivation to pursue physics or other related academic majors. One participant, Theodore, stated that he chose a physics major after completing AP coursework in high school and several physics courses at the community college level because, "[he] felt it was the most flexible option between engineering and teaching." Another transfer student, Tucker, stated that he chose physics after experiencing interest in the content and positive interactions with faculty at the community college with the aim of earning a bachelor's degree and “get[ting] into the FBI [or the CIA] [to] do counterterrorism.”

Two others, Thatcher and Trenton, stated that they originally intended to study engineering before transferring into the Grand Lakes University physics degree program. Thatcher described positive experiences while participating in Advanced Placement Physics courses in high school that led to enrolling as an engineering student. Thatcher also revealed that after experiencing academic challenges at a 4-year university, he enrolled at a community college, nearly completing an associate’s degree prior to transferring to Grand Lakes University as a physics major. Trenton cited strong mentoring by his previous professors at the community college level as a motivation for his continued physics studies. Trenton and Thatcher originally studied engineering before enrolling in the physics program at Grand Lakes University. Trenton, did not gain admission to the engineering program, and Thatcher, failed to meet the academic requirements required for continued participation in the engineering program and changed his academic major to physics.

A fifth student, Tyrell described poor experiences studying physics at the high school level and at the large 4-year university he attended before transferring to Grand Lakes University as a physics major. Tyrell’s transfer to the Grand Lakes University physics program was motivated by a lack of belonging at his previous college**,** and the feeling that his professors did not care about his academic or social growth. For example, when asked about his previous experiences studying physics, Tyrell stated that he believed the professors at the transfer-sending institution “did not care about me...or did not want for me to succeed." These findings are indicative of how their past experiences influenced participation in physics studies at Grand Lakes University and the differences in their cultural capital they gained in previous physics coursework.

Transition Experience

Students' interpretations and their perceptions of transition experiences influenced their perceptions and attitudes towards Grand Lakes University along with their perceived values of studying physics. Their transition experiences, institutional perceptions, and value beliefs about studying physics altered their participation in achievement-related behaviors in their new educational environment.

Overall, the students did not describe major challenges while transitioning from transfer-sending institutions to Grand Lakes University. When describing perceived differences in being a transfer student in comparison to a traditional regular-admit physics major, transfer student participants could not identify major differences between their own, and regular-admit majors' experiences studying physics, choosing classes, or finding their way on campus. When probed to identify differences in transfer and regular-admit student experiences, Trenton stated that "regular-admit learners may know the professors better," and student Thatcher also mentioned that "regular-admit students may have a better understanding of which professors to take." Tucker made the suggestion, consistent with the instructor's interview responses, that regular-admit students may be at an advantage since "courses at the community college level may not cover material in depth" as compared to the introductory courses (e.g., 101 courses) taught at the four-year university. Several of the students characterized their transition experiences as being "seamless" or "not insurmountable"; while others cited "no noticeable differences" between their studies at the transfer-sending and Grand Lakes University. These findings indicate that previous educational, or transition experiences did not represent sociocultural factors that negatively mediated student experiences.

Institutional Perceptions

Students' attitude and perceptions of the transfer receiving institution as a whole and the physics department, along with the perceived value and participation in socialization activities mediate individuals' motivation, goals, and achievement-related behaviors.

All five transfer student interview respondents expressed deeper connections with the physics department in the context of their upper-division coursework than in comparison to university as a whole. When asked about their relationship with the university as a whole, Trenton, a student who was participating in his second semester at Grand Lakes University, described his relationship as "a job," adding "I don't really look at [Grand Lakes University] as anything else"; while another student, Tyrell, a student who was participating in his second semester at Grand Lakes University said, "I don't feel like there's any relationship between giant university complexes and their students, like other than, like the individual level with professors." Although students did not express a deep sense of connection to the institution as a whole, bonds with the physics department, especially with educational practitioners, were evident based on the student interview findings. These bonds with faculty and their physics major peers represent the possession of social capital within the physics learning community.

When describing what it means to be a student in the physics department, Tucker a student pursuing a BA physics degree who was participating in his "next to last semester before graduating" at Grand Lakes University, said "[It's] kind of exciting to think that, you know, a very small portion of campus...I just think it's pretty cool, being in the Department of Physics." Tyrell described the meaning of being a member of the physics department recognizing that, "every new thing that we study or learn about the physical workings of our world it's, it's like that, those aspects manifests, you know, for example like everywhere around this campus there's physical principles, going on." Trenton stated, "it's a department that you intermingle with...you're learning the same subject...everybody does their own liking." Theodore articulated responses that did not relate to relationships with the department, but included statements about how affiliation with the department (a form of social capital) allowed the student to establish his goal to allow him to "set out to do what [he is] best at," as "I have always been strongest in math and science." While several students' responses indicated a sense of connectedness (i.e., social capital) with the physics department, Theodore, who was completing his first academic semester on campus, responded in a manner that did not support a strong connection with any other aspect of the institution.

Transfer Students' Perceived Value of New Student Orientation Activities

Transfer students' attitudes towards the value of new student orientation events altered their participation in future co-curricular activities within the physics department. The university and the physics department hosted new student orientation events to "introduce students to the opportunities to make the most of their [Grand Lakes University] Orientation" (Grand Lakes University, n.d.). According to the participants, new student orientation events were conducted at the university and academic-department level. The orientation events provided opportunities for students to meet their academic advisor, a physics faculty member, and other transfer physics students. According to one of the participants, during the orientation event, the physics department's academic advisor provided information about the physics program and opportunities related to curricular (e.g., course selection) and co-curricular activities. Also, during this meeting, Tyrell mentioned that the physics club president shared information about the *Society of Physics Students* (SPS), a student-based university-sanctioned academic service organization that provides resources and support for undergraduate physics students through local, regional, and national meetings. The transfer student orientation activities represented important socialization activities intended to promote social connections among students and faculty, and promote an awareness of co-curricular activities. According to the student interview results, students' perceived value of participation had both positive and negative impacts on future participation in physics-related co-curricular activities.

It should be noted that of the five students interviewed, only three attended campus-wide and the physics department hosted orientation events. Two students who did not attend new student orientation events, stated that they did not believe that attendance was necessary, citing familiarity of the campus based on themselves previously attending, or their siblings previously attending Grand Lakes University. Of the three students who attended orientation events, transfer students Trenton and Tucker stated that they did not find value in attending, and the other student, transfer student Tyrell, focused his responses on experiences at the orientation events.

When recalling his experiences at the physics department orientation, Tyrell mentioned "meeting the president of the physics club, [seeing] the physics [student] club room, and discussed a little bit of physics with people." When asked about his experience meeting or talking with other physics students, Tyrell stated that "[he] couldn't remember the [identity of the] other students, as [he] was focused on himself." Trenton recalled his campus-wide and departmental orientation experiences as a "long, long affair...that you shouldn't have to go through" as he believed "after [studying at the community college] for two years...you're already experienced enough to deal like with professors and to talk to adults, you know you, mingle with other students and then the same thing in the department...it was kind of monotonous." Theodore shared a similar sentiment, stating "I didn't feel [the orientation] was very useful…there were lots of speeches, that were mostly common sense." These responses indicated that students shared different attitudes toward the value of these socialization experiences, and these events had both positive and negative effects.

The student interview data revealed that several students who placed a low importance on attending, or did not find value in the content of orientation activities tended to have a decreased awareness of, or did not collaborate with other physics majors in dedicated student spaces (e.g., the physics club room), departmental hosted colloquium, or student conferences. These results indicate the value that transfer students attach to participation in the campus- and department-based orientation events indirectly affected their participation in important co-curricular socialization activities. Later in this section of the student interview data portion of the chapter, I will detail how varied orientation experiences may mediate how students interpret the meaning of socialization, how they experience socialization, and how they experience belonging as a physics major. The findings associated with the low value students placed on new student orientation events were connected to lower levels of social capital, embodied through some of the participants' lack of social capital (i.e., peer interactions) in co-curricular settings. Students’ lower levels of social capital may be connected to the importance they placed on social interactions with their physics major peers or a lack of knowledge of, or participation in co-curricular activities. Furthermore, these interactions may also impact students’ self-concept related to ability or the value they placed on physics studies.

Perceptions of Faculty and Peers

In this study, transfer physics majors’ perceptions of socializers such as physics faculty and their peer physics students within the physics program served to increase student motivation and achievement-related behavior while participating in physics studies at Grand Lakes University.

Student interview data revealed positive perceptions of the other physics students and physics faculty members at Grand Lakes University. For example, Thatcher said, “since returning to [Grand Lakes University]” his experiences with faculty “have been solely positive.” Other students’ reflections were also positive; comments include, “I don’t really have any bad comments to say about [faculty,] all seem pretty helpful...they all helped me when I needed [help] or asked for [help],” “[the faculty] are all doing what they are supposed to be doing,” they are “very supportive,” and their experiences with faculty are “very positive.”

The students also had generally positive perceptions of their peers within the physics department, describing their perceptions of their peers, and in some instances in terms of interactions, within the physics department as “[mostly, positive,]” or “more collaborative” in comparison to students from other academic majors. Another student mentioned that they "haven't had any issues" related to student interactions. Trenton provided descriptions that indicated neutral perceptions of other students that potentially arose from a lack of prolonged interactions with peers on campus, stating that his relationships were "pretty like generic" calling them "acquaintances." He mentioned that "because, you know you have like one or two classes with them, and you don't know their schedule...it's not like community college…[the community college was] pretty small...if you are [in] the physics degree [a regular-admit student]...they get to know each other a little bit better," Trenton's neutral perceptions of the other students may have risen from a lack of prolonged interactions with peers on campus. Lastly, Tyrell, who lived on campus and regularly engaged with his peer physics majors outside of classes, stated that he viewed his peers as "more than just colleagues, you know we're all pillars of the same building."

These findings indicated that students held varied, but generally positive perceptions of physics faculty, and to a different extent across individual respondents, peer physics majors. These results are significant as a student's perceptions of their socializer potentially influences their motivations, goals, and achievement-related behavior.

Socialization Activities and Sense of Belonging as a Physics Major

Other peer regular-admit physics majors, peer transfer physics majors, physics faculty, and staff members represent socializers who potentially mediate the transfer students' educational experiences at Grand Lakes University. The student interview data, classroom observation data (detailed later in this chapter), and survey data provided insights about students' perception and attitudes of previous educational experiences that shaped their ways of being as physics majors, and participation in physics-based educational activities.

Since socialization is the consequence of unique experiences, the findings are communicated through a series of five separate student portraits that assist in establishing connections between transfer student's background, perceptions of previous educational outcomes, transition experiences, perceptions of social others, the meaning of socialization experiences, how they experience socialization, the importance they place on a sense of belonging, and their sense of belonging as physics majors. In all cases students describe the meaning of, and how they experience socialization. Further, all recognized the importance of feeling a sense of belonging; however, they described experiencing belonging in unique ways.

Transfer Student Thatcher. After matriculating as a regular-admit engineering major and facing academic and social challenges at Grand Lakes University, Thatcher left the university to pursue studies at a community college. Upon successfully completing several semesters at the community college, Thatcher returned to Grand Lakes University as a transfer physics major. While his perceptions of Grand Lakes University as a whole were neutral, he described positive experiences about the physics department, the faculty, and his peers.

Thatcher stated that socialization as a physics major means becoming a part of a community "that I can go to with questions, being of personal or academic nature, to a support system." He said that socialization as a physics major "made [him] feel like in certain situations that [his] voice would carry more weight than others...If [people] are not inclined to listen to science or fact, I may as well just get a business major." He continued, alluding to the fact that people ignore science as "indicative of the time we live in...because I feel in these times we need more physicists, scientists in general." When asked how he experienced socialization, Thatcher stated he did so internally "through [feeling] a sense of pride and being proud of the physics department" adding "social interaction in the [physics] club room definitely makes [me] feel a sense of the community."

Thatcher stated the importance of belonging had shifted based on his overall experiences. He noted that belonging, "would have been important," but now at a point with "very distinct friends, and I'm not as worried or concerned...while I enjoy that sense of belonging, I would not necessarily classify it as important. I would put my friendships with my roommates above that sense of belonging with the [my classmates] and the department." When asked about the importance of belonging as a physics major in upper-division physics courses, Thatcher mentioned that sense of belonging led to a "sense of equality, a sense that we are on an even playing field."

Thatcher's statements placed emphasis on the importance of physics studies in terms of its status as an authoritative source of knowledge. Although emphasizing the importance of scientific knowledge, he also expressed concern about people who doubted or critiqued science as an authoritative body of knowledge, placing contingencies on his affiliation with physics majors based on others' (i.e., laypeople) view of science. These attitudes and beliefs did not appear to negatively influence his motivation towards physics studies or achievement-related behavior in classroom or co-curricular settings. Despite making these assertions, Thatcher's expectancy-value survey responses suggested high levels of, and increased value beliefs related to his physics studies and he also participated in appropriate achievement-related behaviors.

Inconsistencies between Thatcher's attainment value survey and interview responses suggested that he prioritized relationships with his non-physics major peers and placed contingencies on his participation in physics studies based on societal views on science as an authoritative voice. Both of these beliefs may mediate his task-related goals and future achievement-related behavior. According to Wigfield (1994) the importance students attach to tasks that are related to their identity can influence task-related goals. Thatcher's descriptions of curricular and co-curricular were consistent with interactions and activities observed during the classroom setting research study. However, he did not value, or attend orientation events intended to provide connections with other students or provide information about opportunities for interaction within the physics community.

Transfer Student Trenton. After transferring from a two-year community college and experiencing nonacceptance to a selective engineering program, Trenton enrolled at Grand Lakes University as a physics major. Trenton stated that he was undeterred by his nonacceptance to the engineering major, continuing that he might pursue a graduate degree in engineering as an entryway into the profession. Trenton added that "the competitive nature of engineering" and the fact that

> my GPA wasn't as good as it needed to be, I transferred to physics because…[the physics degree pathway] was pretty much on par with the...beginner level courses…[for] your first few years [of engineering,] so I figured...it wasn't that much of a difference.

Trenton likened his connection to the institution as “a job,” where students have an opportunity to “get your education” by “doing different things” in the aim of pursuing “fields...that you like.” When asked about his place in the physics major, he said

> I kind of enjoy it, you know it’s not what I expected, but it’s better than I expected...because everybody in the physics department is cool...so for now I’m going to stick with [physics] and possibly in the future...pursue a master’s degree in engineering...and maybe up to a doctorate.

Trenton described the meaning of socialization as a physics major as “pretty important” adding that he experienced socialization through a process where a group[s] of people, or even with just one person,” that “bounce[d] ideas off of each other” to “understand the subject better.” Trenton added that this process involves partnerships where more knowledgeable others assist others by “explain[ing] [content] to [other students], rather than them [solving problems independently].” Trenton’s understanding of the importance of collaborative problem solving was solidified after working in isolation when instruction shifted from in-person classes to online learning structures as a result of the COVID-19 pandemic.

Trenton described the importance of a sense of belonging as a physics major in terms of encouraging motivation to “do work.” He described his understanding of the importance of belonging using third person references stating:

> if there’s one person in a group who doesn’t feel like they belong in [the group,] or even the degree, their work isn’t going to be that good. They’re not going to be motivated to do any work or they don’t have that passion to do work...if you feel

like you belong, you don't feel like you want to let everyone down, so you give that extra boost to do better work.

When asked about the importance of a sense of belonging within the physics program, Trenton stated that belonging was "very important." Trenton stated he experienced belonging by "find[ing] his own group that thinks similar to me, or acts similar to me...I don't want to let them down." When asked to identify, "them," Trenton stated that his collaborators

pretty much change every class, when I start a new class, it's like ok, get the lay of the land...once you figure out who's who, you get your acquaintances, sometimes it's friends; so [my peer group] changes. Pretty much every class, unless there is somebody I know.

Trenton's reply signifies that after a full year of academic studies, despite enrolling in upper-division physics courses, he did not provide an affirmative answer whether or not he feels a sense of belonging, however states the need to negotiate his social place among other learners, which varied in "every class" and is contingent on other students. He elaborated by stating, "you start chit-chatting and then you discover that you know one person who had the same path. So I think after the first semester is when it really clicked that I'm not alone, there's other people who have similar paths." He stated his sense of belonging in terms of having similar paths,

kind of made me relieved, because...I was like not anxious, but it was like a weight on top of me...I was going to go into engineering…and then when I didn't [gain acceptance to the Grand Lakes Engineering program], [I] discovered that...it's not abnormal to go from an engineering degree from a community college, and then transfer as a physics major...if we're all in this together then...I can now figure out my own plan. Finally, and most significant, Trenton stated that he "[didn't] really interact with people...unless [he had] to."

While Trenton spoke about his own experiences, he often used hypothetical situations using third person references to explain his beliefs regarding socialization experiences and sense of belonging in the physics community. When describing the importance of experiencing belonging as a physics major Trenton continued to use third person references stating that,

> [if] there's one person in a group, doesn't feel like they belong in that, or even in the degree. The work is not gonna be that good. They're not going to be motivated to do any work, or they don't have that, like, passion to do the work. So, yeah, they'll do it, and to them it just might be a grade or, you know, they're just shooting for a C to pass.

The use of third person language reference patterns indicate that Trenton potentially is distancing himself from the topic of conversation from his own personal identity, perhaps from a lack of first-hand experiences as a new physics major. For example, Trenton frequently used third-person pronouns such as, "they" or "him" when describing relevant socialization experiences. Trenton's survey responses revealed that he was a new student at Grand Lakes University and student interview data revealed that he rarely spends time on campus noting, "I won't go out of my way to be on campus...like unless something special is going on."

Additionally, Trenton expressed a limited interest in physics, and he viewed physics, or other studies as important pathways that offered utility in terms of entering the workforce. Similar to Trenton's interview responses, his subjective-task value survey responses, a measure of motivation for physics studies, revealed negative changes in his perceptions of the importance of, use for, and interest in physics studies. During follow-up questions, Trenton attributed the negative changes on his survey responses to shift from in-person, to online course meetings during the COVID-19 pandemic, stating that "[I] felt the [online] classes were not as interesting...they were not as good as the in-person classes [at Grand Lakes University.]" When asked if he feels that his physics coursework was useful, important, and interesting, he stated that "the physics classes are important and interesting, but I'm not sure the [physics degree courses] are as good as engineering courses for most jobs I'm looking for." These findings indicate that Trenton emphasized the occupational utility of his coursework. These findings did not appear to impact his classroom participation, although he did not engage in co-curricular activities.

Beyond expressing a limited interest in physics studies, Trenton's interview responses revealed that he placed an importance on collaborating with groups of students who possess shared interests and values in promoting a sense of belonging in the physics major. However, he admitted to rarely interacting with his physics major peers outside of physics classes and described affiliations with other students and also experienced non-acceptance to the engineering program. Trenton's preferences for relationships with peers with shared identities outside of physics disciplines corresponded with decreases in attainment values. Attainment values signal individuals' perceived value of importance of tasks attached to their identity (Wigfield, 1994). Decreased attainment values can potentially mediate task-related values, student goals, and achievement-related behavior. Trenton's decreased subjective task value responses, particularly in terms of the importance he places on his identity as a physics major, and interactions with peers in the physics major could potentially result in decreases in his future expectations for success or content-based ability beliefs, especially as he enrolls in more challenging courses within the physics major.

Trenton described the importance of interactions in gaining an understanding of physics or other content. Interview findings revealed descriptions of interactions with students and instructors in class settings. During classroom observations, Trenton was overrepresented in comparison to most other students in terms of student-student and student-instructor interactions in both large and small group settings. Although he stated the importance of interaction, Trenton did not engage in peer interactions in co-curricular settings such as the physics club room, colloquium, or other student conferences such as *PhysCon*, sponsored by the *Society of Physics Students*.

Transfer Student Tucker. After transferring from a community college, Tucker enrolled as a physics major, asserting that this course of study offered utility and was important to his goals as he said, "learning physics is a gateway for other things." In general, he described positive experiences with transition, the institution, faculty, and peers while participating in physics studies.

Tucker defined the meaning of socialization in terms of gaining an understanding of "how the world works" in order to "apply that [knowledge]...in other aspects." He stated that his instructors "pushed me further along, getting deeper into the physics community." When the interviewer asked how he interacted with his peers, he described meeting with students in public spaces in residence halls to "finish projects." After the interviewer questioned if he was cognizant of his own socialization as a physics major, he said that "it was definitely something I was aware of...it didn't kick in until this semester," referring to his first semester of his final year studying at Grand Lakes University.

Tucker described the importance of belonging in terms of confidence, he stated "if you feel like you belong, the confidence level definitely goes up. If you feel out of place and you don't know what's going on, you're kind of stumbling along." When commenting on his sense of belonging, he said,

> I'm pretty basically, Okay, I don't have any direct issues...sometimes I feel like why am I here? But I know it's because I can, I'm okay doing the math and doing the actual physics itself, it's more of a...issue of interest, rather than an issue of capability.

Tucker mentioned that he first experienced a sense of belonging as a physics major while enrolled in an introductory electricity and magnetism course that he completed while studying at Grand Lakes University. He experienced a sense of belonging as a physics major when other non-major students sought his assistance with physics content. He said this experience "probably did help my belonging in a sense that you know, oh, you're the physics major, how do we do this kind of thing. And it was like, I do know how to do it."

Tucker's interview and survey data consistently described his motivational beliefs regarding physics studies. During this interview Tucker cited utility beliefs such as the applicability of physics content knowledge (e.g., ballistics as related to kinematics) to his future military career aspirations. Survey data that suggested that Tucker placed an importance on the utility of what he learned in physics as related to other tasks and the use of physics content knowledge in relation to other subjects were consistent with his beliefs. Furthermore, while saying that learning physics was fun, as these activities differentiated him from laypeople, he also expressed the belief that his motives were founded on the basis of his own physics and math content ability, which aligned with his interest in the subject matter. Tucker's descriptions related to interest in studying physics were consistent with survey data that revealed that he enjoyed completing physics assignments and he liked studying physics.

His descriptions of the perceived value of social interactions in promoting a sense of belonging were consistent with his participation in classroom settings. Tucker's classroom participation activities aligned with his beliefs, as he consistently engaged in social interactions within the classroom. However, Tucker stated that he did not attend campus-wide or departmental orientation events, nor did he regularly engage other physics majors or faculty outside of the classroom.

Transfer Student Tyrell. Tyrell enrolled as a physics major after initially studying mathematics and engineering at a large four-year university. Tyrell did not identify any challenges during transition. He expressed positive experiences regarding Grand Lakes University and the physics department, declaring that "it's the epitome of a university environment...there's everything you could want and need." Although he did not describe extensive social relationships, he maintained a close relationship with his roommate, a regular-admit physics major at Grand Lakes University.

Tyrell stated that socialization as a physics major entails "people talking about physics...trying to extract physics knowledge or insights from each other, or...by doing physics work." When probed about how he experiences socialization, he described the concept of memes, describing physics in terms of Richard Dawkins' (1976) meme theory defining socialization as "something sociocultural that's passed down from generation to generation." Tyrell added that

> there's a certain charity between most living physicists...and people who studied physics in the past...and one of those memes...is the textbook…and everyone goes through phases...while taking physics classes...you're going through these textbooks, which has become societal norms, or memes for physics students.

He expanded his explanation of socialization stating that,

> there is a culture that's being extended, and also constructed upon, just as simply by becoming a physicist, taking the courses, and reading the same textbooks and authors that most other physicists...read....and also the fact that everyone else around me, as a student that is also interacting with the same resources.

When asked if interactions with social others played a role is his socialization Tyrell stated,

> that generally for like myself...and...other physics students, we are flowing in the same path, and it's interaction with your physics professors is one of the ways in which a more broader or deeper understanding of physics in general comes about. It's probably, maybe not necessary, but it's a supplementary, or complementary component, interacting with those works,

Tyrell extended his thinking by mentioning conversations related to seminal physics textbooks such as Young and Freedman's (1949) *University Physics* with members of the Grand Lakes University physics faculty. He continued to state that "it seems like there's only...a few people in the [physics major student community at Grand Lakes University]...that have these obsessions, deeper insight, or appreciation for physics." Tyrell continued, stating that his roommate named Felix, a regular-admit student who also participated in this study, regularly became a part of conversations about how immersion in courses plays on student socialization. Tyrell continued by saying that the experience of going through [upper-division course], "is one that you're taking a historical journey, and you're seeing like the evolution of your field," meaning the evolution of physics as a body of knowledge.

Tyrell spoke of the importance of belonging recognizing that during his "first experience with academia," he said the other institution "[had] no sense of community and I didn't feel like there was any opportunity. I didn't feel like people cared about me, or like wanted to help me out or see me succeed." Tyrell went on to explain that after transferring, "I was not at [Grand Lakes University] very long," before he experienced socialization through attending orientation events and through participation in the Society of Physics Students, Physics Congress event called *PhysCon*, the "largest known gathering of physics students in the United States" (2021). Tyrell described this experience by saying,

> students went to *PhysCon* because they are extremely passionate about physics, so I'm surrounded by like-minded people. There [were] tons of professors, and they were all so friendly...giving out their business cards, [saying] like you can email me, you can call me, whatever. I got to ask questions...about life as a physicist or graduate school.

At that moment, he first experienced a sense of belonging, stating, "it was the first experience where I truly thought I wasn't alone," going on to define what belonging as a physics major meant to him, Tyrell stated that "immediately you get resources, you get access to different people...the kind of people, you know the people in this community...that are going to construct a superior world."

Tyrell's interview responses indicated that he places a high level of importance on his physics studies. Additionally, his self-proclaimed passion for learning physics through extensive interactions with social others and semiotic resources such as physics literature indicate high levels of intrinsic interest in the subject matter. Lastly, Tyrell's description of accumulating social capital after gaining entry to the physics community is consistent with high utility beliefs associated with physics studies. These findings are consistent with high levels of task value beliefs reported in Tyrell's survey responses.

Tyrell's responses indicated that he expresses an understanding of, and recognizes the importance of social interactions and experiencing socialization and a sense of belonging as a physics major. Interview findings regarding Tyrell's descriptions of curricular and co-curricular activities support these beliefs. Lastly, Tyrell engaged in classroom activities that support his beliefs regarding the importance and interest in studying physics.

Transfer Student Theodore. Theodore, stated that he chose a physics major after completing several physics courses at the high school and community college levels because, "[he] felt it was the most flexible option between engineering and teaching," He did not describe challenges or concerns during his transition to Grand Lakes University and stated his experiences with faculty were "positive," adding, "they're willing to help whenever we need to, I usually don't take the open offer, so I can't say too much." Theodore added that his experience with peers were "positive, mostly" as "I usually try to keep to my own business, but when I do interact with the people who are willing to work together, [they are] generally pleasant." When describing the meaning of socialization as a physics major, he stated that he has "[the ability] to work with people when he needs to." When asked about what it means to be a member of the physics community, he stated that, "I have already long thought of myself as a physics person, I'm always trying to understand the topic because that's what I'm most drawn to," adding "I haven't thought much about what it means in the physics community other than the thought I've put into becoming a teacher."

When asked how he experiences socialization, Theodore stated "self-study and cooperative tasks." When probed about the nature of personal self-study he said that

> when a new concept is given, I work on whatever is assigned to me and I know that that's usually enough for me to understand the concepts. When [I don't understand], I go through more of the information until I feel like I've assimilated.

Theodore described self-study resources including his class notes and video content from the internet. When explaining his socialization through participation in cooperative tasks, he stated that collaboration occurs "in the classroom when we are cooperating, usually we'll be working [inaudible] and bouncing ideas off of each other." When asked if he experiences socialization outside of the classroom, in spaces like the physics club room, he replied "I didn't know there was a physics club room."

When asked about the importance of experiencing a sense of belonging as a physics major, he said the importance of belonging was "mostly internal," adding

> I don't need to go out and seek other students to validate my status as a physics student, I think most of us just like to keep to ourselves...I feel like studying physics is internally important to me, but I don't feel an external need for validation.

When asked about his experience within the physics major program, if he experienced a sense of belonging, he replied, "I suppose, yeah...I know everyone's there for the same general reasons I am, and everyone is relatively competent and able to cooperate." While he stated that he was not able to identify a moment when he first experienced a sense of belonging, he said, "the closest thing was when I needed to work with the group, I ended up working with them most of the time."

Theodore's interview responses indicated intrinsic interest and utility beliefs that motivate his physics studies. Theodores's responses regarding the versatility of studying physics indicated external motivations related to his occupational goals. Additionally, other responses regarding his interest in physics topics, coupled with the fact that he reported completing physics courses offered at the high school and community college levels indicate intrinsic interest in studying physics. The interview findings were consistent with survey findings revealing beliefs about the utility, importance, and intrinsic interest in studying physics.

Theodore's responses regarding interaction with faculty and peers indicated a preference to engage in self-study as well as interacting with other physics students in classroom settings. The classroom observations revealed that Theodore contributed to appropriate, although slightly disparate (lower levels of) physics related language use in small group settings. At pivotal moments during classroom discussions, he acted in the role of a more knowledgeable other, often using high level thinking skills to rationalize his assertions. However, Theodore tended to display lower levels of participation and large group settings. These results indicated that his motivations for physics studies transcends his perceived importance of social interactions in larger communal activities. Despite possessing high levels of motivation expressed through survey and interview data, at the time of the research study, Theodore was unaware of opportunities for interaction with his physics major peers in co-curricular spaces such as the physics club room.

Summary of Student Interview Data

The student interview data revealed much variation in the way that the transfer student participants described their interpretations of the meaning of socialization, how they experienced socialization, and although deemed important by all of the participants, the value that they placed on experiencing a sense of belonging as a physics major. The student responses around the meaning of socialization revealed a focus on interaction and making meaning of physics content, whereas their descriptions of how they experienced socialization were centered around interacting with social others or physics-related social artifacts. While all of the students' responses emphasized the importance of a sense of belonging, their statements revealed variation in the value they placed on belonging as related to the importance they placed on social relations with their physics major peers. These results are significant as an individual’s sense of belonging is an indicator of one’s social capital (Ahn & Davis, 2020; Wellman, Haase, Witte & Hampton, 2001). When viewed from a constructivist viewpoint, findings related to student's experiences and interpretations connected to adopting ways of being and gaining a sense of belonging as a physics major were shaped by a complex network of individual and institutional sociocultural influences.

These influences included one's own: previous cultural and social experiences, motivations for participation in physics studies, students' participation in and attitudes regarding socialization activities (e.g., new student orientations, interactions with peers, practitioners, other socializers, semiotic resources such as books or video content) that within the context of the Grand Lakes University were facilitated through interaction with critical stakeholders such as other students, academic advisors, and faculty within the physics department.

The academic advisors who facilitated new student orientation events were not included in this research study. Although inferred through participant interview data, the academic advisors' activities within the context of new student orientation events served to mediate students' awareness of and participation in socialization activities intended to bolster students' sense of belonging and social capital within the academic community. For unknown reasons, the academic advisors' facilitation of orientation activities did not always result in students' participation in beneficial socialization activities. Next, I present instructor interview data that sheds light on practitioners' beliefs about transfer and regular-admit students' expectations for success, motivations for participation, interactional tendencies, and more specifically discipline specific language use — as related to physics studies.

Instructor Interview Data

An instructor interview was conducted during the latter half of the academic semester. Due to logistical concerns associated with the COVID-19 pandemic, the instructor expressed the need to answer the interview questions via email in lieu of in-person or telephone interviews. This section of the chapter, I present information about the instructor's beliefs about: transfer physics students' expectations for success in physics coursework (i.e., expectancies), transfer students' motivations for studying physics (i.e., subjective task values), transfer students' physics-based language use, and the instructor's beliefs about the nature and value of their participation in physics studies. Importantly, the course instructor's beliefs about transfer students were grounded in generalizations based on recollections of conversations with transfer physics students enrolled in upper-division physics courses during previous academic semesters. These conversations informed the course instructor's views of the students' physics-related expectancy beliefs, motivational beliefs, aspects of educational activities such as language use, and other educational interactions. Significantly, the instructor's interview responses regarding beliefs about students' expectation for success, physics-related ability, and motives for studying physics contradicted student beliefs revealed within Chapter IV student survey and interview response data. Also, the course instructor's beliefs regarding transfer students' classroom interactions and social language use contradicted observational findings related to students' achievement-related behavior presented in Chapter V. First, I present data related to the instructor's beliefs about how students' experiences mediate their expectancy beliefs.

Instructor Beliefs About Student Expectancies

The instructor expressed personal beliefs about the students' expectancies (i.e., physics-related self-concept) based on the testimony of transfer students who participated in coursework during previous semesters. The instructor believed transfer students' previous educational experiences impacted the transfer physics majors (the population as a whole) expectations for success in physics coursework at Grand Lakes University. For example, the instructor said, “some students [from previous academic semesters] indicated that they were not introduced to some concepts when they enrolled in the introductory courses at their other school.” When discussing previous transfer students’ accounts of their expectancy beliefs, the instructor stated that “many” of the transfer students voiced an opinion that they “seem to feel that they missed-out on some content or some rigor, so [the transfer students] may feel a little behind when they start [at Grand Lakes University].” When describing transfer students’ level of preparation for advanced physics studies the instructor said, “several [other previous transfer students] have indicated that the [entry-level upper-division physics course] at Grand Lakes University [is] more intense than the courses they took before coming to [Grand Lakes University].”

These findings indicate that the course instructor believes that previous educational experiences, such as coursework completed prior to enrolling at Grand Lakes University, mediate transfer student expectancies. Interestingly, the course instructor’s generalizations about transfer students’ expectancy beliefs contrast six out of seven transfer student participants’ survey responses, who expressed positive ability beliefs and held positive expectations for success in their physics coursework.

Instructor's Beliefs About Student Motivational Beliefs

The instructor expressed an understanding of students' subjective task value beliefs (i.e., motivational beliefs) based on student testimony of transfer students who participated in coursework during previous semesters. The course instructor made assertions that transfer students hold low attainment value beliefs (the importance of their physics studies) and held utility value beliefs connected to internal and external motivations. For example, as related to student attainment value beliefs, the course instructor recounted students' beliefs about the importance of their physics studies, stating "[transfer students] do not feel that they need to perform at a high level in the coursework" and transfer students' utility-based motives for participation include "[the transfer students] want[ing] an A," while many others said, "[they] seem to want to just get a reasonable passing grade."

While recounting beliefs about previous (not included in this study) transfer students' motivational beliefs related to interest and utility, the instructor said, "although there are many exceptions to [these] notions...at the [entry-level upper-division physics course] stage, it is not clear to me that [both transfer and regular-admit] students feel the knowledge is generally useful, but I have the sense that most [transfer and regular-admit] students feel that it is useful for future coursework or within their major," and that "more [students transferring into the physics major from other majors at Grand Lakes University] and [students transferring into the physics major from other institutions] just want to finish the courses and ultimately, the program, and think that is sufficient to get a job."

The course instructor's generalizations of transfer students' motivational beliefs contradicted the student survey and interview findings. The student survey findings were inconsistent with the course instructors' view of transfer students' perceived use for, importance of, and interest in physics studies. The survey data revealed that six out of seven respondents believed "being good in physics" was important. As related to student interview data, three out of five respondents cited the importance of their physics studies in relation to their future studies or occupational goals.

The instructor's generalizations about students' motives regarding the utility of coursework was consistent with the student survey and interview data. For example, the survey data revealed that six out of seven respondents stated that physics was generally useful, and five out of seven students reported that physics was useful in comparison to other subjects. Also, the student interview responses offered specificity about the students' extrinsic and intrinsic utility-based motives attached to their physics studies. Consistent with the instructor's generalizations about the utility of physics coursework, several students placed importance on the occupational utility of their physics studies. The student interviews findings differed from the course instructor's beliefs about students' extrinsic motives for physics studies (e.g., getting a job, grades), as two of the three student respondents stated that their motives for participation were attached to their interest in physics content or applications of physics content as related to future careers.

Instructor Perceptions of Student Interactions

The instructor interviews also focused on gathering the course instructor's perceptions of transfer students' discipline-specific use of social language while participating in upper-division physics courses. When asked about transfer students' social language use, that instructor stated "[they] [did] not make any special attempt to identify if students in [the entry-level upper-division physics course] started at...or transferred to [Grand Lakes University]...I have some notions that [regular-admit physics major] students, on average, communicate using more specific content-based language than transfer students." In recognition of a "broad distribution" of both transfer and regular-admit students, described as "rapidly evolving at [the entry-level upper-division physics course] stage [of study]," the instructor stated that appropriate social language use "is mixed depending upon the specific student."

When asked to define the meaning of physics students' social language use, the instructor said that irrelevant social language involved the "use [of] words that sound similar in the English language, [however have] a different meaning than the physics-related term" or in situations when "the student [would] avoid the scientific word and describe an idea using standard language." The course instructor added a disclaimer stating, "I think this is true for all students but [there] may be [a] higher use of irrelevant language for the average transfer student in comparison to the [regular-admit] student."

When commenting on the nature of the development or adaptation of transfer students' relevant (on-topic) physics-based social language use over time, the instructor said improvement is "true for all students, but those that show the most improvement are generally the ones who have engaged in the program the most and have been most active in the department." Furthermore, the instructor asserted that students' "[physics-based social language] use improves over time...becoming more precise...and continues to improve through the [*physics research course*] sequence." When considering students' social language use development within the confines of [the entry-level upper-division physics course,] the instructor acknowledged that “one individual course is a small step in this evolution” and “this evolution can be accelerated through increased” demand for, and the ”number of presentation and group activities.” The instructor indicated beliefs that “many exceptions [exist] to these notions,” and transfer students’ participation in classroom activities are “somewhat mixed, but from my perspective...are more hesitant to respond to questions, to lead discussions on group problems, or to lead a laboratory activity.”

The instructor interview data revealed important information about the course instructor’s beliefs about transfer physics majors’ language use, the circumstances under which students' physics-based language development occurs, and the value beliefs regarding the importance of social interactions in student language development or other aspects of socialization.

The instructor believed that regular-admit students used “more specific content-based language than transfer students” and that regular-admit students’ participation, in terms of responding to questions and leading discussions, exceeded that of transfer students. However, classroom observation data regarding transfer students’ physics-based social language use was inconsistent with the instructor’s beliefs. Within the observed groups, observations revealed that transfer students were well represented in terms of their social language use in comparison to regular-admit students. Additionally, aggregate data revealed that transfer students’ responses to teacher- and student-initiated interactions (e.g., responding to questions) in large and small group settings exceeded that of regular-admit students. However, when disaggregated at the individual level, similar to the course instructor’s understanding that interactions were “mixed depending on the individual student." The observational data supported the course instructor's belief about individual students' interactions. At the individual level, the incidence of response to, or initiation of questions varied across individual participants in both small and large group settings.

The instructor interview data revealed important information about the course instructor's beliefs concerning the relationship between social interactions and students' physics-based language development. Consistent with the classroom observation findings, students' social language use distribution and development was "mixed" depending upon the student. Additionally, similar to the instructor's beliefs, students' language use increased in precision (i.e., students incorporated higher amounts of order critical thinking over time) while engaging in active-learning processes (i.e., group work). Despite, espousing the importance of social interactions, in relation to the development of discipline-specific language, the course instructor employed teaching strategies during large group sessions that constrained student interaction and limited high order thinking.

Summary of Instructor Interview Findings

The course instructor's beliefs regarding transfer students' expectations for success and motivations (i.e., value students attached to physics studies) have implications related to educational processes and student socialization. Eccles et al. (1983) recognized that a socializer's attitudes about students holds the potential to mediate students' perceptions of their socializer (e.g., instructors or peers), their goals, their expectations to successfully complete physics coursework, the values they place on studying physics, and distally, the choices they make or their actions related to studying physics. Although the course instructors' attitudes and beliefs about students were never disclosed, the instructor held, but never acted upon beliefs related to perceived differences regarding differential abilities among regular-admit and transfer students. In cases where instructors hold, but do not act upon negative beliefs about students, represents a form of socializer behavior that limits organizational learning and potentially hampers the institution's ability to address institutional practices or processes that reinforce inequitable student outcomes. Individual interview data revealed that transfer students held overwhelmingly positive perceptions of the physics department and faculty members. These findings indicate that the instructor's deficit-based beliefs related to transfer students' physics course-related expectations for success, their motivations for participations in physics coursework, physics-related language ability, and participation in the physics learning community, all did not appear to negatively mediate the transfer student participants' ability or motivational beliefs, or participation in activities attached to their physics studies.

As related to this study, one participant who held low expectancy beliefs (e.g., ability beliefs) did not interact with the course instructor or other students during large or small group settings. Despite holding deficit beliefs regarding transfer student expectancies and motivation for studies, the course instructor made no attempts to identify students based on their matriculation status, nor did they engage in active inquiry to gain an understanding of, or attempt to address concerns about differences among individuals' dispositions toward studying physics — that may mediate classroom or co-curricular participation. Furthermore, despite espousing the importance of facilitating active learning processes for the purpose of discourse appropriation or socialization, the course instructor employed teacher-centered pedagogy approaches in large group settings (a form of socializer behavior) that constrained student language use and critical thinking. Detailed information about student language and critical thinking are presented in the classroom observation section, later in this chapter.

Several themes emerged across the instructor interview data. The instructor's perception of transfer students': course expectation and motivational beliefs, social language use, interactions, and socialization—are described in terms of indeterminate sociocultural factors. According to the interview data, the instructor recognized the dynamic, malleable nature of (a) student social language use; (b) tendencies toward classroom interaction participation; and (c) to a lesser extent, transfer students' expectancy value beliefs, particularly around transfer students' statements regarding motivation for participation and course outcome expectations. According to Eccles et al., (1983) these findings are significant, as the socializer's (i.e., the instructor) attitudes, beliefs, and behaviors are formed through their perceptions of students' backgrounds and past experiences. These perceptions may contribute to a) behaviors or (b) attitudes and expectations that mediate students' perceptions of their socializer's attitude and beliefs, their self-concepts, goals, ability-beliefs, expectations for success, motivations for participating in physics studies, task value, and ultimately achievement-related behaviors.

According to the interview data, the instructor adopted a deficit-thinking approach regarding transfer students' expectancies and task value beliefs related to physics studies; asserting that some students did not feel that studying physics was important and their participation was linked to academic performance or career placement, both representing goals associated with extrinsic motivation. From a socialization perspective, the instructor recognized that interdependent cultural influences, such as past events (e.g., matriculation pathway), students' interpretation of past events, and individual goals serve as antecedent factors that in turn alter their achievement-related choices. However, the instructor did not describe their own perceptions, behaviors and beliefs as a socializing force within the classroom or other educational settings.

In many ways, similarities exist between the instructors' and transfer students' perceptions regarding the importance of socialization experiences on increasing students' motivation to study, or to adopt ways of being as physics majors. In particular, both the instructor and many student participants stated in interviews, or demonstrated in classroom settings, the importance of sustained interactions in terms of encouraging a sense of communal belonging or using, developing, or adapting physics-related language. Next, I detail classroom observation data that informs our understanding of classroom activities that mediate, and are mediated by students and the course instructor's beliefs, attitudes, and behaviors.

Chapter V

Classroom Observational Data

The previous chapter presented data and relations about students' previous and current educational experiences, their beliefs regarding physics-ability, expectations for success in physics coursework and the value of physics studies, and finally, their goals and how these factors altered their educational experiences at Grand Lakes University. Student interview data provided a deep understanding of the connections between students' attitudes, beliefs, and their participation in classroom and co-curricular activities. In Chapter IV, I presented pertinent data related to the course instructor's attitudes and beliefs about transfer students' expectations for success in physics courses, physics-content ability, and value placed on physics studies, interactional tendencies, and language use. In Chapter V, I will present classroom observational data that details student-instructor and student-student interactions in large and small group settings. The classroom observation data presented within this chapter reveal students' classroom-based achievement-related behaviors that were mediated by their expectations for success, and their motivations for participation in coursework (detailed by student survey and interview data) and their socialzier's (i.e., course instructor's and peer physics students') attitudes, beliefs, and behaviors (detailed by instructor's interview and classroom observations).

Student-Instructor Interactions

Student-instructor interactions were counted and categorized for each class session. The type and number of student-interactions varied among students and the type of class structure including Teacher-Initiated Interactions (TII) such as Triadic Dialogue

(TD) and Teaching Questions (TQ). Student-Initiated Interactions (SII) included Student Questions (SQ) and Student Commentary (SC). TD patterns involve the use of teacher-initiated questions, often rhetorical, where students respond followed by the instructor providing feedback or by asking for follow-up information related to previous questions. Open-ended TQs generally resulted in extended conversation or dialogue between the individual or groups of students and the instructor. SQs were posed for the purpose of clarifying information conveyed by the instructor, whereas SCs, in many cases, were associated with individual reflection regarding class content.

Within the observed classes, student-instructor interactions occurred within small and large group settings. The nature of student-instructor interactions varied between small and large group settings. Within large group settings the teacher-initiated interactions, in the form of Triadic-Dialogue (TD), represent the dominant discourse pattern.

Student-instructor interactions within large group settings revealed a disproportionate overrepresentation of responses to teacher-initiated interactions by a small number of transfer physics majors. Within large group settings, aggregate data for the total number of TII revealed that, on average, transfer students, who represented 56% of the total number of students enrolled in the class, responded to 1.5 times as many teacher-initiated interactions in comparison to regular-admit students (1.76 times as many, excluding one transfer student's 20 responses to TII in large group settings). During small group settings, the nature of student-instructor interactions shifted toward the use of student-initiated questions by a small portion of transfer students that was overrepresented in comparison to other transfer, or regular-admit physics majors enrolled in the physics course. Within small group settings, aggregate data for the total number of SII revealed that on average, transfer students, who represented 56% of the students enrolled in the class, initiated 1.8 times as many student-instructor interactions in comparison to regular-admit students (5.9 times as many, excluding one regular-admit student's 14 questions in large group settings). These findings show transfer students' agency as several transfer students took an active role in their studies (as viewed through participation rates in large and small group settings). Disaggregated data for individual student teacher-initiated interactions and student-initiated interactions in both small and large group settings are presented in Appendix K, Table K5 and Table K6.

Student-Instructor Interaction Patterns

The number of, and type of student-instructor interaction varied between both the large and small groups' activity settings. Large group, or lecture-based portions of class meetings represented sixty percent of the observed class period time and were conducted in a traditionally configured classroom. The instructor engaged in lecture or monologue from a location in the front of the classroom. During lectures, students were seated in pairs or individually throughout the classroom. They participated by listening to information conveyed by the instructor, recording class notes, and by engaging in TII and SII.

During small group sessions, students worked in rare instances individually, or in self-selected groups seated at tables facing each other. These small groups represented forty percent of the observed class period time. During this time, transfer students worked with other transfer students and with regular-admit students. For example, transfer students Theodore and Tucker worked with regular admit student Frank. Also, transfer students Tanner and Theodore worked together in small group settings. Also, transfer student Thatcher regularly collaborated with regular-admit student Floyd in small group settings. The vast majority of classroom interactions occurred in small group settings in the form of student-student interactions. During small group sessions, the students worked collaboratively, engaging in problem solving as related to content discussed in the preceding large group sessions.

Aggregate Student-Instructor Interactions in Large Group Settings. In general, the incidence of Teacher-Initiated Interactions and Student-Initiated Interactions within the large group settings varied across the observed class sessions (see Table 4). However, the proportion of teacher-initiated interactions (i.e., TD, TQ) was greater than that of student-initiated interactions (i.e., SQ, SC). The proportion of Teacher-Initiated Interactions (TII) and Student-Initiated Interactions (SII) for each class session was calculated to gain a sense of the teacher-centeredness versus the active-learning (i.e., student-centeredness) nature of the lecture portion of class meetings. During most large group sessions, triadic dialogue (see Table 3) was the most common form of classroom interaction. The frequency of dominant discourse patterns in large group settings are presented in Table 3.

Table 3

Number of Teacher- and Student-Initiated Interactions Within Large Group Settings

Activity Structure	2/12	2/17	2/19	3/2	3/11	Total
TD	9	36	18	5	34	102
IQ	0	0	0	4	0	4
SQ	13	10	5	2	5	35
SC	1	3	1	0	4	9

Note. Course enrollment was 16 students.

The aggregate data of the relative proportion of TII and SII during large group sessions demonstrate the prevalence of instructor-initiated interactions.

As seen in Table 4, during four out of the five observed large group session classes, the proportion of TII exceeded that of SII, where triadic dialogue served as the dominant means of interaction between the students and the classroom instructor. These findings reinforce the teacher-dominated nature of large group, lecture-based instructional pedagogy structures.

The percentage of TII and SII from the observed large group sessions is displayed in Table 4.

Table 4

The Percentage of Teacher- and Student-Initiated Interactions from the Observed Class Large Group Sessions

Activity Structure			Class Session		
	12-Feb	17-Feb	19-Feb	2-Mar	11-Mar
% TII	37	73	75	82	79
% SII	63	27	25	18	21

Note. Course enrollment was 16 students.

Within large group settings, teacher-initiated interactions represented that dominant discourse pattern.

TII and SII individual Transfer Student Data During Large Group Sessions. The proportion of TII and SII associated with transfer students (see Table 5) provides insight about transfer students' participation within large group classroom settings. Overall, transfer students participated in 1.5 as many teacher-initiated questions as compared to regular-admit learners in large group sessions. In large group settings, the transfer students posed 1.8 times as many student-initiatives (excluding one non-participant outlier who posed 14 SII over the observed class dates) in comparison to regular-admit students. However, these results are deceiving. When the participation data are disaggregated at the individual level, a small number of transfer students contributed a disproportionately high number of interactions. Additionally, 4 of the 7 regular-admit student participants engaged in no student-initiated interactions with the instructor in large group settings. The frequency of transfer students' participation in TII and SII in large group settings are presented in Table A below.

Table 5

Percentage of Transfer Physics Student Teacher- and Student-Initiated Interactions in Large Group Settings

Activity Structure			Class Session		
	12-Feb	17-Feb	19-Feb	2-Mar	11-Mar
% of total TII	56	72	72	27	56
% of total SII	93	77	66	50	33

Note. Transfer students represent 56% of the class enrollment.

When viewed at the individual student level, the data reveals disparate participation rates. This data reveal that some transfer students rarely (Theodore = 2) participated in or responded to student-instructor interactions; or never (Tyson = 0 student-instructor interactions) participated in or responded to TIIs in large group settings. While other students (Tanner = 27 student-instructor interactions) dominated both their transfer student and regular-admit classmates' response rates to both SII and TII in large group settings. Within large group settings, regular-admit learners contributed to a minimum of one, and a maximum of 20 student-instructor interactions. Additionally, it should be noted that all students were present in class on all of the observed dates with the exception of Tyson on 3/11. Disaggregated data such as participation frequency and descriptive statistics related to student responses to teacher-initiated interactions, and participation in student-initiated interactions in large group settings is presented in Appendix K, Table K5.

These findings indicate that the instructional approach, a form of socializer behavior, mediated the nature of student interactions in large group settings. The use of lecture or monologue, coupled with triadic-dialogue in large group settings, mediated the nature and extent of student-instructor and student-student interaction. Although Eccles et al. (1983) posited the connection between expectations for success, ability beliefs, and motivations for participation in studies, student survey data regarding students' expectations for success in physics, their ability beliefs related to studying physics, or the value they placed on studying physics did not serve as a predictor for participation rates (i.e., teacher-initiated interactions, student-initiated interactions) in large group classroom settings. For example, Tyson held low ability beliefs and displayed low levels of participation in large group settings. Another student, Theodore held positive beliefs but displayed low levels of participation in large group settings. The disconnection between student ability and motivational beliefs and classroom participation rates in large group settings indicate that other, undiscovered factors mediate participation. More research is needed to understand the connection between motivation and participation in large group settings.

Aggregate Student-Instructor Interactions Data in Small Group Settings. Similar to the large group setting**,** the incidence of TII and SII within the small group portion varied during the observed class sessions. Very few instructor-initiated questions were posed (on average one per observed class session) during small group sessions across the observed class session. In small group settings, the transfer students posed 1.9 times as many instructor questions in comparison to regular-admit students' rates. Again, these results are not representative of every transfer student, since when the participation data is disaggregated at the individual level, a small number of transfer students contributed a disproportionately high number of interactions. For example, Tanner posed 14 questions to the instructor where Tyson only posed one instructor question during the observed classes.

In contrast to large group settings, the distribution of interactions shifted from teacher-initiated to student-initiated interactions within small group settings. The proportion of TII and SII for each class was calculated, to gain a sense of the teacher-centeredness versus the active-learning nature of the small group portion of class meetings. In small group settings, student questions represented the most common form of student-instructor interaction (see Table 6) throughout the observed class sessions. The number of observed TII and SII in small group settings is displayed in Table 6.

Table 6

Number of Teacher- and Student-Initiated Interactions Within Small Group Settings

Activity Structure	Class Session				
	2/12	2/17	2/19	3/2	3/11
TD	0	0	0	0	0
TQ	1	0	0	0	1
SQ	23	15	13	19	21
SC	0	0	0	0	0

Note. Class enrollment was 16 students.

The aggregate data of the relative proportions of TII and SII during small group sessions demonstrates a prevalence of student-initiated interactions. During all of the observed class sessions (see Table I), the proportion of SII vastly exceeded that of TII, where students' questions served as the dominant means of classroom interaction with the instructor.

While engaging in problem solving, the students consulted other group members with the goal of clarifying, assessing, and evaluating their problem-solving approaches. The classroom observation data reveals that when groups of students are unable to reconcile their misunderstandings or uncertainties related to problem solving, they rely on the course instructor's assistance. Interestingly, the group engaging in the largest number of student-instructor interactions, during small group settings, experienced the greatest critical thinking development and language adaptations over the observed class periods.

For instance, in small group settings, Trenton and Tanner (Table B) initiated a large number of student-instructor questions in relation to the other students. Conversations between the course instructor and students during these interactions revealed that the instructor modeled higher order thought processes related to the evaluation of problem-solving approaches, and in limited instances provided feedback to students regarding the evaluation of the students' problem-solving outcomes.

As presented later in this chapter, analysis of Trenton and Tanner's conversations revealed the course instructor's contribution of a lengthy conversation with Trenton and Tanner's group in comparison to other groups. Over the course of the observed class sessions, the number of course instructor's interactions between Tanner, Trenton, and the course instructor decreased in frequency. These patterns of interaction, although most likely unintentional, involved the use of instructor-based scaffolding techniques providing a great amount of support evaluating critical thinking in relation to problem solving. The instructor's support decreased across the observed class dates, most likely encouraging and contributing to Trenton and Tanner's development of autonomous higher order critical thinking activity. Trenton and Tanner's proximity to the front of the classroom, where the course instructor routinely engaged in administrative tasks (e.g., prepping for the next portion of lecture), presumably contributed to this group engaging in a larger number of interactions with the instructor. Other groups (Table A and Table C) posed questions to the course instructor at lower frequencies and also experienced increases, to a lesser extent, compared to Table B (Tanner and Trenton), in higher order language use in small group settings. Most significantly, the students in all the other observed groups rarely, if ever, consulted other groups of students during small group sessions, instead relying on the course instructor for guidance.

The tendency for students to consult the course instructor is consistent with findings from student interview data, as all of the respondents expressed positive perceptions of the physics faculty members (i.e., course instructors). For example, students expressed during interviews that their interactions with faculty “have been solely positive,” or “very supportive,” and that the "[physics faculty members] helped me when I needed [help] or asked for [help].” Furthermore, the interview and classroom observations data revealed that students place a greater importance on support of faculty over their academic peers within the physics major. As in many cases, students sought the expertise of the course instructor to provide feedback regarding their problem solving approaches and outcomes. Within small group settings, interactions with the course instructor both encourage, and indirectly discourage the development of students’ critical thinking and the adaptation of their language use. The inclination of the course instructor to provide guidance or verbal feedback about students’ problem-solving approaches aided in modeling higher order thinking. Simultaneously, and most likely unintentionally, impeded student-student dialogue within, and across student groups in small group settings. Additionally, students relied heavily on the course instructor in small group settings. This indicates low levels of student confidence regarding risk-taking or experimenting while engaging in group problem solving. Additional detail related to frequencies of the students’ and the course instructor’s on-topic physics related language use, definitions of physics content-related critical thinking attributes, and analyses of the incidence and frequency of students' critical thinking language use in small group settings are presented later, in the student-student interactions section of this chapter.

Table 7

Percentage of Teacher- and Student-Initiated Interactions in Small Group Settings

Activity Structure			Class Session		
	2/12	2/17	2/19	3/2	3/11
%TII	4	0	0	0	5
%SII	96	100	100	100	95

Note. Course enrollment was 16 students.

Student-initiated interactions represented the dominant discourse pattern in small group settings.

TII and SII Individual Transfer Student Data During Small Group Sessions. The proportion of TII and SII associated with transfer students indicates that transfer students' ability-beliefs and expectancies may lead to both low and high levels of interaction with the course instructor in small group settings. Nine transfer physics majors accounting for fifty six percent of the 16 students enrolled in the observed classes. Considering the proportion of transfer physics majors, the disaggregated transfer physics major TII and SII participation rates suggests an overrepresentation of transfer student SIIs as compared to regular-admit students (see Table 8) on three dates (e.g., 2/12, 2/19 and 3/2). A balanced participation (i.e., parity) was observed on two dates (e.g., 2/17 and 3/11) in terms of the number of SII, as compared to regular-admit learners. As suggested by Eccles et al. (1983) developmental models that connected students' ability beliefs, students’ expectations for success, the value that students place on educational activities, socializer behaviors, and achievement-related choices; these findings related to student participation may be related to transfer students' decreased physics-content ability beliefs, lowered expectations in relation to their ability to learn new physics concepts, and the course instructor's forthcoming with information related to potential solutions or justifications for student thinking as related to problem solving.

Tyson’s survey responses, for example, revealed low physics-content ability beliefs and low expectations for success in completing physics course work and learning new concepts in his upper-division coursework. He was noticed working alone on three out of the five observed classes, and worked with another student (Faraz) on one occasion (Tyson was absent on one date (3/17/2020)), while engaging in problem solving in small group sessions. During the observed dates, Tyson was observed participating in only one student-instructor interaction across all of the observed dates in small group sessions. Tyson’s lack of interactions with his peers and the course instructor could have been mediated by his low physics-related ability beliefs. Unfortunately, no other sources of data are available to augment the understanding of this student’s lack of interactions in the classroom setting. Conversely, Trenton and Tanner both held highly positive ability beliefs; however, Tanner’s beliefs regarding the ability to learn something new were higher than Trenton’s. The class observations revealed that Tanner participated in three times as many student-instructor interactions (in the form of student questions to the instructor) in comparison to Trenton, perhaps revealing varied levels of student agency connected to their ability beliefs, that led to a large number of interactions supported through Tanner’s high levels of interest in his physics studies. By contrast, Tyson and

Trenton held lower expectations connected to their ability to learn new content or skills in upcoming physics coursework. These beliefs may have led to Tyson participating in a low number of student-initiated or teacher-initiated interactions. Alternatively, lower expectations for success may Trenton may have posed a large number of student questions due to his decreased ability beliefs related to learning new physics concepts. The previous examples represent extreme examples from the research data. More research is needed to better understand students' motivations for participation related to student-instructor interactions in small group settings. While these findings highlight extreme examples, other students' ability-beliefs were not predictive of their participation in student-instructor interactions in small group settings. The idiosyncratic nature of the connection, if any exist, between student beliefs and interactional findings suggest the need for further inquiry to identify connections between student ability beliefs and their participation in student-instructor interactions in small group settings. These findings have implications for future research, policy, and educational practice.

Table 8

Percentage of Transfer Physics Student Teacher- and Student-Initiated Interactions in Small Group Settings

Activity Structure			Class Session		
	2/12	2/17	2/19	3/2	3/11
% of total TII	0	0	0	0	1
% of total SII	71	53	85	78	52

Note. Transfer students represented 56 percent of the class enrollment.

As a whole, the average values across all of the observed dates for TII (M= 0%) and SII (M=68%) revealed an over-representation of the number of transfer student TII and SII interactions in small group sessions. However, the individual transfer student SII and TII participation data provides additional insight into the true nature of transfer student participation in small group settings. These results show that, as a whole, the seven transfer student participants enrolled in the physics classes initiated nearly twice as many student questions in comparison to six of the regular-admit physics student participants in small group settings.

These findings indicate that a combination of student ability beliefs and instructional approach (a form of socializer behavior) potentially mediate the nature of student interactions in small group settings. The use of problem-solving sessions in small group settings resulted in a decrease in TII and increase in SIIs in the form of student questions. Interestingly, a large amount of verbal interactions between the course instructor and students were prompted by the initiation of student questions in small group settings. The frequency of teacher utterances within the group settings is presented in Table 9.

Classroom observations revealed that transfer students' participation to teacher-initiated and student-initiated interactions varied across individual participants. For example, Tyson, never participated in TII, and engaged limited in SII with the instructor during small group settings. In contrast to Tyson's lack of interaction, other students, Tanner and Thatcher dominated both their transfer, and regular-admit peer student-instructors (e.g., TII and SII) interaction rates in small group settings.

When compared to findings from survey and interview data from this study, disparate participation rates may be explained by referencing the expectancy-value survey data. One student, Tyson reported decreased expectations related to physics content ability, which may have impacted his participation in teacher-initiated and student-initiated interactions in the classroom settings. As a whole, the other six transfer student survey respondents reported positive expectations for successful completion of their physics coursework and physics related ability beliefs that supported the findings of appropriate levels of participation and interaction in the classroom setting. According to Eccles et al. (1983) socializer behavior and expectancy-value beliefs mediate achievement-related activities (i.e., classroom participation). Despite identifying previous instances of, and possessing deficit beliefs regarding transfer students' experiences and dispositions, the relationship between instructor practices and students' educational activities remains uninterrogated. The effect of the course instructor's deficit beliefs are unknown as the instructor's attitudes and beliefs about students were never revealed to students enrolled in the physics course and the academic major.

Emerging Themes in Student-Instructor Interactions

An untold number of sociocultural influences alter classroom activities. During classroom interactions, a socializers' behaviors, along with a student's individual psychosocial factors, mediate educational activities.

As a socializer behavior, instructional design mediated the nature and frequency of both TII and SII large and small classroom settings. During large group sessions the instructor employed two instructional strategies with the goal of communicating and forming themes within the relevant course content: monologue and triadic dialogue. The instructor engaged in periods of monologue for the purpose of making logical expositions—the process of making logical arguments which required connections between previous and new course content (Lemke, 1990). Within large group settings, the course instructor sought to expose thematic patterns within the course content using triadic dialogue, for the purpose of employing more knowledgeable students in exposing thematic content relations. Teacher-centered activity structures resulted in constrained individual's participation and peer dialogue in large group settings. An extremely small number of student-student interactions were observed during large group settings.

Within small group settings the instructor encouraged, but did not require students, to participate in collaborative problem-solving processes. While engaging in collaborative problem-solving sessions, student-centered active-learning structured activities encouraged abundant student-student and student-instructor interactions. However, informal instructor expectations, or other unexamined factors (such as students' physics-related ability beliefs, or motivations for physics studies) most likely resulted in some students working independently or by engaging in a limited number of student-instructor and student-student interactions in small group settings.

The next portion of this chapter focuses on the nature of student-student interactions within small group settings. This discussion includes (a) the definition of on-topic and off-topic social language observed in small group settings; (b) definitions of metrics for verbal interactions within small group settings; and (c) data which reveals the distribution, development, and adaptation of on-topic discipline-specific social language (e.g., on-topic talk, critical thinking) in small group settings.

Student-Student Interactions

Within the observed classes, student-student interactions occurred exclusively in small group settings. In large group settings, no substantial instances of student-student interactions were observed. Student-student interactions were counted and categorized according to the number of on-topic utterances and the frequency of critical thinking attributes per total number of utterances spoken in small group settings. The distribution (i.e., extent of on-topic language use, level of critical thinking), development (i.e., change in language use distribution over class periods), and adaptation (i.e., development of the critical thinking attributes) of social language varied on the individual and group level. On-topic social language was defined as individual student conversation directly related to discussing tasks related to course content assigned by the instructor.

While critical thinking can occur at the individual level, Newman et al, (2004) recognized the link between critical thinking and social interaction. Within this study, critical thinking was observed in social processes, primarily through student-student interaction in the small group setting. This study used modified metrics for measuring critical thinking based on Garrison's (1992) and Newman et al. (1995) models of the stages of critical thinking, more recently used by Thompson (2018) to identify aspects of problem clarification (p-clar), the use of critical assessments (c-assess) of one's or others' assertions, and the formation of judgements (ju) to evaluate or justify assertions within group problem solving settings.

Student-Student Interaction Patterns

The number and type of classroom interactions varied between both large and small groups' activity settings. Across the observed classes, there were no instances of student-student interactions noted within large group settings. In large group settings, student-instructor interactions represented the only means of communication. These interactions were centered on the instructor's use of triadic dialogue or student questions, which typically involved individual student interactions or choral responses by groups of students. Within small group settings, abundant student-student interactions were observed and were characterized by dialogue, discussion, and in rare instances, debate. While students routinely engaged in critically assessing their own thinking or others thinking regarding the rationale for problem solving while engaging in dialogue, in rare instances, debate among students in small group settings often led to learners justifying their assertions in relation to physics content. Of the seven student groups which assembled in small group settings, I chose to observe three groups using a purposeful sampling, primarily based on the number of transfer student participants within each sampled group.

Social Language. The observation of student conversations within small group settings revealed variation in the composition and distribution of discipline-specific social language among and between individuals and groups of physics students enrolled in the upper-division physics section. Within small group settings, on-topic (i.e., relevant) and off-topic (i.e., irrelevant) conversations were observed at various frequencies within and across the observed class dates. Additionally, the frequency of critical thinking language attributes observed during on-topic conversations were useful in understanding language adaptation in social settings. The metrics used in this study for measuring on-topic social language use and critical thinking attributes are discussed in the next section of this chapter.

Metrics for Measuring Student-Student Interaction. Both time-on-task and the frequency of on-topic and off-topic utterances served as useful metrics of participant interactions in small group settings. In this study, an utterance is defined as an uninterrupted chain of spoken or written language. Small group interactions (e.g., verbal communication) were observed during each minute of group work and categorized as on-topic or off-topic. When compared to the total time for each group session across the observed class dates, these data show varied levels of on-topic discipline-specific social language use across groups and individuals during the observed class periods. A more precise metric of student participation in small group settings involved the use of tracking the frequency of on-topic utterances. The total number of on-topic utterances varied across groups and dates, due to varied on-task student behavior and varied time allotted for group work. The proportion of utterances each participant spoke in comparison to the total number of on-topic utterances spoken during each group session provided information about the frequency of the participants' (i.e., students, instructor) individual and group on-topic social language use for each group session and across the observed classes. Data tables for (a) time-on-task data for each group in small group settings; (b) the total number of on-topic utterances spoken during small group settings; and (c) the total number of on-topic utterances spoken by each group in small group settings are presented in Appendix K.

Aggregate Language Distribution

The frequency of individual's (e.g., students and instructor) on-topic social language utterances were determined by counting the number of on-topic utterances spoken during each minute of the small group sessions. Since the total number of utterances spoken across individual group sessions varied across the observed classes, a weighted average of the frequency (i.e., percentage) across dates were used to capture aggregate social language use trends. Aggregate data of individual student's utterances of on-topic social language use revealed disparate patterns across individual participants within groups. Although disparate in frequency across individuals within groups, all of the members within the observed groups participated in discussion using on-topic language during conversations. Additionally, the number of on-topic utterances spoken by the instructor varied across groups, and showed disparate instructor interaction rates across the observed groups. The aggregate individual participation data are presented in Appendix K.

Intra-Group Social Language Use Trends. The frequency data of individuals' on-topic utterances within small group settings allowed for the examination of the distribution of the students' on-topic utterances between group members within individual groups. With the exception of one student (Trenton), the aggregate data for the frequency of individual student's social language use revealed that individuals spoke at different rates within small group settings and the distribution of student conversation within groups remained stable across the observed class setting. For example, students at Table A (Theodore, Tucker, and Floyd) regularly participated in on-topic physics related conversations. These conversations were mostly led by Tucker and Floyd, where Theodore contributed regularly, however at a lower frequency than other group members. Trenton's use of social language within small group settings increased over time, eventually reaching parity with his group member, Tanner (see Table 9). Social language use was abundant, but slightly disparate within the groups across the observed class dates indicating student agency of the observed transfer and regular-admit physics student participants.

In general, the amount of talking by each participant within groups varied on each date. However, each of the participant's contributions to group conversation were consistent across the observed class dates. For example, Theodore spoke less frequently in comparison to his group members in small group settings. However, when he participated in group conversations, he acted as a more knowledgeable other, by providing insights to his rationales for thinking or by connecting previous course knowledge to new situations. For example, while discussing problems related to the photoelectric effect, Frank posed a question to Tucker and Theodore asking, “so isn't Vs equal to hc over lambda minus phi all over e?” Theodore responded to the question and justified his answer to the group in terms of the fundamental definition of the energy of a photon stating, “if we're talking about one electron has its energy and electron volts it will pass through that number of volts...one electron volt is the energy one needs to pass through one equals 3.98 electron volts it will pass one electron will pass through 3.98 volts.” Theodore’s contributions to problem solving dialogue assisted in the other students reconciling their previous knowledge in the context of the problem the group members were solving in small group settings. Another student, Trenton, demonstrated an increase in the frequency of discipline-specific social language use, eventually reaching parity with Tanner, the other group’s participant. This shift in interactional patterns within Trenton and Tanner’s on-topic social language use corresponded to decreases in instructor participation with this group in small group settings.

Individual Student Social Language Use Trends. The frequency of individual student's on-topic social language use allowed for the examination of language development across the observed class dates. In general, individual students regularly participated in appropriate, but slightly different amounts of on-topic conversations about physics, in comparison to other group members while participating in group work in small group sessions. (see Table 9). These results indicate that collaborative problem-solving in small group settings promoted student interaction. Also, the representation of all group members suggests that collaborative solving processes in small group settings are meaningful to these students and driven by their expectancies and motivations for studying physics. A comparison of individual student's on-topic social language use across the observed class dates is presented in Appendix K. The frequency of on-topic social language expressed in terms of the number of on-topic utterances spoken by each participant per the total number of utterances spoken within the group are displayed in Table 9.

Table 9

On-Topic Group Social Language During Small Group Sessions.

Table	Student	Class Session				
		2/12	2/17	2/19	3/2	3/11
Table A	Frank	169/378	151/276	70/220	239/524	125/302
Table A	Tucker	134/378	88/276	105/220	232/524	117/302
Table A	Theodore	75/378	36/276	36/220	50/524	54/302
Table A	Instructor	0/378	1/276	9/220	3/524	6/302
Table B	Tanner	185/317	67/120	80/168	121/265	73/136
Table B	Trenton	60/317	34/120	64/168	128/265	43/136
Table B	Instructor	72/317	19/120	24/168	16/265	20/136
Table C	Thatcher	178/363	74/177	131/237	31/56	168/304
Table C	Floyd	134/363	76/177	99/237	20/56	107/304
Table C	Instructor	51/363	27/177	7/237	5/56	29/304

Note. The proportion of on-topic utterances are displayed as the ratio of the total number of on-topic utterances spoken by each student in small group settings to the total number of on-topic utterances spoken during each class session for each group.

Critical Thinking Language Distribution. The research findings from classroom observations revealed that student-student and student-instructor interactions in small group settings provided ample opportunities for physics students to engage in social processes that led to the adaptation in students' social language. Collaborative problem solving in small group settings encouraged students to engage in deeper critical thinking processes while evaluating problem solving processes and outcomes.

Newman et al. (1995) assert that clear links exist between critical thinking, social interaction, and deep learning. Within this research study student socialization includes the acquisition of physics discourses. An important aspect of discourse appropriation includes the ability to engage in critical thinking (Kozminski et al., 2014). Critical thinking, the analysis of facts to form judgement, represents a fundamental aspect of problem-solving discourses that generally includes the rational analysis or evaluation of factual evidence (Glaser, 1941). Considering that deep learning requires a critical understanding of course content and is promoted by active learner participation—then small group sessions provided opportunities for learners to engage in social interactions and provided opportunities for the observation of students' critical thinking processes.

This study uses modified metrics for measuring critical thinking based on Garrison's (1992) and Newman et al. (1995) critical thinking metrics, later used by Thompson (2018) to identify aspects of problem clarification (p-clar), the use of critical assessments (c-assess) of one's or others' assertions, and the formation of judgements (ju) to evaluate or justify assertions within group problem solving settings. Critical thinking attributes observed within small group session conversations were coded using critical thinking indicators (i.e., p-clar, c-assess, ju), and then presented as frequency data in comparison to the total number of on-topic utterances spoken in small group settings. Examples of the application of codes (e.g., p-clar, c-assess, ju) to conversational data is located in Appendix L; Table L4). The frequency of critical thinking attributes was used to identify the extent and the development or alterations of students' critical thinking processes, a form of social language adaptation that occurred while students engaged in problem solving within the small group settings. Examples of critical thinking metric indicators applied to transcript data and the total number of each critical thinking attribute from the small group settings are displayed in Appendix M.

The frequency of each critical thinking code was calculated to determine the extent and development of critical thinking processes, while engaging in collaborative problem solving in small group settings. The incidences (i.e., number of p-clar, c-assess, and ju codes) and frequencies of critical thinking metrics for three groups across each of the class sessions are displayed in Table 10 and Table 11.

Table 10

The Incidence of Each Critical Thinking Code Assigned to Transcript Data During Small Group Sessions

Date	CT code	12-Feb	17-Feb	19-Feb	2-Mar	3-Mar
Group A	p-clar	5	75	48	68	30
	c-assess	59	40	39	70	47
	ju	19	27	32	71	92
	Total On-topic Utterances	378	276	220	524	302
Group B	p-clar	45	30	48	36	28
	c-assess	49	28	41	50	33
	ju	22	15	27	41	64
	Total On-topic Utterances	319	120	168	265	136
Group C	p-clar	65	57	60	41	38
	c-assess	61	40	84	18	49
	ju	52	9	40	15	83
	Total On-topic Utterances	363	177	237	56	304
	Time alloted for Group Work (in minutes)	37	23	19	45	27

Note. Course enrollment was 16 students. Examples of critical thinking codes are presented in the appendix.

Table 11

The Frequency of Critical Thinking Codes Assigned to Transcript Data During Small Group Sessions

Table	CT code	Sessions				
		12-Feb	17-Feb	19-Feb	2-Mar	11-Mar
Table A	p-clar	0.01	0.27	0.22	0.13	0.1
	c-assess	0.16	0.14	0.18	0.13	0.16
	ju	0.05	0.1	0.15	0.14	0.3
Table B	p-clar	0.14	0.32	0.25	0.15	0.21
	c-assess	0.15	0.23	0.35	0.21	0.24
	ju	0.07	0.05	0.17	0.17	0.47
Table C	p-clar	0.18	0.32	0.25	0.45	0.13
	c-assess	0.17	0.23	0.35	0.32	0.16
	ju	0.14	0.05	0.17	0.27	0.27

Note. The frequency of critical thinking codes represents the proportion of critical thinking codes to the total number of on-topic utterances spoken by group participants for small group sessions.

[a]Color scales highlight the relative differences of the average weighted percentage of utterances spoken throughout the observed dates within small group settings. The shade of color is proportional to the frequency of the critical thinking metric.

The critical thinking frequency data (see Table 10 and Table 11) showed variation in the abundance of each critical thinking code within group sessions across the observed class sessions. With the exception of the initial class meeting (e.g., 2/12), the frequency of problem clarification (p-clar) codes within student discussion was greatest for Table A and decreased in frequency across the observed class periods. When analyzing the frequency of problem clarification for Table C, one data point (3/2), the frequency of problem clarification codes fell outside of the trend of reduction of the frequency of problem clarification over time. After reviewing the transcript and audio recordings, one possible explanation of this unusual data involved a large amount of off-topic conversation, combined with the fact that one of the group members left the room twice during this data session resulting in extended amounts of silent work during class on this date.

One explanation of the trend of decreased problem clarification while problem solving is general increases in deeper (i.e., higher order) critical thinking processes that may be associated with increases in content knowledge gained during physics coursework, or by observing the course instructor model higher order thinking when answering student questions. These critical thinking processes included a) the assessment (i.e., c-assess codes) of proposed problem-solving processes (e.g., problem solving strategy) or outcomes (e.g,, evaluation of computational outcomes) and b) the judgement or evaluation of the validity problem solving processes or outcomes. In general, the total number of critical assessment codes increased for Tables A, B, and C across the observed classes and the number of judgement codes increased for Tables A and B, and varied across dates for Table C. Tables A and B experienced the greatest adaptation of social language use through the development of higher order critical thinking (i.e., c-assess and ju codes) over time. These findings indicate that active-learning activity structures mediate student interactions, social language use, and critical thinking processes. Additionally, these findings show that active learning structures such as group work observed in small group settings contributed to the acquisition of physics-related linguistic practices in the form of critical thinking, a form of embodied cultural capital. The use of critical thinking within physics courses and within other relevant academic or professional contexts represents the embodiment of cultural capital, which is a person's means of communication and self-presentation, acquired from within their primary and secondary discourses (Bourdieu, 1990).

Emerging Themes in Student-Student Interactional Data

Instructional design mediated student-student interactions in classroom settings, similar to student-instructor interactions. In stark contrast to the activity structures observed in large group settings, extensive student-student, and to a lesser extent, student-instructor interactions were observed during collaborative problem-solving processes in small group settings. In small group sessions, on-topic social language use varied across individuals and groups of students over the observed class dates. During small group sessions, students engaged in extensive dialogue and discussion with their classmates, and to a lesser extent, with the instructor. In general, most students participated in on-topic discussions, acted in the role of a more knowledgeable other using a variety of critical thinking attributes that developed in complexity over the course of the observed class periods. These findings suggest that as a whole, transfer students possess social capital, embodied through social relations with their peer classmates (e.g., other transfer and regular-admit students) and course instructors as observed in the classroom setting. Furthermore, transfer students' development of, and adaptations in discipline-specific social language use and critical thinking attributes represent the embodiment of linguistic capital, a form of cultural capital that is connected to their primary and secondary discourses. At the individual level, students' social relations and language use varied, as some students were overrepresented in interactions, where other students displayed low levels of interaction or language use in large or small group settings. These findings could be connected to an individual's ability-related self-concept or motivations for participation, which from a Bourdieuian perspective could be connected to one's habitus, as viewed through intellectual dispositions.

Interestingly, two students, transfer student Tyson and regular-admit student, Faraz, did not engage in group work, but worked independently in 4 out of 5 class sessions. These student actions may have resulted from a lack of instructor expectations regarding participating collaborative problem solving during small group sessions. Additionally, although uninvestigated because Tyson did not participate in student interviews, his self-described decreased ability in physics as compared to other students, or by some other unseen sociocultural force potentially mediated his participation in this research study or in student or teacher-initiated interactions in large and small group settings. Additionally, for student Trenton, research revealed incongruence between classroom participation and other measures related to content-related expectations, value beliefs, and sense of belonging. The inconsistent nature of Trenton, and other students' responses about the value of studying physics, socialization outside of the classroom and his classroom participation rates warrants further research.

Summary of the Classroom Observations

The observation of student-instructor and student-student interactions in classroom settings provided interesting insights into classroom participants' behaviors (i.e., actions and interactions). This insight assisted in providing a holistic understanding of transfer physics students' socialization activities. The observational data revealed that instructional design, a form of socializer behavior, mediated student activity. When viewed as a whole, the aggregate classroom observation data suggested that transfer students, as a group, were well represented in terms of student-instructor interactions in large and small group settings. Additionally, the observation of purposefully sampled transfer students revealed appropriate distribution and development of social language and critical thinking attributes at the individual and group level. However, when disaggregated at the individual level, as an individual instrument, classroom observations failed to provide a complete understanding of the socialization process, as a multitude of psychosocial and structural sociocultural factors mediate students' experiences.

Summary of Study Findings

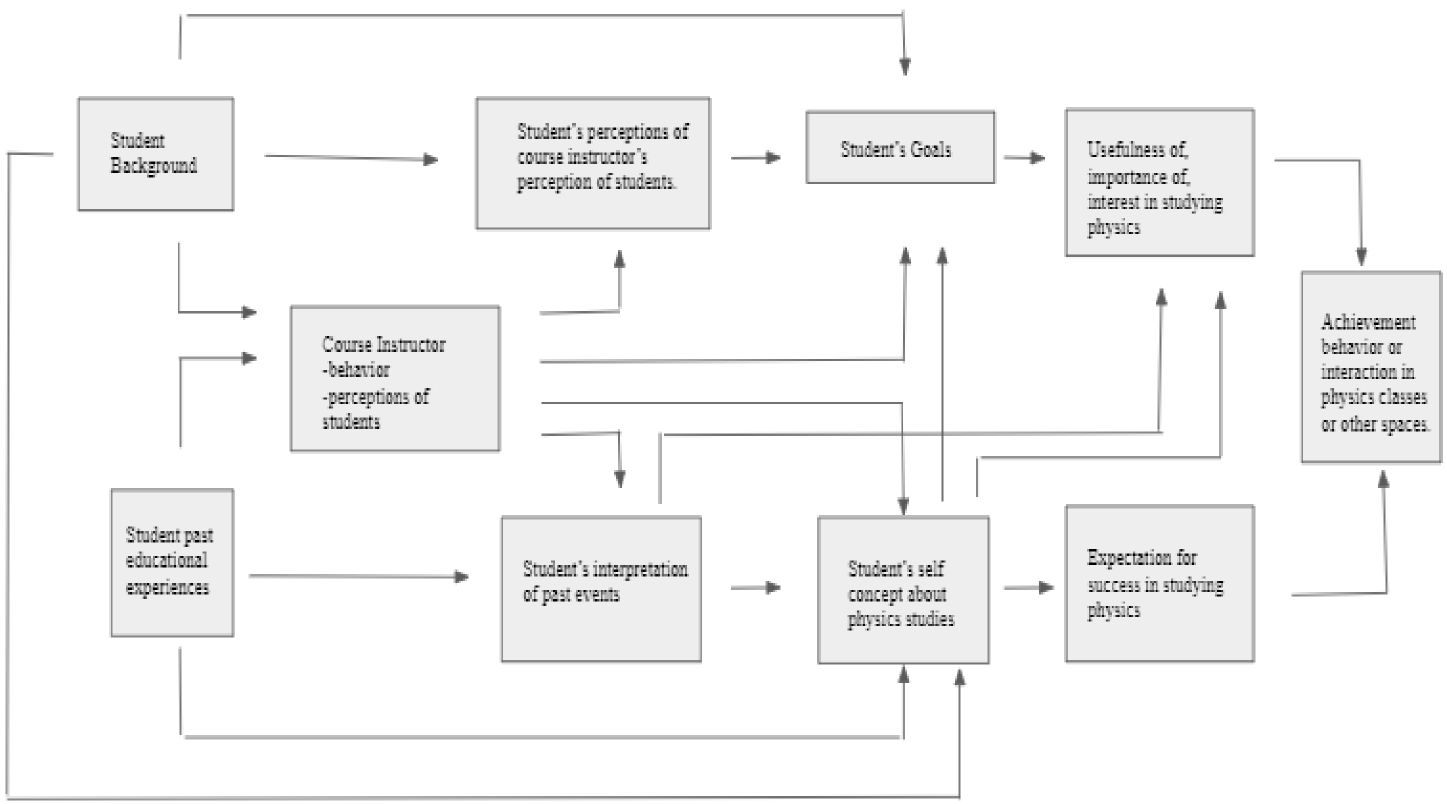
The findings of this study revealed that transfer physics majors' achievement-related socialization activities is a complex phenomenon. In many instances, students' socialization activities are influenced by their individual characteristics or institutional factors. Survey and interview data revealed transfer students possess ability beliefs and motives that generally support participation in the physics program. In some cases, transfer students' ability beliefs may have contributed to both low and high levels of student-student and student-instructor interaction in large and small group settings. Other students emphasized the importance of gaining content knowledge in preparation for entry into the workforce. Some students' socialization as physics majors were influenced by their preference for relationships with students outside of the physics program, and by a lack of value placed on new student orientation activities. The value students' place on, or their participation in, new student orientation events hosted by the university and the physics department further mediated their participation in co-curricular activities.

Faculty interview data revealed that the instructor held deficit beliefs about transfer students' physics expectations for success, their motivations for studies, social language use, and participation rates. Many of these findings were inconsistent with positive student ability beliefs, motivations for studies, and participation rates as revealed in student surveys, interviews, and classroom observation findings. Additionally, the course instructor espoused the importance of student interaction in gaining content knowledge and physics-based social language ability. However, within the classroom setting, the course instructor employed lecture-based teaching approaches that constrained student interaction.

As a whole, the classroom observations revealed appropriate levels of interactions between most students; however, instructional strategy shaped the nature of student interaction. In contrast to large group settings that constrained student interactions, active learning approaches in small group settings yielded high levels of both student physics-based language use and critical thinking development around evaluating problem-solving processes. Figure 5 shows the relationship between individual student and practitioner characteristics, behaviors, attitudes, and beliefs that potentially alter participation in socialization activities (Eccles et al., 1983).

Figure 5

Illustration of Relationships Among Sociocultural Variables



Chapter VI

Discussion of Findings

Nearly half of all university physics programs are facing threats such as budget cutbacks or program closures as a result of decreased public funding, enrollment declines, and demographic shifts (Redden, 2021). Since most physics programs typically incur high operational costs and low enrollment of students, many higher education institutions are now evaluating the economic viability of even the most time-honored degree programs. Grand Lakes University's strategic pillars call for expanding educational opportunities and for providing experiential and engaging student opportunities that advance progress toward institutional objectives. Motivating practitioners to address factors that shape physics students' educational experiences may address aspects connected to strategic pillars that increase students' motivation for their studies, student retention, and student graduation rates.

Many professional organizations task undergraduate institutions with establishing strategic planning recommendations that promote successful educational outcomes of physics majors (American Institute of Physics, 2020; American Association of Physics Teachers, 2005; Kozminski et al., 2014; Grand Lakes University, n.d.). Much research has emerged regarding programmatic recommendations for undergraduate physics programs. These research-based program recommendations address sociocultural factors including knowledge of student populations, curricula and pedagogy, institutional resources, institutional climate, and the creation of supporting and inclusive learning communities (Kozminski et al., 2014; American Institute of Physics, 2020; American Physical Society, 2005; McNeil, n.d.). These findings apply to higher education physics programs, yet research regarding how complex sociocultural factors influence transfer physics students' distinctive socialization experiences requires ongoing study.

Vygotsky's social constructivist theory is useful for understanding human activity that is mediated through interaction with social others or material semiotic resources that mediate an individual's activity. However, the Eccles et al. (1983) developmental model identified specific connections among cultural factors, historical events, expectancies, motives, and achievement-related behavior—all of which informed the understanding of links among individual and institutional sociocultural variables that mediated transfer physics student socialization experiences.

This study revealed that transfer physics students' participation in educational activities was influenced by a host of individual and institutional psychosocial factors. Institutional factors that mediated students socialization experiences included their: (a) beliefs about their own capacity to study physics; (b) their expectations for success in physics coursework; (c) their value beliefs related to studying physics; (d) their unique past educational and transitional experiences; (e) their institutional perceptions; (f) their perceptions of faculty and peers; (g) how transfer students experienced belonging as physics majors; and (h) their perception about the meaning of socialization, and how they experienced socialization. Also, institutional factors such as practitioners' teaching and the promotion of co-curricular activities influenced the transfer physics students' participation in educational activities. Significantly, while all of the transfer student respondents held positive perceptions of their transfer experiences and most students regularly participated in physics related classroom activities, some of these students did not place value on cocurricular activities or they may not have been aware of cocurricular activities that promote socialization as physics majors at Grand Lakes University. Furthermore, while the course instructor held deficit beliefs about transfer students' physics related abilities, motivation for studying physics, and their participation rates in educational settings, the instructor did investigate these beliefs via inquiry, nor did they modify their instructional approaches to account for potential differences in student ability, motivation, or differential participation rate in physics learning settings.

This study was guided by the following research questions and sub-questions:

1. How do regular-admit physics students, transfer physics students, and the physics course instructor describe personal beliefs related to their own or others' (a) physics content ability; (b) expectations for success in physics studies; and (c) how values attached to the value they place on their physics studies (i.e., utility of, importance of, and interest in) change as a result of participation in upper-division physics coursework?
    a. How do ability beliefs, expectations for success in physics coursework and the values students attach to physics studies influence students' participation in classroom or co-curricular activities?
2. How do individuals or groups of transfer physics majors or the physics instructor describe their own or others' socialization experiences related to participation in upper-division physics classrooms at transfer receiving institutions?
3. In what ways do transfer physics majors enrolled in upper-division physics courses at Grand Lakes University interact when participating in classroom activities?
    a. What are the larger or main activities (or sets of activities) occurring within upper-division physics classrooms at Grand Lakes University?

b. What upper-division physics classroom sub-activities comprise this or other activities?

4. To what extent do transfer physics majors enrolled in upper-division physics courses at Grand Lakes University engage in social language related to physics or other related disciplines?

    a. What discipline-specific content-based social languages are relevant (i.e., closely related to physics or other related discourses) or irrelevant (i.e., not connected to physics or related discourses)?

5. How is transfer students' at Grand Lakes University use of physics-related language or classroom activities developed over time within upper-division physics classrooms?

    a. How do individuals or groups of transfer physics majors adapt social language use throughout their experiences within their initial upper-division physics course?

    b. How does transfer physics majors' use of social language or activities become stabilized or transformed?

In this chapter, I first discuss the study's findings. Next, I will describe the limitations of this study. Last, I offer implications for policy and educational practice followed by context-specific implications for future research.

Key Research Findings

Several key findings in relation to the research questions emerged from the student survey, student interview, instructor interview, and classroom observations. These key findings are related to (a) transfer physics majors' physics-related ability beliefs, expectations for success, and the value they placed on their physics studies; (b) transfer physics majors' socialization experiences and corresponding sense of belonging;

(c) students' and the course instructor's classroom actions and interactions; (d) students' use of physics-related social language, their language development over the observed classes, and language adaptation in relation to physics-related higher order critical thinking; and (e) the course instructor's lack of reflection or inquiry regarding beliefs about transfer physics majors' physics content ability, expectations for success, their motives for participation in physics studies, and the nature of their physics-related curricular or co-curricular interactions or activities. These findings serve to inform the study implications for policy, practice, and future research.

Transfer Physics Majors' Expectancy and Value Beliefs

The first research question focused on how transfer physics students' beliefs about their physics-related abilities, expectations for success, value they placed on their physics studies influenced their activities connected to upper-division physics coursework at Grand Lakes University. The findings of this study indicated the importance of students' (and the course instructor's beliefs about transfer students' beliefs) content ability-related beliefs, their expectations for success in physics studies, and their value beliefs. All were attached to their participation but were not absolute predictors of students' participation in physics classroom or physics content-related co-curricular activities. A baseline comparison of regular-admit (previously socialized) and transfer (unsocialized) students' survey responses revealed that both groups of students reported positive physics-based ability beliefs, expectations for successful completion of physics courses, and value beliefs; all of which supported their participation in physics studies. However, disaggregated results revealed that one student who expressed lower ability beliefs displayed low levels of participation in the classroom setting.

Although students' physics content-ability beliefs and the value the transfer students placed on physics studies generally supported their participation in physics-related educational activities, several students expressed lower ability beliefs regarding their capability to “learn something new” in upper-division physics coursework. Interestingly, the classroom observation data revealed that individual transfer students as a whole engaged in both disproportionately high and disproportionately low numbers of student-instructor interactions in the small group classroom settings, but there is more to the story. One of my main arguments calls for the need to look at individual students by comparing findings across multiple instruments. The use of multiple measures allows for researchers to gain a understanding of the interrelation among the complex network of sociocultural factors that mediate student experiences and mediate achievement-related curricular and co-curricular activities. Students' low ability beliefs may have negatively mediated participation in classroom activities. However, some transfer students who possessed low ability beliefs regarding their ability to learn something new in physics also displayed the highest numbers of student-instructor interactions in small group settings. Findings related to students who engaged in unusually high numbers of student-instructor interactions in classroom settings may indicate high levels of interest in physics studies or a lack of confidence in their abilities to learn something new in physics. Students who lack confidence in their ability may have initiated a large number of student-instructor interactions, for the purpose of seeking guidance about problem solving strategies or outcomes. Unfortunately, student interview data did not yield information to clarify these findings. More research is needed to fully understand the complex relationships between student ability beliefs and participation in classroom settings.

Additionally, a comparison of transfer students' survey responses before and after the completion of physics coursework across an academic semester revealed that as a whole, transfer students initially possessed and maintained positive physics-based ability beliefs, expectations for success in physics coursework, and value beliefs related to physics studies. While the majority of the students held high motivational beliefs, one student reported decreased value belief responses related to the importance he placed on interacting with his peer physics majors. Despite reporting low value beliefs related to the importance of social interactions with peer physics majors, this student engaged in high levels of participation within the classroom setting. Beyond the findings of this individual student, the other transfer student participants in this study possessed positive expectations for success and placed value on their physics studies. These beliefs supported their participation in physics coursework within the classroom setting and suggest that the transfer physics participants possess social capital that supports achievement-related behaviors in the classroom setting.

Individual student interview responses of five transfer students revealed important insights about the value students placed on studying physics or interacting with peers in co-curricular settings. The student interview data revealed that several students expressed high levels of interest in studying physics that were both intrinsic and extrinsic in nature. Several students showed their interest through saying they enjoyed studying physics, while others demonstrated their interest in physics through their classroom or co-curricular activities. Other students' interests were connected to intellectual curiosity that drives their physics studies (i.e., intrinsic interest) versus practical experiences needed to finding a job (i.e., extrinsic interest). Significantly, two student interview respondents placed an importance on social relationships with students outside of the physics major who were non-physics major roommates or who shared previous educational trajectories separate from studying physics. While these students displayed high levels of classroom participation, they did not participate in physics-related co-curricular activities, nor did they interact with students in common spaces outside of the classroom.-

Interview data revealed information about the course instructor's beliefs about transfer physics students' expectations for success and value beliefs related to physics studies. The instructor relayed beliefs about transfer students through a series of statements that represented generalizations about the student population at Grand Lakes University. When asked about transfer physics majors, the course instructor stated that transfer students held low expectations for success in their physics studies. These findings contradicted the findings that the majority of transfer students held positive physics-content ability beliefs and beliefs related to expectations for success in physics coursework. Furthermore, the course instructor asserted that transfer physics students placed little importance on their physics studies and they attached utility value to their studies in relation to securing employment after graduation. Significantly, these findings also contradicted the student survey findings. According to survey findings all of the transfer students reported positive attainment values (i.e., the importance placed on studying physics) on pre- and post-surveys. However, the course instructor statements were consistent with students' interview responses that communicated placing utility value on their physics studies; most students stated that the utility value of their studies was connected to intrinsic interest in content applicable to future careers. Finally, despite espousing the importance of collaborative interactions in classroom settings, the course instructor employed instructional strategies that constrained students' physics-based dialogue in large group settings. Conversely, in small group settings the instructor employed an instructional approach that corresponded with high levels of content-based dialogue and the development of critical thinking processes around the evaluation of problem-solving processes and outcomes.

Since practitioner related deficit beliefs may underpin aspects of instructional design, the course instructor's beliefs concerning (a) transfer students' expectations for success; (b) motives for participation in physics coursework; (c) language use; or (d) rates of participation (although undisclosed to students) may influence instructional behaviors that mediate student socialization experiences. Eccles et al. (1983) posited that a student's own beliefs (or their socializer's attitudes and expectations about students) potentially mediate students' perceptions and attitudes toward their socializer (e.g., course instructor), task-specific self-concept, goals, expectancies, and subjective task values, all of which mediate achievement-related behavior such as classroom participation or participation in co-curricular activities.

Students' Socialization Experiences and Sense of Belonging

The second research question focused on transfer students' descriptions of their socialization experiences related to participation in physics coursework at Grand Lakes University. Individual student interview responses provided relevant information about transfer students' (a) unique previous educational experiences; (b) transition experiences when beginning their studies at Grand Lakes University; (c) perceptions of Grand Lakes

University and the physics department; (d) perceptions of faculty and peer physics majors; (e) socialization experiences; (f) sense of belonging; and (g) statements regarding their value beliefs related to educational activities, all of which influenced their participation in classroom and co-curricular activities.

Student responses indicated that a variety of sociocultural factors influenced transfer students' participation in physics coursework or other socialization activities at Grand Lakes University. Students' positive and negative experiences studying physics at previous institutions led to their enrollment in the physics program at Grand Lakes University. These participants noted they did not encounter challenges during their transition into the Grand Lakes University physics program. Of note, while transferring to Grand Lakes University, three of the five participants did not attend or did not find value in the content of orientation events conducted by academic advisors. Decreased participation in student socialization activities (lower social capital) could be explained through decreased attainment value beliefs communicated during student interviews. The importance transfer students placed on participation in new student orientation events impacted their physics-based co-curricular activities such as collaboration within common student spaces or participation in physics-related student organizations. Of the students who did not attend or find value in the orientation events, three respondents were either unaware of or did not participate in important co-curricular activities such as the physics club room—a common space where students meet to work on assignments and/or to socialize. Another student who attended the orientation event mentioned networking with established physics students and that his regular participation in co-curricular activities bolstered his sense of belonging as a physics major and intrinsic interest in physics studies. These findings are significant as several of the transfer physics participants engaged in a limited number of interactions with their physics peers and were unaware of socialization opportunities within the physics club or physics-based student groups hosted by the department.

The interview findings revealed that transfer students held neutral-to-negative perceptions of the institution as a whole. However, students' positive perceptions of the physics faculty and their physics-major peers mitigated negative institutional perceptions. While all of the transfer physics student participants expressed beliefs regarding the importance of belonging within the physics major community, two transfer physics majors found value in social affiliations with students outside of the physics major community and rarely participated in physics-related co-curricular activities. Most importantly, another student attributed his strong sense of belonging as a physics major and increased interest in physics subject matter to regularly interacting with his physics-major peers in common spaces and attending student-based professional meetings. Although several transfer students stated that they did not regularly interact with other physics majors outside of class or were unaware of co-curricular activities within the physics department, all interview participants (excluding transfer student Tyson) participated regularly in the classroom settings. Additionally, faculty interview data was consistent with the student interview findings that support the value of sustained interactions in curricular and co-curricular activities in relation to students' adoption of physics discourses. These findings are relevant as attainment value is related to the importance individuals attach to a task as it relates to their conception of their identity and ideals or their competence in a given domain (Wigfield, 1994). Eccles and colleagues' developmental model affirms that students who recognize the importance of performing tasks (i.e., engaging in physics studies) will maintain motivations to set and establish goals through appropriate achievement-related choices. According to Lave and Wenger (1991), learning is viewed as a process where, through legitimate peripheral participation, newcomers become a part of a community of practice. Legitimate peripheral participation involves socialization in a community of practice that is mediated through apprenticeships with more knowledgeable others, who are presumably socialized members of the community. These interactions help to shape learners' understanding and make meaning, which, over time, alters one's identity and shapes their relationship with other community members. As related to a constructivist point of view, a variety of interrelated sociocultural influences shape transfer students' experiences in their new educational surroundings. Individuals' perceptions related to tasks (i.e., physics studies) and social affiliations in learning communities mediate individual motivation and achievement-related behavior (Eccles et al., 1983).

Classroom and co-curricular socialization activities and beliefs may mediate participation in what Lave and Wenger (1991) and Rogoff (1990) described separately as culturally-based collaborative endeavors that extend transfer students' skill and involvement related to transfer physics majors' physics discourse appropriation. A host of individual and institutional psychosocial and structural sociocultural influences mediate students' adoption of physics-discourse-based ways of being. These sociocultural influences, particularly engaging in regular collaborative interactions with other physics department members, help individuals become acquainted with the standard tasks, vocabulary, and organizing principles of the community of practice.

Acquiring these skills, dispositions, or value beliefs (i.e., habitus) through participation in meaningful activities eventually helps them gain an identity as a socialized member within a community of practice (Lave & Wenger, 1991). Even though ample socialization opportunities exist at Grand Lakes University, explicit efforts on the part of institutional socializers (e.g., faculty, peers within academic programs) are needed to guide learners' movement from limited to full participation within academic communities (Lave & Wenger, 1991; Rogoff 1990). Implications related to these and the upcoming findings will be addressed later in this chapter.

Classroom Actions and Interactions

The third research question focused on the classroom participants' interactions within upper-division physics classes at Grand Lakes University. Contrary to the course instructor's beliefs that transfer students were generally more hesitant to lead discussions or to ask questions than regular-admit physics students, the findings of the classroom observations revealed that the transfer students were well represented in terms of interactions in large and small group settings. Observational data from classroom settings supported the course instructor's belief that participation rates varied among individual students.

During large group sessions, lecture or monologue and triadic dialogue, characterized by instructor-student-instructor turn taking in the classroom, represented the dominant classroom communication pattern. Lemke (1990) recognized that patterns of interaction and discourse in classrooms are altered by the instructor's choice of activity structure. Lemke (1990) further defined activity structures as "a sequence of predictable options for who will say or do what sort of thing next" (p. 49). These instructional strategies resulted in a limited number of classroom participant interactions and constrained meaningful dialogue between the instructor and students.

Classroom observations of participant interactions revealed that in large group settings, a small proportion of transfer physics students engaged in student-instructor interactions that exceeded that of regular-admit students enrolled in the course. The student-instructor interactions frequently involved the use of triadic dialogue, which limited students' use of higher-order communication processes, such as students assessing their own or others' assertions or providing a rationale for their content-related beliefs. Additionally, the use of teacher-centered activity structures in large group settings also limited interactions between learners.

Within small group settings, many of the transfer student participants were observed engaging in collaborative problem solving while interacting with other transfer students, regular-admit students, and occasionally with the course instructor. During small group sessions, the nature of instructor-student interactions shifted from teacher-initiated interactions to student-initiated discussion and dialogue. These interactions involved students posing clarifying questions, making critical assessments of their own and others' potential solution beliefs, and evaluating rationales for problem solving strategies or outcomes.

During small group sessions, the greatest proportion of student-instructor interactions were initiated by transfer students. In many cases, the student-instructor interactions involved students consulting the course instructor about the merits of their problem solving strategy, or by students asking the course instructor to provide information about problem solving approaches. A small segment of the transfer students enrolled in the course engaged in the majority of student-instructor interactions. Significantly, several transfer students never engaged in interactions with the instructor during the observed classes. Both large and small numbers of student-instructor interactions may have been attributed to transfer students' low ability beliefs in relation to learning new content within their upper division coursework. Higher levels of interaction may have been connected to students' lack of physics-related content and lower levels of interaction may have been related to low levels of student agency. More research is needed to understand the connections between students' expectations for success and interactions with course instructors in the classroom setting.

Student-student interactions within the small group settings involved learners engaging in on-topic (i.e., relevant) and off-topic (i.e., irrelevant) conversations. The frequencies of individuals' and groups' on-topic social language use (i.e., critical thinking processes) were disparate in distribution and varied across the observed class dates. Within small group settings, student-student and student-instructor discourse occurred in the goal of identifying, assessing, and evaluating problem-solving strategies and outcomes. Importantly, in both large and small group settings, interactions occurred spontaneously, as the instructor did not explicitly state expectations for student participation.

Social Language Distribution, Development and Adaptations

The final research questions focused on patterns of discourse that emerged when transfer physics majors engaged in problem solving in small group settings. Collaborative group work in small group settings was associated with extensive student-student and student-instructor discussion, dialogue, and debate. Transfer physics majors engaged in both on- and off-topic discipline-specific social language use that varied in distribution across the participants. Interactions in small group settings contributed to the development and adaptation of students' critical thinking processes across the observed class sessions.

The findings are that transfer and regular-admit physics students engaged in on-topic discipline-specific social language that was slightly uneven across individual students and with the exception of one of the observed students, stable in distribution across the observed class dates. While the frequency of students' physics-based language use varied across individual students on various dates, most students were represented within social interactions. In addition to coding on-topic discipline-specific social language use, this research involved coding critical thinking language-based attributes to determine the extent to which group members engaged in critical thinking processes also varied across the observed groups.

One transfer student who expressed decreased physics-based ability and physics related value beliefs did not engage in collaborative group work. His lack of interaction resulted in limitations in the understanding of this student's critical thought process. Although critical thinking can occur while engaging in self-talk or interaction with material semiotic resources (e.g., text), students' critical assessments and judgments about potential solutions or problem-solving outcomes were observed through verbal interactions in the small group setting. These findings are significant as a lack of social interaction and dialogue on this student's part hampers the ability to identify his content-knowledge or critical thinking abilities. It should be noted that the instructor did not provide student guidelines for participation in group discussion, nor did other students invite this individual to participate in collaborative group work in the small group settings. Other students engaged in extensive physics-content-related conversations that allowed for the observation and analysis of critical thinking processes in the classroom setting. One recommendation based on these findings includes the incorporation of the prescribed, random, and dynamic grouping of students. Such grouping methods encourage social interactions among students and provide opportunities for learners to experience a wide variety of perspectives, as well as promoting social presence in classroom settings.

From a constructivist standpoint, the incorporation of collaborative problem-solving sessions, that employed discipline-specific social language, represented an instructor mediated behavior that encouraged the students' use of higher order thought processes in the classroom setting. The observation of three groups composed of transfer and regular-admit students, revealed ongoing dialogue among the groups and, with varied frequency for the observed groups, consultation with the course instructor. Dialogue among students and the course instructor was centered on clarifying aspects of problems or seeking validation of their problem-solving strategies. The observation of student discussion in small group settings revealed increases in the frequency of all three groups of students' higher-order thought processes (i.e., embodied linguistic capital) across the observed class dates. These findings imply that small group settings centered on collaborative problem solving promote meaningful dialogue amongst learners. Such circumstances provide opportunities for students to seek clarification about problem solving strategies, assess their or other's thinking, and provide justification for thinking regarding the value of their strategies or outcomes.

Adaptations in transfer and regular-admit physics-based social language involved shifts in the distribution of lower-order and higher-order critical thinking processes. The complexity of critical thinking observed during student conversations shifted from lower-level to higher-level critical-thinking-based language for all of the observed groups. Increases in the complexity of the observed groups' critical thinking, as observed in language use in group settings, were associated with social processes (e.g., student-student and student-instructor interactions) in small group settings. These represent significant findings that support the course instructor's beliefs about the value of sustained academic interactions and authoritative guidelines that prescribed standards for goals in relation to content-knowledge and the acquisition of scientific skills such as critical thinking (Kozminski et al., 2014; McNeil, n.d.).

Summary of Findings

To summarize, transfer physics majors (a) physics ability-related self-concept, their motivations for participation in physics-related activities; (b) their sense of connection with the physics department, physics faculty members, and other physics students; and (c) the nature and frequency of interactions with other students and faculty in classroom or co-curricular settings, all further mediate individual student's socialization as physics majors at Grand Lakes University. This study revealed that socialization as a physics major was impacted and mediated by all of the previously mentioned activities and beliefs, and was further mediated by complex interrelations among these factors that varied over time and across members of the physics department community. These findings have important implications for policy, practice, and future research.

Study Limitations

There were several limitations in this study. First, the research was limited to one section of the entry-level upper-division physics course in which transfer physics majors participated after beginning studies at Grand Lakes University. Although the research was representative of the typical transfer students' experiences, one of the participants, transfer student Thatcher, was enrolled in the upper-division physics course for the second time after unsuccessfully completing the course in previous semesters. This student briefly attended Grand Lakes University as an engineering major before enrolling at a community college before returning to Grand Lakes University as a physics major. While this student stated that he maintained his relationships with students he originally attended Grand Lakes University with during his previous enrollment, this student did not appear to experience socialization issues within his role as a physics major. Thatcher mentioned that he carried positive perceptions of the physics faculty members and his physics major peers. Of significance, this student stated that he prioritized his friendships with his roommates over social relationships with his physics major peers. Despite prioritizing relationships outside of the physics department, Thatcher participated regularly in the classroom setting and mentioned the importance of interacting with other students within shared student spaces such as the Grand Lakes University physics club room. Furthermore, another transfer student, Tyson, who expressed negative expectancies and subjective-task belief responses on the pre-survey, did not participate in collaborative learning activities in small group settings, nor did this student complete the post-survey or respond to solicitation to participate in student interviews. The small sample size, the research venue, and the idiosyncratic nature of students' responses and observational data may not be representative of other transfer physics majors' individual perceptions, attitudes, values, and participation experiences in upper-division physics courses at Grand Lakes University.

Second, the original research protocol called for conducting classroom observations over ten class sessions over the course of an academic semester. A shift from in-person to remote class meetings due to the COVID-19 pandemic hampered the ability to observe collaborative group work in small group settings. However, the abundant data collected over the course of five class meetings allowed for an understanding of the distribution, development and adaptation of discipline-specific social language use within upper-division physics courses. Unfortunately, these circumstances limited the number of follow-up questions and probes during the instructor interview. These limitations resulted in an incomplete understanding of the course instructor's beliefs about transfer students' abilities and motivations for participation in physics coursework.

Third, while the group compositions (i.e., student members within each group) remained stable, consisting of the same students over the observed class periods, the student composition in terms of matriculation and number of students in each group during small group sessions varied, making intergroup comparisons of the frequency of students' social language use impossible. For example, some student groups consisted of two students, other groups contained three students. Additionally, some groups were mixed in terms of matriculation, containing both transfer and regular admit physics students, where other groups contained only transfer students or only regular-admit students. It should be noted that in the observed upper-division physics course, there was an additional laboratory class, taught by a different instructor that met weekly at a separate class time. During the laboratory sessions, students worked collaboratively in small groups to collect, analyze, and communicate experimental data and findings. These classes were not observed as a part of this research study. The group composition and the nature of participant interaction were unknown within the laboratory settings, limiting the understanding of how these laboratory sessions shaped students' language development or socialization activities.

Fourth, the research protocol did not call for the incorporation of academic advisors' understanding of transfer students' experiences or goals related to transfer student orientation or advising activities. Since Grand Lakes University academic advisors facilitate new student orientation events, a lack of data regarding academic advisors' roles and perspectives related to transfer students' participation hampers the understanding of why the transfer physics majors did not attend or find value in campus-based socialization activities. Academic advisors' or other relevant staff members' perspectives of transfer physics majors' socialization experiences should become a focus of future research.

Lastly, in many instances, students' utterances transcribed from the audio or video recordings during large and small group sessions were unobserved (i.e., not recorded) or inaudible due to background noise or overlapping speech, and were not included in the data analysis. In large group settings, the total number of inaudible or unrecorded utterances represented an insignificant portion of the total number of participant interactions. Additionally, in small group settings, only three of the six groups were observed, because one group did not contain transfer students, and because the other two groups contained individuals who chose not to participate in this research study.

Implications for the University and the Physics Department

The results of this study reinforce the importance of action on the part of stakeholders associated within the physics education community of practice, who share interests in cultivating an institutional culture that embraces evidence-informed subject-based pedagogies. Such professional activities should (a) account for students' content-based ability beliefs and the value they place upon participation in coursework or co-curricular activities; (b) interrogate practitioners' beliefs and assumptions about students' content-abilities, motivations for participation, and educational activities across a variety of markers of student difference (e.g., matriculation status or other relevant differences;, (c) routinely use disaggregated data across individual and groups of students; and (d) leverage the understanding of students' or practitioners' ethics, beliefs, values, and behaviors while designing and facilitating programmatic change initiatives related to instructional processes in the context of professional learning communities or greater communities of practice.

Professional learning communities that exist within the confines of physics departments, the university, or extended professional associations offer important venues to adopt and mobilize institutional policy, and practice recommendations that promote an organization's ability to learn (Dufour & Eaker, 1998). Apart from providing concrete suggestions regarding reflection on physics students' and instructors' psychological beliefs and values when modifying policy and practice, most importantly, the upcoming suggestions allow circumstances that first, inspire, and then enable learners to discover factors that inhibit or facilitate organizational learning or produce new strategies that increase organizational knowledge (Eilertsen & London, 2005).

The next section will first detail policy and leadership considerations related to employing knowledge of a variety of ethical paradigms that serve as an impetus for practitioners to adopt a critical stance toward addressing institutional processes that shape student experiences. Such approaches should involve creating policies that enable inquiry that reveals and then compares students' and instructors' underlying beliefs, assumptions, and values about physics studies that, in turn, influence student participation in classroom or co-curricular socialization activities. Specifically, these policies should encourage diagnostic benchmarking, which is achieved through the collection and disaggregated analysis of the course instructors' and students' assumptions, beliefs, and values using multiple approaches to measure individual requirements (e.g., surveys, interviews or discussions, classroom observations, etc.). Such measures inform practitioners' understanding of the interrelations between stakeholders' assumptions, beliefs, values, and how these and other yet-to-be-discovered factors influence behaviors, such as students' classroom participation or course instructors' teaching methodologies. Other policy considerations involve including all critical stakeholders in data-driven decision-making processes. Including all critical stakeholders (e.g., practitioners, students, etc.) increases the cognitive capacity of the organization when imparting organizational change (Kezar & Lester, 2011).

Policy and Leadership Considerations

Policy implications at the institutional level come from four places: a) knowledge related to assessment data that showed inequitable outcomes for transfer physics majors;

b) research findings that revealed how sociocultural factors (i.e., motivational factors, interactions, and socializer perceptions and activities) influence student socialization activities; c) the recommendations in the extant literature regarding institutional priorities and practices; and d) missions related to student learning and organizational viability and sustainability. The Grand Lakes University mission statement espouses the importance of providing multiple pathways (e.g., transfer pathways) toward earning educational credentials along with a commitment to assisting students in achieving successful outcomes that build human, infrastructure, and resource capacity ([Grand Lakes University] Mission Statement, n.d.).

From an operational value standpoint, current institutional policy emphasizes the importance of creating an inclusive, agile, and responsive approach toward facilitating educational programs. Enabling this approach to facilitate educational experiences requires the adoption of a transformative approach toward leadership that first creates a shared vision bound around what Senge (1990) called a common aspiration. Considering that most academic divisions within higher education are characterized as loosely coupled organizational units that have highly specialized functions, implementing mission driven change pose challenges (Morgan, 1986). Working under the assumption that most academic organizational units are rarely influenced by means of administrative influence or power regarding mission or vision driven teleological change initiatives, educational leaders should seek to impart change by appealing to practitioners' principles of morals and ethics as a motivation for change (Kezar, 2001; Burns, 1978).

Ethical-Based Impetus for Change. Decision-making as related to programmatic initiatives that critique and interrogate institutional processes that perpetuate inequitable learning outcomes call for the use of knowledge of multiple ethical paradigms (Dantley & Tilman, 2010; Wood & Hilton, 2012). Wood and Hilton (2012) suggest that viewing decision-making processes through the lens of multiple ethical paradigms provides change agents with frames of references from a student, leadership, and societal perspective that serve as an impetus for change. This study revealed that despite believing that transfer students' abilities, motivations, use of language, and interactional tendencies were both malleable, the instructor did not interrogate or examine their thinking or practice to address these concerns. Practitioners who hold deficit beliefs about students frequently shift the responsibility of student outcomes to other stakeholders, such as, by attributing previous educational experiences to lower levels of ability or motivation (Bensimon, 2005; Wood & Hilton, 2012). Instead, change agents should call on practitioners to reflect on decision-making using ethical paradigm frames that: (a) support equitable treatment of learners; (b) place an emphasis on people over principles; (c) challenge the status quo by confronting practices or processes that lead to inequity; (d) serve the best interest of students by promoting professional standards; and (e) promote leadership by establishing shared community values at the departmental, university, and community of practice level.

Unlike transactional management approaches that adopt and implement change-based policy without reflecting on the assumptions and beliefs that underpin decision-making, transformative leadership models seek to "raise the level of human conduct and ethical aspiration of both the leader and led, and thus it has a transforming effect on both" (Bums, 1978, p.20). From a leadership perspective, framing challenging educational issues within ethical paradigms assists in viewing problems from a variety of perspectives and may provide connections between the individual change agent, initiatives within institutions, and initiatives of their affiliated communities of practice. The study findings presented next have ethical implications that suggest the need for policy and practical considerations which address factors that impact student experiences while studying physics at Grand Lakes University.

The study revealed that the observed instructor did not routinely engage in programmatic decision making that incorporates knowledge of how individual or institutional sociocultural influences alter individual or groups of students' activities or socialization experience. These findings suggest the need for policies that enable inquiry that leads to the discovery of new knowledge that informs our understanding of transfer students' (and other students') socialization, particularly in terms of initiating inquiry related to physics students' ability beliefs, their expectations for success, the value placed on studies, and the relationship between students' socialization activities in relation to their espoused importance of belonging within the physics major community. Within the departmental settings, educational leaders should facilitate the creation of policies and institutional structures that oversee the factors that mediate student experience (American Institute of Physics, 2020). Bensimon (2005) recommended creating a culture of inquiry through the adoption of policies related to equity cognitive frames. Specifically, these equity cognitive frames focus on how institutional practices or practitioner perceptions impact educational outcomes and experiences. Individual and institutional factors that alter transfer physics majors' and other students' educational experiences can be addressed through policies that facilitate ongoing inquiry. Addressing these factors requires the adoption and implementation of institutional policies and practices that routinely reflect on how practitioners' beliefs, attitudes, and assumptions influence decision making.

Also, practitioners should adapt assessment policies to routinely use disaggregated indicators at the group (e.g., transfer student population, etc.) and the individual student level. Routinely, disaggregating data will provide greater clarity as to how practitioners can alter institutional assessment practices to better understand how individual and institutional sociocultural factors impact students' educational activities. Furthermore, adapting and implementing equity-based policies and practices can be better accomplished through adopting what Kezar and Holcombe (2017) described as shared leadership. Shared leadership represents a transformative leadership approach that capitalizes on the cognitive capacity of all critical stakeholders when developing theories of change regarding student socialization or other relevant educational experiences. (American Institute of Physics, 2020).

Complex problems, such as socialization experiences, of a diverse student body, call for use of a greater cognitive capacity, which should be assumed by each and every educational stakeholder. The complicated results of this research study emphasize the need for policy that includes a wide range of stakeholder perspectives to account for how known and yet-to-be-discovered sociocultural factors alter students' educational experiences. Last, the results of this research study also reinforce the need for policy regarding the provision of professional development and other resources within the contexts of professional learning communities or faculty learning communities that support ongoing inquiry. Educational processes within higher-education settings are dynamic and ever-changing, which necessitates addressing how complex networks of time-changing sociocultural influences alter students' educational experiences.

Archetypal sociocultural models like Eccles et al.'s (1983) developmental model help to frame practitioners' understanding of student experiences. However, the distinctive nature of individual or groups of students' socialization experiences requires that institutions dedicate resources to identify emerging factors (e.g., the impact of COVID-19, funding decreases, etc.) that influence transfer physics students' socialization experiences. Additionally, university policies should provide practitioners with credit towards institutional service requirements commensurate with time contributions and knowledge yielded from ongoing assessment inquiry (American Institute of Physics, 2020).

Educational Practice Considerations

Higher education stakeholders play a crucial role in shaping students' educational experiences. Garrison's (2016) Community of Inquiry (COI) model serves as a useful mental model that places educational experiences at the intersections of social presence, cognitive presence, and teaching presence. In doing so, the model provides a framework for understanding educational processes that potentially mediate student experiences. Garrison, Anderson and Archer (2001) advocate that the COI model guides practitioners to promote learning environments which incorporate each type of presence. Social presence is the way students identify with the learning community. Cognitive presence is the extent to which learners make meaning by connecting with course content through sustained discourse. Finally, teaching presence is the way practitioners design, implement, and modify cognitive and social processes that are purposefully meaningful and worthwhile educational outcomes.

The COI framework is helpful in framing key factors related to facilitating student experiences in physics classrooms or within the physics learning community. Based on this study, several key factors should be considered by educational practitioners when developing or adapting programs related to aspects of physics student programs or physics course instruction. Each factor relates to at least one of the types of presence. First, the course instructor held deficit beliefs based on negative generalizations about transfer students' expectations for success in physics coursework, physics-content abilities, motives for studying physics, and language abilities. Despite harboring these beliefs, the instructor did not seek to identify transfer students or investigate how student beliefs and motivations influence their achievement-related behaviors. Establishing a teaching presence calls for the collection of data related to sociocultural factors that allow for the instructor's beliefs to be compared to those of the students. The collection and analysis of data related to student physics-related abilities, expectations for success in physics coursework, and the value students place on physics studies allows for diagnostic benchmarking of factors that mediate short- and long-term achievement-related behavior in curricular and co-curricular settings (Dowd, 2005). Institutional policies should provide resources to support the ongoing incorporation of data-related benchmarking processes that inform decision-making related to the facilitation of instructional pedagogies or other aspects of programmatic function. For example, as employed in this research study, Wigfield and Eccles's (2000) Expectancy-Value item questions were useful in identifying student content ability beliefs, expectations for success in content studies, and motivational values (connected to habitus) connected to participation in educational activities.

The modification and use of Wigfield and Eccles's (2000) survey items and student interview data allowed for the understanding of students' beliefs and motivations connected to broad or specific aspects of the physics program at Grand Lakes University. Survey and interview data can assist practitioners in adjusting their educational practices to address individual or groups of students' unique educational needs. For instance, course instructors can use belief and motivation data in identifying circumstances where students would benefit from the adaptation of educational resources or instructional approaches. In cases where survey or interview data revealed that individuals possess limited ability beliefs or expectations for success, teaching presence may involve modifying instruction to move students from states where they require assistance to perform tasks to a state of autonomy. Techniques for modifying teaching approaches may involve presenting course content at graduated levels of difficulty (i.e., scaffolding), coupling learners with more knowledgeable others (e.g., classmates, tutors, etc.), or providing other material resources to mediate learning (Rogoff, 1990).

Student survey and interview responses revealed the importance students place on participation in coursework, their identity as physics majors, or participation in co-curricular activities. Presenting various forms of assessment data to a wide variety of stakeholders assists practitioners in making the purposes and benefits of student participation in these activities explicit to transfer physics majors or other students within the academic community. Lastly, establishing teaching presence may include using survey or interview data related to the utility students place on their physics studies in relation to current or future coursework or topics of study. Student assessment data about uses of physics content provides discussion points within the classroom (or in online course management structures) that assist in creating a future vision of the relevance of course content to future studies.

The purposeful communication of practitioners' rationale for collecting expectancy and task value data through the use of student survey or interview results is an important part of what Gee (1999) described as creation of metaknowledge of discourses (i.e., ways of being). As stated in previous chapters, creating metaknowledge assists learners in seeing how their current states of being (i.e., primary discourses) are related to or impact physics-related discourses. Teaching strategies that shed light on how their primary discourses relate to target discourses (e.g., physics-related ways of being) represent what Rogoff (1990) described as apprenticeships in thinking. Rogoff (1990) viewed apprenticeships in thinking as important intellectual tools that assist in developing one's thinking as he or she participates in educational activities under the guidance of practitioners and socialized student peers. Such apprenticeships aid in creating a consciousness of differences in students' current states of being (i.e., novices) as compared to those of fully socialized physics majors (Lave & Wenger, 1991). Ideally, creating knowledge of these states of being, coupled with interactions with socializers (e.g., educational practitioners, other physics students, learning assistants), will assist in moving learners through the zone of proximal development from unsocialized newcomers to socialized participants (who possess social capital) within the physics major community at Grand Lakes University.

The use of survey and interview data not only aids practitioners in designing educational activities, but this data also assists individuals in examining and reflecting on their own content-related ability beliefs, expectations for success, and motivations for participation. All of these factors alter students' academic progress and their identities as students within their chosen academic major. Anonymized data should also be made available to relevant stakeholders (including the physics students) within professional learning communities as a part of formative and departmental assessment.

Second, effective practice calls for establishing social and cognitive presence. Social presence requires practitioners to design and implement educational activities to communicate students' personal characteristics to other students in the learning environment. Similar to social presence, establishing cognitive presence involves employing teaching techniques intended to connect learners' motivational beliefs to future academic or professional goals. Techniques that promote social and cognitive presence foster a student's sense of belonging in classroom settings by establishing dialogue among classroom participants (i.e., students and the class instructor).

While the research revealed abundant social interactions and value beliefs connected to the content, the findings of this study highlight the importance of identifying aspects of sociocultural factors that mediate student experience. Finally, this study revealed that instructional activity within large group settings limited student interactions that provided opportunities to share and project personal characteristics or content-based motivational beliefs.

One possible strategy for achieving social and cognitive presence includes providing opportunities for students to share personal information (social presence) or learning goals related to course participation (cognitive presence) through the use of discussion prompts in online course management systems. Some potential discussion topics may include students' personal background information, past coursework experience, expectations in relation to physics coursework, and perceived value of the content-knowledge or skills students gain that support their academic or occupational goals. Discussion forums offered within online class platforms (e.g., Google Classroom, Canvas, Discord, Blackboard, etc.) provide venues for instructors to facilitate dialogue related to topics that promote social and cognitive presence and foster social connections (a form of capital) among class participants. Beyond creating connections with other students and the course content, discussion threads provide the instructor with opportunities to gather information about students' previous experiences with the content, course expectations, and motivation for participation.

Third, establishing teaching presence, along with satisfying institutional and disciplinary learning goals, calls for a shift from teacher-centered to active-learning activity structures. As observed in large group settings, teacher-centered activity structures constrained student dialogue. One course-design aspect that provides for engaging active-learning opportunities is flipping the classroom, where the burden of reviewing course content is shifted to the student prior to attending class (Mazur, 1997). Flipped classrooms or using Just-In-Time-Teaching (JiTT) techniques involve structuring class time around the use of mini-lectures and conceptual questions to engage learners. Administering questions through the use of student response systems (e.g., web-based response or clickers) offers all class participants formative feedback related to content understanding.

As related to the findings of this study, flipped classroom approaches that incorporate formative-based open-ended conceptual questions provide opportunities for a greater number of students to engage in content-based discourse. Such activity promotes conceptual understanding and forms thematic connections, which are both important aspects of discourse acquisition (Gee, 1990, Lemke, 1990, Mazur, 1997). Activities that promote dialogue and critical evaluation of thinking, deepen learners' understanding of content-related skills and knowledge. Establishing expectations for student participation can improve students' interaction rates. These expectations should involve encouraging all students to engage in dialogue through the administration of open-ended formative questions. Formative assessments embedded in instruction provide information that enables ongoing inquiry. Formative assessments coupled with student dialogue encourage students to make critical assessments and justify their thinking. These strategies require students to demonstrate content knowledge and discipline-specific linguistic ability (a form of embodied cultural capital). The illumination of student thinking processes provides instructors with opportunities to modify (and to further scaffold when needed) teaching approaches to address students' errors in thinking. Scaffolded instructional approaches are important tools for moving learners through the zone of proximal development (Rogoff, 1990).

In small group settings, students engaged in extensive in-group dialogue with the goal of clarifying their problem-solving strategies, making assessments of thinking, and evaluating problem solving processes and computational outcomes. Observations of interactions within small group activity settings revealed extensive physics-related social language use. For most groups, the social language use involved the development of higher-order critical thinking processes. According to the instructor, the acquisition of discipline-specific social language and higher-order thinking (i.e., critical analysis, or epistemic thinking) represents an important learning outcome that students will use in future upper-division courses and applied research sequences.

Observations in small group settings revealed that much of students' higher-order thinking was associated with the clarification, critical analysis, and evaluation of problem-solving strategies as opposed to the meaning and relevance of problem-solving outcomes in relation to physics or other relevant content disciplines. Based on these findings, practical tools for establishing teaching presence include explicitly stating the importance of acquiring and using critical thinking processes within upper-division physics courses and explicitly stating the future utility of these skills in research course sequences.

These goals can be accomplished by providing open-ended classroom activities that require students to supply justification or rationales for thinking or outcomes. From an instructional standpoint, assisting learners in the acquisition of higher-order thinking skills should involve modeling and then encouraging appropriate student contributions (i.e., justifications or evaluation of thinking). In recognition of both the growth in the critical thinking processes observed in small group settings and the lack of participation noted by some students, practitioners should set expectations for group participation and activity that encourages contributions and an openness of exchange from all individuals. Fourth, while classroom interactions play an important role in the socialization of transfer physics majors, the results of this study also revealed the importance of interactions with social others in informal education settings. Such interactions include those with faculty or other practitioners outside of the classroom setting (e.g., during orientation events, during office hours, during departmental functions, or via email) and those with peers in dedicated student spaces or in student-based learning communities (e.g., physics club, or PhysCon). Intentional interactions and communications can be used to extend social (capital) and cognitive presence by highlighting social and academic opportunities in co-curricular spaces within the physics department.

Student interview data revealed the significant role that interactions with physics faculty members and peers played in the academic studies of students transitioning from other institutions (or degree pathways) to Grand Lakes University. One of the key findings from this study was that transfer students either did not participate in new student orientation events or did not place value in the information presented in these orientation events. Students who placed little value on these events also tended to prefer socializing with non-physics majors and were generally unaware of opportunities to collaborate with other students within the physics department. The students' interactional tendencies may result from previously acquired, or impact the future acquisition of social capital, an embodied form of cultural capital that represents a sociocultural factor that mediates educational experiences. Establishing teaching presence may involve actively seeking out and advising students about opportunities that exist within departmental or institutional student communities.

Additionally, practitioners and other socialized physics students can promote new students' social interactions by frequently inviting new community members to use shared common spaces and to participate in student learning communities. Student interview data revealed that participation in campus-based physics student groups in common student spaces and at regional physics student organization conferences were credited with increasing one of the participants' sense of belonging as members of the physics student community. Furthermore, interacting with socialized members of the Grand Lakes University physics community promotes transfer students' awareness of discipline-specific ways of being. The acquisition of physics-related ways of being is requisite to an individual's entry into communities of practice as formal members of professional disciplines (Gee, 1990; Lave & Wenger, 1991).

Implications for Future Research

As previously mentioned, existing research focused on broad populations of transfer students or transfer students pursuing various STEM majors (Carlan & Byxbe, 2000; Cegile & Settlage, 2014; Community College Resource Center, 2015; Freeman, Conley, and Brooks, 2006; Hall & Sandler, 1982; Jackson and Laanan, 2015; Jackson, Starobin, & Laanan, 2013; Laanan, Starobin, Eggleston, 2010; Linder & Airey, 2009; National Academies of Science, Engineering, and Medicine, 2018; Starobin, Smith, & Laanan, 2016; Van Dinh, 2017; Xu, 2015; Xu, Slonki, McPartlan, & Sato, 2018). Yet, research focused specifically on transfer physics majors' socialization experiences is limited. The findings of this study provide a context-specific understanding of factors that shape transfer physics students' experiences as related to participation in classroom or co-curricular activities—and adds to a growing body of research. However, the complex, idiosyncratic nature of individual transfer physics majors' socialization experiences calls for additional and ongoing research efforts. Such an ongoing inquiry consists of research related to institutional sociocultural factors and research related to individual sociocultural factors that mediate students' socialization experiences.

Research Related to Institutional Sociocultural Influences

The results of this research study reveal the course instructor's behavior influenced the nature of student interaction and language use in the classroom setting. The course instructor's statement that the entry-level upper-division physics course represented a small step in the evolution of students' social language development or adoption of physics discourses emphasized the need for ongoing inquiry regarding stakeholder activities and beliefs connected to student socialization. Considering that statement, the limitations on the timeframe over which data was collected warrants the need for a longitudinal study that investigates practitioners' and students' classroom interactions and co-curricular activities throughout the entire physics course sequence. This type of research, while extensive, could provide a holistic view of transfer physics majors' or other students' educational experiences.

Second, while students engaged in extensive dialogue while evaluating problem solving processes and outcomes, the course instructor regularly addressed students' questions in small group settings offering feedback by directly answering student questions. In these circumstances, the course instructor often modeled higher order thinking while directly addressing students' questions about problem solving processes or outcomes. Also in these circumstances, instructional activities likely provided scaffolding that boosted the confidence levels of students who possessed lower ability beliefs. Although the course instructor intended to provide assistance, the nature of the student-instructor dialogue may have also constrained student-student dialogue between students working on similar tasks. The students' positive perceptions of the instructor and the instructor's willingness to provide information to satisfy their questions provided students with feedback to successfully complete problem-solving tasks. However, in many cases the instructor provided information that satisfied students' questions, eliminating the need for further collaborative student discussion. More research is needed about how the nature of the course instructor's interactions or other aspects of instructional design limits dialogue within and across groups in small group sessions.

Additionally, although not directly addressed in this study, it became apparent that the closed-ended nature of questions or problem-sets in large and small group settings led to convergent thinking, constraining extended critical thinking processes. Rarely were students observed demonstrating alternative rationales for problem solving outcomes in relation to relevant topics or phenomena. More research is needed to understand the course instructor's rationale for adopting closed-ended questions that fail to explicate this type of student thinking.

Third, the course instructor held beliefs that transfer students possessed low expectations for success and attributed their participation in physics coursework to external motivations such as grades or employment. In some ways, the course instructor's beliefs about transfer students' expectations for success in physics coursework were consistent with student survey findings. Several transfer students' survey results revealed decreased ability beliefs regarding the capability to learn new physics content while participating in upper-division coursework.

The student survey and interview results revealed that, overall, most students held high expectations for success in physics coursework and held motivations connected to intrinsic interest, placing an importance on physics content as related to future coursework and future careers. In cases where students held uncertainty about their ability to learn something new in their physics coursework, all but one student initiated large numbers of student-instructor interactions in the goal of gathering feedback needed to successfully complete in-class assignments. These findings indicate transfer student agency that supported achievement-related behavior in classroom settings. Additional ongoing inquiry is needed to inform practitioners' understanding of students' psychosocial beliefs that mediate students' achievement-related behavior.

Finally, despite holding beliefs related to differences between transfer and regular-admit students' expectations for success in physics coursework, physics-content ability, and the value these students place upon studying physics, the course instructor did not actively seek to interrogate programmatic or classroom related structures that potentially reinforced differences in participation or outcomes among students. Furthermore, despite holding deficit beliefs about and acknowledging the malleability of transfer student beliefs that drive motivations for physics studies, the instructor and other practitioners failed to interrogate their beliefs or institutional practices that constrained interactions or socialization activities. Ongoing reflective practice could assist in informing practitioners of incongruences among the espoused and actual practice.

Research Related to Individual Sociocultural Influences

Significant findings included students' physics-related ability beliefs, expectations for success in studying physics, and the value they attached to studying physics; all influence their participation in classroom and co-curricular activities. Findings revealed that students' ability beliefs may have both positively and negatively mediated their participation in classroom activities during small group sessions. One student who expressed low ability beliefs did not participate in student-instructor or student-student interactions in large and small group settings. Another student who expressed low ability beliefs regarding “learning something new” in the upper division physics course displayed moderately-high levels of student-instructor interactions in large and small group settings, and experienced among the highest development and adaptation in critical thought processes throughout the academic semester. This student’s high levels of participation in student-instructor interactions may have been influenced by a lack of confidence related to learning new physics content in upper-division physics courses. A third transfer student, who expressed high expectations regarding his ability to learn something new in physics, engaged in the highest number of student-instructor interactions in both large and small group settings. This student also experienced the highest development and adaptations of critical thinking language use of the observed student groups in small group settings. This student’s high levels of student-instructor interactions in large and small group settings may have been connected to high levels of intrinsic interest in studying physics. Additional and ongoing inquiry in the form of student interviews is needed to fully understand the connections between students’ ability beliefs, expectations for success, and achievement-related behavior in the classroom or co-curricular settings.

All of the transfer students who participated in student interviews in this study espoused the importance of experiencing a sense of belonging and of the value of interactions in relation to socialization as physics majors at Grand Lakes University. Interview findings revealed that several students did not place importance on or participate in new student orientation activities. Furthermore, these beliefs and behaviors led to a lack of knowledge of physics-related co-curricular activities. Four of the five students who participated in individual interviews stated that they did not attend or they did not find value in transfer student orientation events hosted by the university and the physics department. Three of these students were unaware of or did not participate in co-curricular opportunities intended to promote peer collaboration in the physics major. One student who attended the orientation event attributed his participation to higher levels of peer collaboration, co-curricular activity, and a sense of belonging within the physics department. Future research about student orientation events should include the perspectives of academic advisors who facilitate new-student orientation events. These perspectives may provide insights about transfer students' low levels of participation and the low importance they place on these activities.

Conclusions

The purpose of this study was to gain an understanding of how transfer physics students' participation in educational activities was influenced by a host of individual psychosocial factors, such as their beliefs about their own capacity to study physics, expectations for success in physics coursework, value beliefs related to studying physics, unique past educational and transitional experiences, institutional perceptions, perceptions of faculty and peers, how transfer students experienced belonging as physics majors, their perception about the meaning of socialization, and how they experienced socialization. Additionally, this study revealed how institutional factors such as practitioners' teaching and the promotion of co-curricular activities influenced students' participation in educational activities.

One key finding revealed that most of the transfer physics majors held physics-content-related motivational and ability beliefs that supported their participation in classroom activities. Despite holding motivational and ability beliefs that supported high levels of classroom participation, many of the transfer students did not participate in physics-related co-curricular socialization activities. Students' lack of co-curricular engagement was connected to the low importance they placed on new student orientation events which endorse co-curricular socialization opportunities within the physics department. However, one participant who expressed lower motivational beliefs also exhibited low levels of interaction in the classroom setting. Other students' negative expectations for success in learning new things in physics may have led to higher levels of student-instructor participation in the goal of gaining academic support from physics faculty. Students' interview findings revealed preferences for social affiliations with students outside of the physics major. For one of the respondents, social affiliation preferences with other students outside of the physics major appeared to coincide with decreased participation in co-curricular activities. However, this and most other students displayed high levels of participation in the classroom setting. Several students placed an emphasis on the importance of the utility of their physics studies in relation to occupational outcomes which revealed extrinsic and intrinsic motivations for participation in the academic major. While most student participants' motives were connected to intrinsic interest in physics, two participants enrolled in the Grand Lakes University physics program after experiencing non-admission from engineering programs. One of these students expressed a lack of interest in his physics studies, stipulating that the knowledge he gained within the physics program was not as relevant to "jobs" that aligned with his occupational goals.

Another key finding revealed that a wide array of sociocultural factors influenced transfer students' participation in their physics studies, their socialization activities, and their sense of belonging within the physics major community at Grand Lakes University. As related to transfer students' participation within the physics program, positive and negative experiences while studying physics at previous institutions influenced their enrollment in the physics program. Furthermore, students' transitions from their previous institutions to Grand Lakes University were uneventful and did not contribute to challenges related to their physics studies. While holding neutral-to-negative institutional perceptions of Grand Lakes University as a whole, the participants held overwhelmingly positive perceptions of the physics faculty and physics student peers that contributed to achievement-related behaviors within the academic environment.

While the transfer physics majors widely expressed the importance of belonging as a physics major and as a member of the physics department community, the participants experienced socialization in different ways. These findings had significant implications for students' socialization as physics majors. Of note, several participants stated that they did not find value in or that they did not attend university-hosted and physics-department-hosted new student orientation events intended to promote awareness of socialization opportunities. Several participants who did not attend orientation activities were unaware of and did not regularly participate in co-curricular socialization activities. Students who participated in co-curricular activities, such as interaction with their peers in dedicated student spaces or participation in physics-based student organizations, cited these activities as promoting interest and a strong sense of belonging within the physics major and the extended learning community.

Last, educational practitioners play an important role in facilitating classroom and co-curricular socialization activities, as their attitudes, beliefs, and actions influence students' experiences. Interview data revealed that the course instructor believed—based on generalizations formed from student testimony—that transfer students possessed lower levels of physics content ability, and that they held low expectations for success in physics coursework in comparison to regular-admit students. Also, the instructor carried the belief that transfer students maintained external motivations for physics studies based on job prospects after graduation or numeric grades attached to participation in physics coursework.

Interestingly, the course instructor's beliefs about transfer students were inconsistent with student survey data, which revealed most transfer physics students placed value on their physics studies, held positive expectations for success in physics coursework, and possessed positive physics-content ability beliefs. Despite espousing the importance of collaborative interactions in classroom settings, the course instructor employed instructional strategies that constrained students' physics-based dialogue in large group settings. Conversely, in small group settings the instructor employed an instructional approach that corresponded with high levels of content-based dialogue and the development of critical thinking processes around the evaluation of problem-solving processes and outcomes.

As educational practitioners recognize and reflect on how classroom stakeholders' beliefs and practices impact transfer physics students' educational experiences, it is necessary to understand that these findings point to the importance of researching students' socialization on an individual student basis using multiple, triangulated measures. Sociocultural frameworks represent useful mental models to understand the complex relationships between factors that alter students' socialization experiences in physics or other academic programs. However, these models fall short of explaining idiosyncratic student socialization experiences. Such inquiry assists in refining educational practices that support student socialization while simultaneously addressing factors that increase the sustainability of academic programs in a wide variety of educational contexts.

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Appendix A

COPUS Observation Tool

COPUS STEM Classroom Observation Instrument
Linked:
http://www.cwsei.ubc.ca/resources/files/COPUS_protocol.pdf

Classroom Observation Protocol for Undergraduate STEM – COPUS

This protocol allows observers, after a short 1.5 hour training period, to reliably characterize how faculty and students are spending their time in the STEM classroom.[†] For further information, see: www.cwsei.ubc.ca/resources/COPUS.htm
Smith MK, Jones FHM, Gilbert SL, and Wieman CE. 2013. The Classroom Observation Protocol for Undergraduate STEM (COPUS): a New Instrument to Characterize University STEM Classroom Practices. CBE-Life Sciences Education, Vol 12(4), pp. 618-627

Observation codes

1. Students are Doing

L	Listening to instructor/taking notes, etc.
Ind	Individual thinking/problem solving. Only mark when an instructor explicitly asks students to think about a clicker question or another question/problem on their own.
CG	Discuss clicker question in groups of 2 or more students
WG	Working in groups on worksheet activity
OG	Other assigned group activity, such as responding to instructor question
AnQ	Student answering a question posed by the instructor with rest of class listening
SQ	Student asks question
WC	Engaged in whole class discussion by offering explanations, opinion, judgment, etc. to whole class, often facilitated by instructor
Prd	Making a prediction about the outcome of demo or experiment
SP	Presentation by student(s)
TQ	Test or quiz
W	Waiting (instructor late, working on fixing AV problems, instructor otherwise occupied, etc.)
O	Other – explain in comments

2. Instructor is Doing

Lec	Lecturing (presenting content, deriving mathematical results, presenting a problem solution, etc.)
RtW	Real-time writing on board, doc. projector, etc. (often checked off along with Lec)
FUp	Follow-up/feedback on clicker question or activity to entire class
PQ	Posing non-clicker question to students (non-rhetorical)
CQ	Asking a clicker question (mark the entire time the instructor is using a clicker question, not just when first asked)
AnQ	Listening to and answering student questions with entire class listening
MG	Moving through class guiding ongoing student work during active learning task
1o1	One-on-one extended discussion with one or a few individuals, not paying attention to the rest of the class (can be along with MG or AnQ)
D/V	Showing or conducting a demo, experiment, simulation, video, or animation
Adm	Administration (assign homework, return tests, etc.)
W	Waiting when there is an opportunity for an instructor to be interacting with or observing/listening to student or group activities and the instructor is not doing so
O	Other – explain in comments

3. Student Engagement (optional)

L	Small fraction (10-20%) obviously engaged.
M	Substantial fractions both clearly engaged and clearly not engaged.
H	Large fraction of students (80+%) clearly engaged in class activity or listening to instructor.

Student engagement alternatives:

(1) Just mark when engagement is obviously high or obviously low.

(2) Count "N" students near you (~10) and assess how many appear engaged at every 2 minute interval. Enter value for all engaged instead of L/M/H. NOTE what your value of N was.

Suggestions regarding codes and comments:

- Clarify code choices with comments.
- Consider indicating your confidence regarding coding, especially when you aren't sure about choice of codes.

HOW TO USE OBSERVATION MATRIX: Put a check under all codes that happen anytime in each 2 minute time period (check multiple codes where appropriate). If no codes fit, choose "O" (other) and explain in comments. Put in comments when you feel something extra should be noted or explained.

[†] *This protocol was adapted from: Hora MT, Oleson A, Ferrare JJ. Teaching Dimensions Observation Protocol (TDOP) User's Manual. Madison: Wisconsin Center for Education Research, University of Wisconsin–Madison; 2013.*

Date: ______________ **Class:** ____________________ **Instructor:** ______________________ **No. students** _______ **Observer Name:** ________________________

Classroom arranged how? ____

1. **L**-Listening; **Ind**-Individual thinking; **CG**-Clicker Q discussion; **WG**-Worksheet group work; **OG**-Other group work; **AnQ**-Answer Q; **SQ**-Student Q; **WC**-Whole class discuss; **Prd**-Predicting; **SP**-Student present; **TQ**-Test/quiz; **W**-Waiting; **O**-Other

2. **Lec**-Lecturing; **RtW**-Writing; **FUp**-Follow-up; **PQ**-Pose Q; **CQ**-Clicker Q; **AnQ**-Answer Q; **MG**-Moving/Guiding; **1o1**-One-on-one; **D/V**-Demo+; **Adm**-Admin; **W**-Waiting; **O**-Other

For each 2 minute interval, check columns to show what's happening in each category (or draw vertical line to indicate continuation of activity). OK to check multiple columns.

COPUS

	1. Students doing													2. instructor doing												3. Engagement			Comments: EG: explain difficult coding choices, flag key points for feedback for the instructor, identify good analogies, etc.
min	L	Ind	CG	WG	OG	AnQ	SQ	WC	Prd	SP	T/Q	W	O	Lec	RtW	Fup	PQ	CQ	AnQ	MG	1o1	D/V	Adm	W	O	L	M	H	
0 - 2																													
2																													
4																													
6																													
8 - 10																													
	L	Ind	CG	WG	OG	AnQ	SQ	WC	Prd	SP	T/Q	W	O	Lec	RtW	Fup	PQ	CQ	AnQ	MG	1o1	D/V	Adm	W	O	L	M	H	
10 - 12																													
12																													
14																													
16																													
18 - 20																													
	L	Ind	CG	WG	OG	AnQ	SQ	WC	Prd	SP	T/Q	W	O	Lec	RtW	Fup	PQ	CQ	AnQ	MG	1o1	D/V	Adm	W	O	L	M	H	
20 - 22																													
22																													
24																													
26																													
28 - 30																													

1. **L**-Listening; **Ind**-Individual thinking; **CG**-Clicker Q discussion; **WG**-Worksheet group work; **OG**-Other group work; **AnQ**-Answer Q; **SQ**-Student Q; **WC**-Whole class discuss; **Prd**-Predicting; **SP**-Student present; **TQ**-Test/quiz; **W**-Waiting; **O**-Other
2. **Lec**-Lecturing; **RtW**-Writing; **FUp**-Follow-up; **PQ**-Pose Q; **CQ**-Clicker Q; **AnQ**-Answer Q; **MG**-Moving/Guiding; **1o1**-One-on-one; **D/V**-Demo+; **Adm**-Admin; **W**-Waiting; **O**-Other

For each 2 minute interval, check columns to show what's happening in each category (or draw vertical line to indicate continuation of activity). OK to check multiple columns.

page 2

	1. Students doing													2. instructor doing												3. Engagement			Comments: EG: explain difficult coding choices, flag key points for feedback for the instructor, identify good analogies, etc.
min	L	Ind	CG	WG	OG	AnQ	SQ	WC	Prd	SP	T/Q	W	O	Lec	RtW	Fup	PQ	CQ	AnQ	MG	1o1	D/V	Adm	W	O	L	M	H	
30 - 32																													
32																													
34																													
36																													
38 - 40																													
	L	Ind	CG	WG	OG	AnQ	SQ	WC	Prd	SP	T/Q	W	O	Lec	RtW	Fup	PQ	CQ	AnQ	MG	1o1	D/V	Adm	W	O	L	M	H	
40 - 42																													
42																													
44																													
46																													
48 - 50																													

Further comments:

Smith MK, Jones FHM, Gilbert SL, and Wieman CE. 2013. The Classroom Observation Protocol for Undergraduate STEM (COPUS): a New Instrument to Characterize University STEM Classroom Practices. CBE-Life Sciences Education Vol 12(4), pp. 618-627
A protocol sheet in Excel format is available at: www.cwsei.ubc.ca/resources/COPUS.htm.

Appendix B

Survey Instrument

This tool was used and modified (including the title of the survey) with permission of the authors.

Directions: The purpose of this study is to gain an understanding of students' experiences while enrolled in upper-division physics courses at [redacted]. When answering the questions, please consider your reactions toward your experience as a whole and not about isolated incidents.

The survey is made up of four sections.

Part 1. Demographic and Background Information.
Part 2. Ability Beliefs Items
Part 3. Expectancy Items
Part 4. Usefulness, Importance, and Interest Items

Demographic and Background Information Questions

What is your name?

What is your Banner ID#?

1. What is your classification in college?
____ Freshman
____ Sophomore
____ Junior
____ Senior
____ Graduated
____ Unclassified

2. Did you begin college here or transfer from another institution?
____ Here
____ Somewhere else

3. If you attended another institution, was that institution a 2-year community college or a 4-year college?
____ 2-year community college
____ 4-year college
____ I did not attend another institution, I began my studies at [redacted]

4. When did you begin studying at the main campus of [redacted]?

Month _____ Year _____

5. In what year do you expect to complete the degree for which you are now working? 20____

Ability Beliefs Items
1. How good in physics are you?

____ Very Good
____ Good
____ Acceptable
____ Poor
____ Very Poor

2. If you were to list all the students in your class from the worst to the best in physics, where would you put yourself? (one of the worst one of the best)

____ Much better
____ Somewhat better
____ The same
____ Somewhat worse
____ Much worse

3. Some kids are better in one subject than in another. For example, you might be better in math than in reading. Compared to most of your other school subjects, how good are you in physics? (a lot worse in physics than in other subjects a lot better in physics than in other subjects)

____ Much better
____ Somewhat better
____ The same
____ Somewhat worse
____ Much worse

Expectancy Items
4. How well do you expect to do in physics this year? (not at all well very well)

____ Very High
____ Above Average
____ Average
____ Below Average
____ Very Low

5. How good would you be at learning something new in physics? (not at all good very good)

____ Very Good
____ Good
____ Acceptable
____ Poor
____ Very Poor

Usefulness, Importance, and Interest Items

1. Some things that you learn in school help you do things better outside of class, that is, they are useful. For example, learning about plants might help you grow a garden. In general, how useful is what you learn in physics? (not at all useful very useful)

____ Very Important
____ Important
____ Moderately Important
____ Slightly Important
____ Not Important

2. Compared to most of your other activities, how useful is what you learn in physics? (not at all useful very useful)

____ Very Important
____ Important
____ Moderately Important
____ Slightly Important
____ Not Important

3. For me, being good in physics is (not at all important very important)

____ Very Important
____ Important
____ Moderately Important
____ Slightly Important
____ Not Important

4. Compared to most of your other activities, how important is it for you to be good at physics? (not at all important very important)

____ Very Important
____ Important
____ Moderately Important
____ Slightly Important
____ Not Important

5. In general, I find working on physics assignments interesting [fun].

____ Strongly Agree
____ Agree
____ Undecided
____ Disagree
____ Strongly Disagree

6. How much do you like doing physics? (not at all very much)

____ Extremely
____ Very
____ Moderately
____ Slightly
____ Not at all

Thank you for participating in my study.

Appendix C

Student Interview Instrument

FOCUS GROUP INSTRUMENT
Modified version of the Weidman, Twale and Stein's (2003) Doctoral Student Socialization Questionnaire. Modified by Catherine (Kate) E. DeLuca in Dissertation Study SOCIALIZATION AND SENSE OF BELONGING IN AN ONLINE NURSE PRACTITIONER PROGRAM: A CASE STUDY
Permission was granted to use this instrument and is attached in Appendix D.

SEMI-STRUCTURED INTERVIEW GUIDE

Welcome and Introduction
Thank you for agreeing to participate in this interview. My name is Patrick Chestnut and I am a doctoral student enrolled in the [redacted]. My dissertation focuses on the socialization experiences of transfer physics majors enrolled in upper-division physics courses at the [redacted] main campus location. This interview is to help me to gain insight about your experiences as a student.

Review of Consent
As a participant in this interview I have previously sent you a consent form to be signed and returned. I would also like to review the consent with you at this time. I would like to remind you that the interview can be stopped at any point without penalty. This interview has no influence on your status as a student at [redacted].. Do you have any questions at this time?

Demographic Form
I have also previously given you a demographic form to complete so that I have background on you and your educational experiences.

Explanation of Interview Procedure
I am going to go over the interview procedure so that you are aware of the next steps. I will be focusing on your experience as a physics student to date. If you would like to skip a question just indicate that you would like to do so and you can skip the question. There is no penalty for skipping questions. Toward the end of the interview I will also give you an opportunity to provide any additional information that you think should be included in your interview responses.

Ice breaker Question:
Tell us your name, your college major, and where you live.

Grand Tour	Probe	Follow Up
1. Prior to your enrollment in the physics degree pathway, what is your experience with studying physics?		1. If he/she has experience – what made you decide to pursue your studies at [redacted]? 2. If he/she doesn't have experience – What are your thoughts about studying physics? What were any concerns you may have had?
2. Tell me about your experience studying physics at [redacted]		
3. In your experience, what are some of the differences in being a transfer student in comparison to a traditional regular-admit or a regular-admit students?		
4. What types of interaction did you experience with the school prior to enrolling as a physics major at [redacted]		a. Did you feel prepared to start studying physics at [redacted] main campus? b. How could this have been improved? c. What type of support did you feel during this time, if any? d. What was your experience during the on-campus orientation?
5. Tell me about your experience with faculty.	Positive or negative?	a. In what ways do you interact with faculty?
6. Do you talk to faculty about non-classroom topics?	Personal advice? Academic advice?	a. How would you describe the faculty members with whom you have interacted?
7. Tell me about your experience with other students.	Positive or negative? Is it what you expected?	a. In what ways do you interact with other students?

8. Do you talk to other students about non-classroom topics?	Personal advice? Academic advice?	a. How would you describe your interaction with the other students in the physics program?
9. What does it mean to be a student at [redacted]		a. In the physics department?
10. How does [redacted] support you as a physics student?		a. How does the physics department support you as a physics student?
11. How would you describe your relationship with [redacted]		a. To the physics department? b. To the faculty? c. To other students?
12. What challenges have you faced as a physics student?	Academic? Social? Other?	
13. In your experience, how would you describe the environment [redacted]	Professional? Scholarly? Supportive? Friendly?	a. In the physics department? b. In your upper-division physics classes?
14. What has been your experience transitioning to becoming a physics student?		a. How did you prepare for this role? b. How did you engage in this role?
15. What does socialization as a student in the physics degree major/program mean to you?		
16. How do you experience socialization in your program?		
17. How important is a sense of belonging for a physics student?		
18. What has your	As a physics major? As	a. If yes - Was there a

experience in the program in terms of feelings or a sense of belonging? Have you experienced a sense of belonging?	a physics student within upper-division physics classes?	moment? b. How did you know? c. What does that mean for you? d. If no – what would make you feel a sense of belonging? e. From the school? f. From your faculty? g. From your advisors? h. How will you know?

19. What advice would you give to a new physics student at [redacted]		
20. Is there any additional information that you feel would be important to include in this study?		

Closing

Thank you for participating in this interview. Your responses will be kept confidential. In fact, your name will be replaced with a pseudonym so that you will not be identified. All participant identities will be indexed and the information will be kept separate from the transcripts of the interviews. If you have any additional questions about the study, please feel free to contact me in person in office [redacted]

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Appendix D

Permission to Use Interview Instrument

From: Chestnut, Patrick L [redacted]
Sent: Thursday, October 31, 2019 12:15 PM
To: Kate DeLuca <deluca899@duq.edu>
Subject: [External] Permission to Use Focus Group Interview Questions from Study: SOCIALIZATION AND SENSE OF BELONGING IN AN ONLINE NURSE PRACTITIONER PROGRAM: A CASE STUDY

Dear Dr. DeLuca,

My name is Patrick Chestnut, I'm a doctoral candidate in the Educational Leadership Doctoral program at [redacted]

I'm writing to request permission to use a modified version of the interview questions you composed and used in your dissertation study titled, *SOCIALIZATION AND SENSE OF BELONGING IN AN ONLINE NURSE PRACTITIONER PROGRAM: A CASE STUDY.* Specifically, I would like to modify and use the interview guide and interview questions located in Appendix F (p. 189-192) to gather student perspectives related to the socialization experience of transfer physics majors within a IRB approved qualitative research study for my dissertation.

I plan to use this instrument in conjunction with classroom observations to understand teacher and student interactions *and* pre- and post-surveys using Wigfield and Eccles (2000) Ability and Expectancy-Value Instrument.

I plan to administer a modified version of your instrument towards the end of transfer physics majors' first semester at the transfer-receiving institution. I plan to use dual coding schemes to identify thematic patterns from the data.

I plan to collect data from January to May 2020 in anticipation of completing this qualitative research study before Summer 2020.

Your focus group interview instrument will shed light on our students' experiences!

Thanks in advance,
Patrick Chestnut
[redacted]

From: Kate DeLuca <deluca899@duq.edu>
Sent: Thursday, October 31, 2019 12:16 PM
To: Chestnut, Patrick L
Subject: RE: [External] Permission to Use Focus Group Interview Questions from Study: SOCIALIZATION AND SENSE OF BELONGING IN AN ONLINE NURSE PRACTITIONER PROGRAM: A CASE STUDY

Patrick,

You have my permission to use and modify the interview questions I used for my dissertation. Best of luck!

Thanks
Dr. DeLuca

Appendix E

Solicitation Instrument

Solicitation to be used in-person. In-person classroom solicitations will used this as a script.

Greetings,

My name is Patrick Chestnut, a graduate student from the Department of Education at [redacted]. I would like to invite you to participate in my research study to investigate physics students' experiences while enrolled in upper-division physics courses at [redacted]. You may participate if you are enrolled in (or teach) upper-division physics courses at [redacted].

As a participant, you will (a) be asked to voluntarily allow for the videotaping, audio recording, and in person observations of your physics class on ten occasions (for the entire duration of the class); (b) complete brief surveys on two occasions (during class in the second week of the semester and again around week 12)- each survey is composed of four sections (student background information, ability beliefs, course expectations, and the usefulness of class experiences) and will take around 10-15 minutes to complete; (c) some students will be invited (via email) to voluntary participate in focus groups to gather additional information about your educational experiences as related to participation in upper-division physics courses; and (d) instructors will be invited to voluntarily participate in individual interviews related to their perspectives about student experiences as related to participation in upper-division physics courses.

There are minimal risks associated with participating in this study. Participants will not receive compensation for participating. A potential benefit includes contributing to the knowledge base related to student experiences in upper-division physics courses at [redacted]. All data collected will be stored in a secure location (e.g., locked office cabinet, password protected computer). Participating in this study could potentially increase educational practitioners understanding of classroom experiences and inform institutional practices to enhance the teaching and learning process.

If you would like to participate in this research study, please sign and return the provided consent form. If you do not wish to participate, please return the blank consent form.

Do you have any questions now? If you have questions, please contact me in person during my regular office hours in [redacted]

Thank you,
Patrick Chestnut
Graduate Student
[redacted]

Appendix F

Solicitation for Student Interview

Solicitation to be used via email.

Greetings,

You are invited to complete a focus group interview as part of a research project conducted by Mr. Patrick Chestnut of the [redacted] You are being invited to participate because you are a transfer student currently enrolled in upper-division physics courses in the [redacted]. Participation is completely voluntary. Your physics instructor will not have any knowledge of your participation, and participation will not affect your grade in any way.

If you choose to participate, you will be asked several questions within a group setting comprised of other transfer students about your educational experiences to date. The focus group interview will take approximately 90 minutes. If you are willing to participate please email or call Patrick Chestnut to arrange an interview.

Please feel free to contact me if you have any questions regarding this research study.

Thank you,
Patrick Chestnut

Graduate Student
College of Education
[redacted]

Appendix G

Solicitation for Faculty Interview

Solicitation to be used via email.

Greetings,

You are invited to complete an interview as part of a research project conducted by Mr. Patrick Chestnut of the Department of [redacted]. You are being invited to participate because you are a course instructor teaching upper-division physics courses in the [redacted]. Participation is completely voluntary. Your employer will not have any knowledge of your participation, and participation will not affect your employment in any way.

If you choose to participate, you will be asked several questions related to your perspectives of transfer students' education experiences while participating in upper-division physics courses. The interview will take approximately 90 minutes. If you are willing to participate please email or call Patrick Chestnut to arrange an interview.

Please feel free to contact me if you have any questions regarding this research study.

Thank you,
Patrick Chestnut

Graduate Student
College of Education
[redacted]

Appendix H

Faculty Interview Instrument

Welcome and Introduction

Thank you for agreeing to participate in this interview. My name is Patrick Chestnut and I am a doctoral student enrolled in the [redacted] in the Educational Leadership EdD program. My dissertation focuses on the socialization experiences of transfer physics majors enrolled in upper-division physics courses at the Rowan University main campus location. This interview is to help me to gain insight about your perspectives of transfer physics majors' experiences while enrolled in upper-division physics courses at Rowan University.

Review of Consent

As a participant in this interview I have previously sent you a consent form to be signed and returned. I would also like to review the consent with you at this time. I would like to remind you that the interview can be stopped at any point without penalty. This interview has no influence on your status as an employee of [redacted].. Do you have any questions at this time?

Explanation of Interview Procedure

I am going to go over the interview procedure so that you are aware of the next steps. I will be focusing on your perceptions of transfer physics majors enrolled in upper-division physics courses to date. If you would like to skip a question just indicate that you would like to do so and you can skip the question. There is no penalty for skipping questions. Toward the end of the interview I will also give you an opportunity to provide any additional information that you think should be included in your interview responses.

1)What are your perspectives related to transfer physics majors' use of discipline-specific content-based language use while enrolled in upper-division physics classes at Grand Lakes University?
a)Do these students use relevant (i.e., closely related to physics or other related discourses) or irrelevant (i.e., not connected to physics or related discourses)?

2)What are your perspectives on transfer physics majors' interactions while participating in classroom activities?

3)How do transfer physics majors' discipline-specific language use develop over time while participating in upper-division physics classes at Grand Lakes University (pseudonym)?
a)How do individual or groups of transfer physics majors adapt social language use throughout their experiences within upper-division physics courses?

4)How would you describe the process where individuals or groups adopting ways of being consistent with undergraduate physics studies (i.e., student socialization) while participating in upper-division physics classes at Grand Lakes University?

5)What are your perceptions related to transfer physics majors belief about their own (a) physics-content ability; (b) expectations related to course experiences; (c) view of the utility (i.e., usefulness) of physics content learned in classes; and (d) interest in physics coursework within upper-division physics courses at Grand Lakes University?

Appendix I

IRB Compliance Statement

Redacted to maintain participant confidentiality.

Appendix J

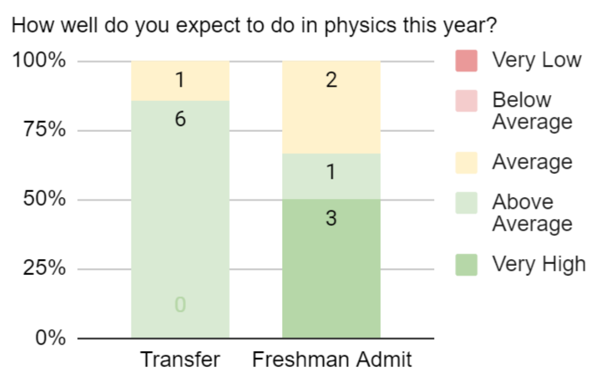
Expectancy and Task-Value Survey Responses

Aggregate EVT belief survey results comparing (a) transfer and regular-admit pre-survey and (b) transfer student pre- and post-survey results

Expectancy. The expectancy belief related survey questions required students to indicate: (a) How well do you expect to do in physics this year?; and (b) How well do you expect to do in physics this year? The data were presented in stacked 100% bar graphs. The aggregate transfer and regular-admit responses to the above expectancy belief questions are presented below in Tables J1 and J2.

Figure J1

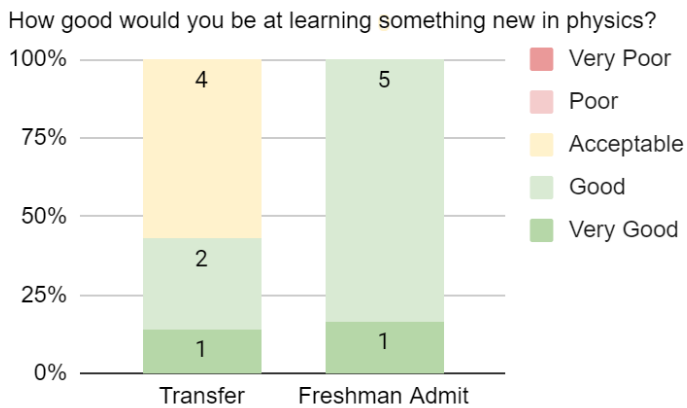
Pre-Survey Responses for Transfer and Regular-Admit Expectancy Belief Survey Questions.



As the possible responses ranged from very low to very high in a Likert scale format (1-5), presenting the data in a stacked 100% bar chart format allowed for a visual cross comparison of the results across participants of varied numbers (7 transfer students vs. 6 regular-admit respondents). From Figure J1, it was evident that all participants across both transfer and regular-admit status expect to perform at an "average," "above average," or "very high" in physics during the current academic year.
These initial expectancy beliefs varied between transfer and regular-admit students as 6 of 7 transfer student respondents stated that they expect to perform above average, where 1 of 6 regular-admit stated that they expect to perform at above average, and 3 of 6 reported expecting to perform at very high levels. According to the survey results, regular-admit learners report slightly higher expectancy beliefs regarding course performance outcome expectations compared to transfer students

Figure J2

Pre-Survey Responses for Transfer and Regular-Admit Expectancy Belief Survey Questions.

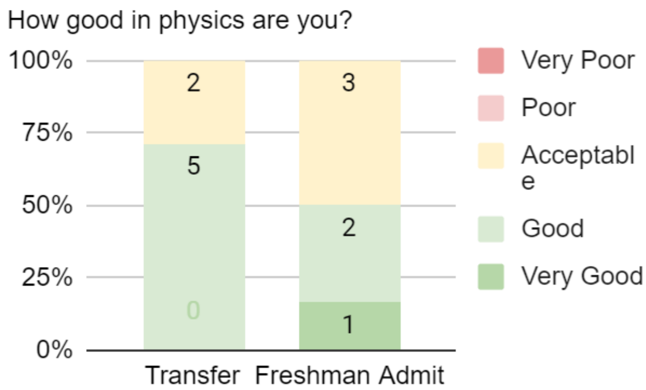


From Figure J2, it was observable that all participants across both transfer and regular-admit status expect to be "acceptable, good, or very good" at learning something new during the current academic year. These initial expectancy beliefs varied between transfer and regular-admit students as 4 of 7 transfer student respondents stated that they expect to perform "acceptably," 2 of 7 stated "good," and 1 of 7 reported that they would be "very good" at learning something new in physics. The distribution of expectancy responses for regular-admit students were slightly higher as 5 of 6 regular-admit students reported that they would be good, and 1 of 6 students stated they would be very good at learning something new in physics. According to the survey results, regular-admit learners report slightly higher expectancy beliefs in terms of ability in learning something new in physics compared to transfer students.

Ability**.** The task values questions related to ability required students to indicate: (a) How good are you in physics?; (b) If you were to list (rank) all of the students in class, where would you put yourself?; and (c) Compared to most of your other school subjects, how good are you in physics. The aggregate transfer and regular-admit responses to the above ability belief questions are presented below in Tables J3, J4, and J5.

Figure J3

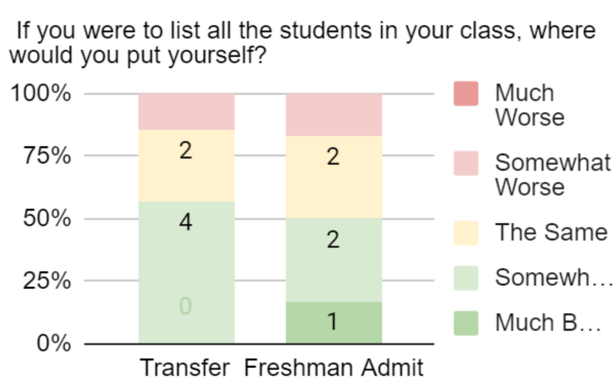
Pre-Survey Responses for Transfer and Regular-Admit Ability Belief Survey Questions.



From Figure J3, shows that all participants across both transfer and regular-admit status expect to be "acceptable, good, or very good" as related to physics ability. These initial ability beliefs varied between transfer and regular-admit students, as 2 of 7 transfer student respondents stated that they expect to perform "acceptable" and the remaining 5 of 7 responded that they are "good" in physics. The distribution of ability responses for regular-admit students was slightly higher as 3 of 6 regular-admit students reported that they are "acceptable" in physics, and 2 of 6 students stated they are "good," and 1 of 7 respondents stated that they are "very good" in physics. The pre-survey distributions of responses across transfer and regular-admit students as related to student perception of physics ability showed no differences across students of differing matriculation status.

Figure J4

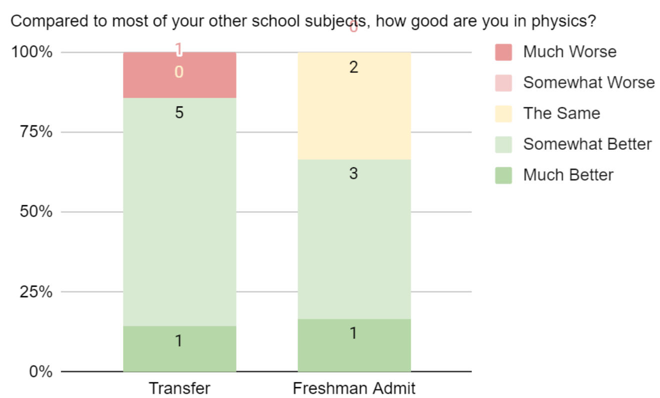
Pre-Survey Responses for Transfer and Regular-Admit Ability Belief Survey Questions.



From Figure J4, shows that all participants across both transfer and regular-admit rank their ability compared to all of the students in their class as somewhat worse through much better. These initial pre-survey ability beliefs varied between transfer and regular-admit students, as 1 of 7 students stated their relative ability was “somewhat worse” than other students, 2 of 7 students stated their relative ability was “the same,” where the remaining 4 of 7 transfer respondents ranked their ability as “somewhat better” than their classmates. The distribution (i.e., range of responses) of ability responses for regular-admit students was similar to that of transfer student, as 1 of 6 regular-admit respondents stated that they were “somewhat worse,” 2 of 6 ranked their ability as “the same,” 2 of 7 responded “somewhat better,” and 1 of 6 stated they were “much better” in terms of ability belief as related to relative ability compared to other students. The survey results regarding students’ perceived physics ability compared to other students are similar across transfer and regular-admit students varied across individual participants.

Figure J5

Pre-Survey Responses for Transfer and Regular-Admit Ability Belief Survey Questions



From Figure J5, shows that all participants across both transfer and regular-admit rank their physics ability compared to other school subjects from much worse through much better. These initial pre-survey ability beliefs varied between transfer and regular-admit students, as 1 of 7 students stated their relative ability of physics to other subjects was “much worse,” 5 of 7 stated “somewhat better,” and 1 of 7 stated “much better.” Whereas, 2 of 6 regular-admit students responded that their physics ability compared to other subjects was “the same,” 3 of 6 respondents stated their ability was “somewhat better,” and the remaining 1 of 6 stated their abilities were “much better.” The survey results regarding perceived physics ability compared to other subjects are similar across transfer and regular-admit students at large, however varied significantly across individual participants.

Task value. The task value related survey questions required students to indicate: (a) In general, how useful is what you learn in physics?; (b) Compared to most of your other activities, how useful is what you learn in physics?; (c) How important is being good in physics?; (d) Compared to most of your other activities, how important is it for you to be good at physics?; (e) n general, [do] I find working on physics assignments interesting [fun]?; and (f) How much do you like doing physics? The aggregate transfer and regular-admit responses to the above task value (i.e., utility, impotence, and interest) belief questions are presented below in Tables J6-J11.

Figure J6

Pre-Survey Responses for Transfer and Regular-Admit Utility Belief Survey Questions.

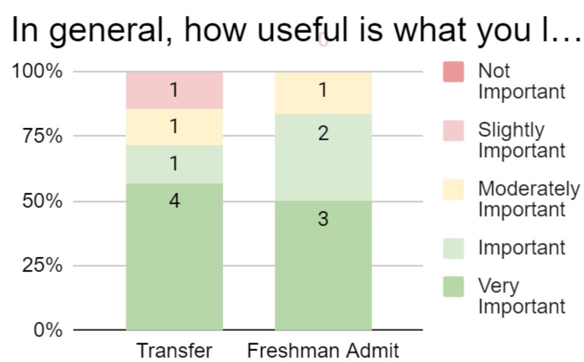


Figure J6, shows that when asked about the utility of what students learn in physics, the range of responses varied across all participants from “slightly important” through “very important.” Of the transfer student respondents, 1 of 7 stated that what they learn in physics is “slightly important,” 1 of 7 stated “moderately important,” 1 of 7 responded “important,” and many respondents stated “very important.” Of the regular-admit students, 1 of 6 responded that what they learn in physics is “moderately important,” 2 of 6 stated “important,” and 3 of 6 stated “very important.” While the transfer students responses span a greater range of the response values, with the exception of one student who responded that what they learn is “slightly important,” the responses of the transfer students are similar to that of regular-admit learners in terms of utility of learned physics content. The survey results regarding perceived utility of physics learned across transfer and regular-admit students at large are similar, however, varied across individual participants.

Figure J7

Pre-Survey Responses for Transfer and Regular-Admit Utility Belief Survey Questions.

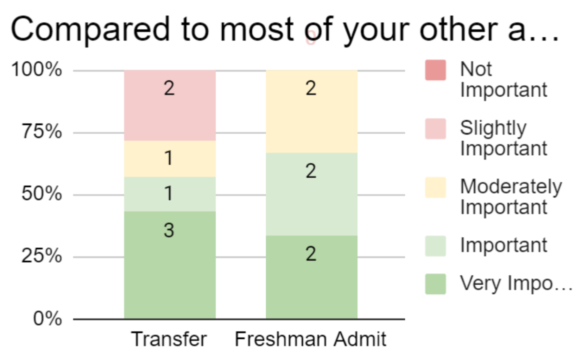


Figure J7, shows that when asked about the utility of what students learn in physics, compared to other activities, the range of responses varied across all participants from "slightly important" through "very important." Of the transfer student respondents, 2 of 7 stated that compared to most other activities, what they learn in physics is "slightly important," 1 of 7 stated "moderately important," 1 of 7 responded "important," and many respondents, 3 of 7 stated "very important." Of the regular-admit students, 2 of 6 responded that what they learn in physics is "moderately important," 2 of 6 stated "important," and 2 of 6 stated "very important." While the transfer students responses span a greater range of the response values, with the exception of two students responding that what they learn is "slightly important," the responses of the transfer students demonstrate a differential belief in comparison to regular-admit learners in terms of relative utility of physics as compared to other subjects. The survey results regarding perceived utility of physics, compared to other subjects across transfer and regular-admit students at large are similar, however, varied across individual participants.

Figure J8

Pre-Survey Responses for Transfer and Regular-Admit Importance Belief Survey Questions.

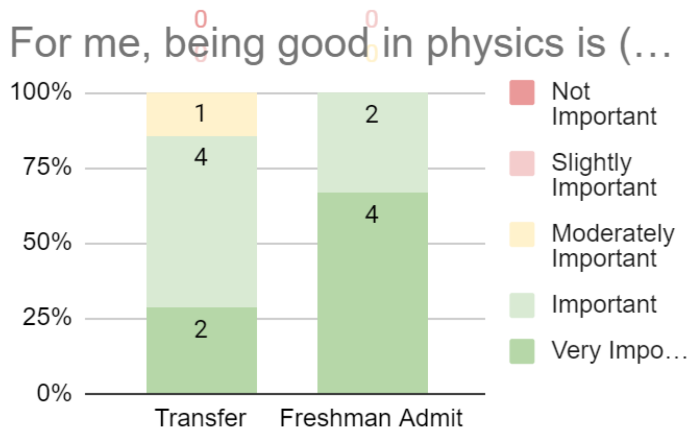


Figure 8, shows that when asked about the self-perceived importance of being good in physics, the range of responses varied across all participants from "slightly important" through "very important." Of the transfer student respondents, 1 of 7 stated "moderately important," 4 of 7 responded "important," and many respondents, 2 of 7 stated "very important." Of the regular-admit students, 2 of 6 stated "important," and 2 of 6 stated "very important." While the transfer students' responses span a greater range of the response values, with the exception of one student who responded that what they learn is "moderately important," the responses of the transfer students are similar to that of regular-admit learners in terms of relative utility of physics, compared to other subjects. The survey results regarding perceived physics ability across transfer and regular-admit students at large show similar results, however varied across individual participants.

Figure J9

Pre-Survey Responses for Transfer and Regular-Admit Importance Belief Survey Questions

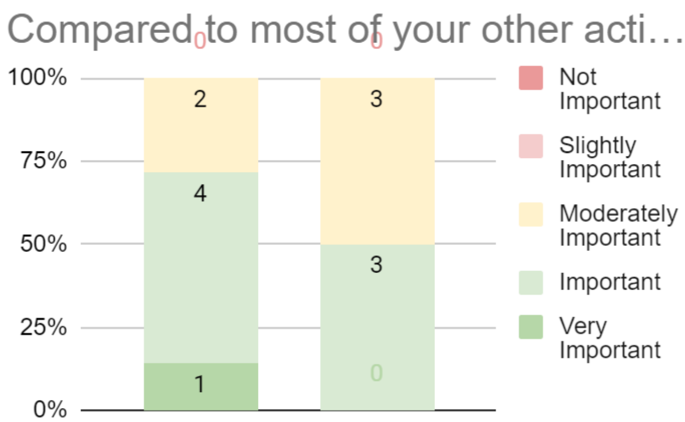


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Figure J9, shows that when asked about the self-perceived relative importance of being good in physics compared to other activities, the range of responses varied across all participants from "moderately important" through "very important." Of the transfer student respondents, 2 of 7 stated "moderately important," 4 of 7 responded "important," and many respondents, 1 of 7 stated "very important." Of the regular-admit students, 3 of 6 stated "moderately important," and 3 of 6 stated "important." While the transfer students' responses span a greater range of the response values, with the exception of one student who responded that what they learn is "very important," the responses of the transfer students were similar to that of regular-admit learners in terms of relative importance of physics, compared to other subjects.

Figure J10

Pre-Survey Responses for Transfer and Regular-Admit Interest Belief Survey Questions.

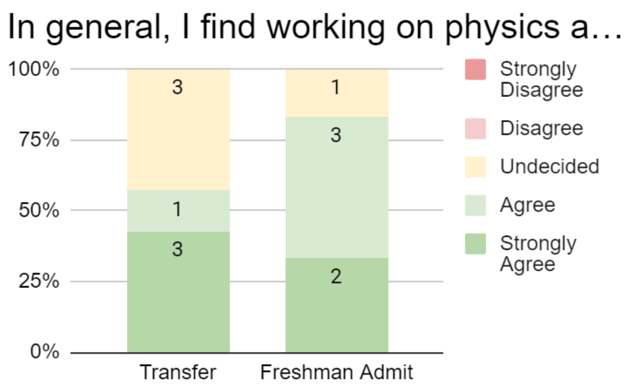

Figure J10, shows that when asked about the self-perceived interest in working on physics assignments, the range of responses varied across all participants from "undecided" through "strongly agree." Of the transfer student respondents, 3 of 7 stated "undecided," 1 of 7 responded "agree," and 3 of 7 stated "strongly agree." Of the regular-admit students, 1 of 6 stated "undecided," 3 of 6 stated "agree," and similar to the transfer respondents a significant proportion, 2 of 6 responded "strongly." Both the transfer students' responses have similar distributions and spanned a similar range of the response values, indicating similar beliefs in terms of the interest in working on physics assignments.

Figure J11

Pre-Survey Responses for Transfer and Regular-Admit Interest Belief Survey Questions

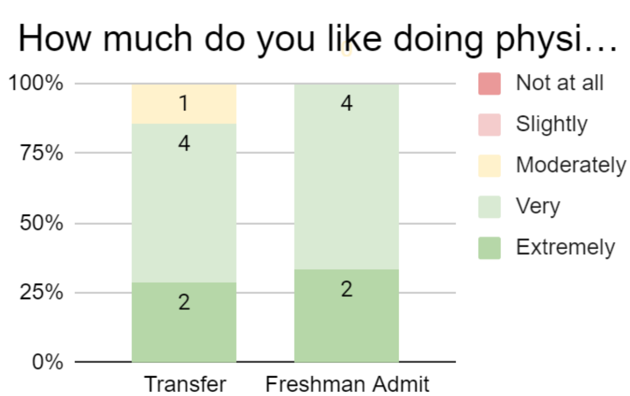

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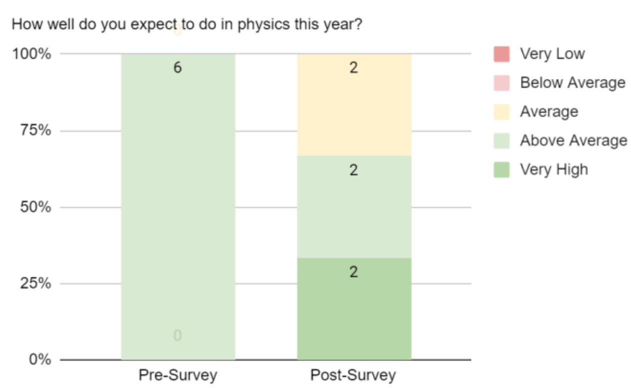
Figure J11, shows that when asked how much you like doing physics, the range of responses varied across all participants from "moderately" through "extremely." Of the transfer student respondents, 1 of 7 stated "moderately," 4 of 7 responded "very," and many respondents, 2 of 7 stated "extremely." Of the regular-admit students, 4 of 6 stated "very," and 2 of 6 stated "extremely." While the transfer students' responses spanned a greater range of the response values, with the exception of one student who responded that what they learn is "moderately," the responses of the transfer students were similar to that of regular-admit learners in terms of interest in doing physics.

Comparison of transfer students' pre- and post-survey data. The second part of this discussion presents a comparison of the transfer students' pre- and post-survey responses related to expectancy and task-value beliefs. The survey results included the transfer students who completed both the pre- and post-survey in the aim of observing changes in student disposition throughout the academic semester. These results are representative of students' expectancy and task-value beliefs changes after participating in the observed upper-division physics course at Grand Lakes University.

Expectancy. The expectancy belief related survey questions required students to indicate: (a) How well do you expect to do in physics this year?; and (b) How well do you expect to do in physics this year? The data were presented in stacked 100% bar graphs. The aggregate pre- and post-survey transfer physics major responses to the above expectancy belief questions are presented below in Tables J12, J13, and J14 below.

Figure J12

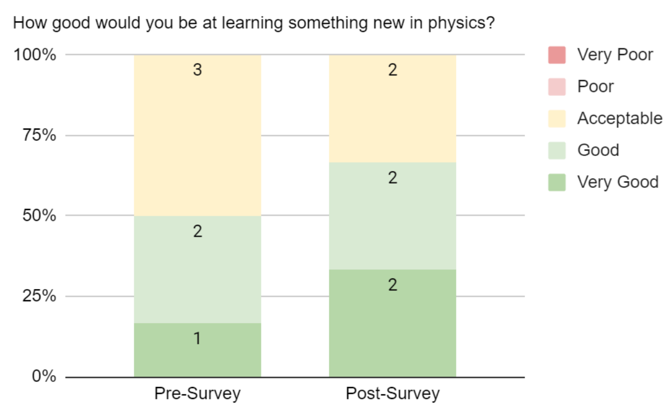
Pre-Survey and Post-Survey Responses for Transfer Physics Majors' Expectancy Belief Survey Questions.



As the possible responses ranged from average to very high in a Likert scale format (1-5), presenting the data in a stacked 100% bar chart format allowed for a visual cross comparison of the results across participants of varied numbers (6 transfer student respondents). From Table J12, 6 of 6 transfer physics majors responded that they expected to perform “above average” in physics this year. The distribution of answers changed on the post survey as 2 of 6 respondents stated that their expectations at the completion of the research study shifted to “average,” 2 of 6 reported “above average,” and the remaining 2 of 6 participants responded with expectancy values as “very high.” The overall data trends suggest that equal proportions of transfer physics students experienced slight decreases, slight increases, or no changes in expectancy values during the academic semester. These changes do not signify dramatic changes in expectancy values.

Figure J13

Pre-Survey and Post-Survey Responses for Transfer Physics Majors’ Expectancy Belief Survey Questions.



From Figure J13, 3 of 6 transfer physics majors responded that they expected to perform “acceptable,” 2 of 6 “above average,” and 1 of 6 “very good” in physics this year. The distribution of answers changed on the post survey as 2 of 6 respondents stated that their expectations of the completion of the research study shifted to “acceptable,” 2 of 6 reported “good,” and the remaining 2 of 6 participants responded to expectancy values as “very good.” The overall data trends suggest no changes in expectancy values during the academic semester. These changes do not signify dramatic changes in expectancy values.

***Ability*.** The task values questions related to ability required students to indicate: (a) How good are you in physics?; (b) If you were to list (rank) all of the students in class, where would you put yourself?; and (c) Compared to most of your other school subjects, how good are you in physics. The aggregate pre-survey and post-survey transfer physics majors' responses to the above ability belief questions are presented below in Tables J14, J15 and J16.

Figure 14

Pre-Survey and Post-Survey Responses for Transfer Physics Majors' Ability Belief Survey Questions.

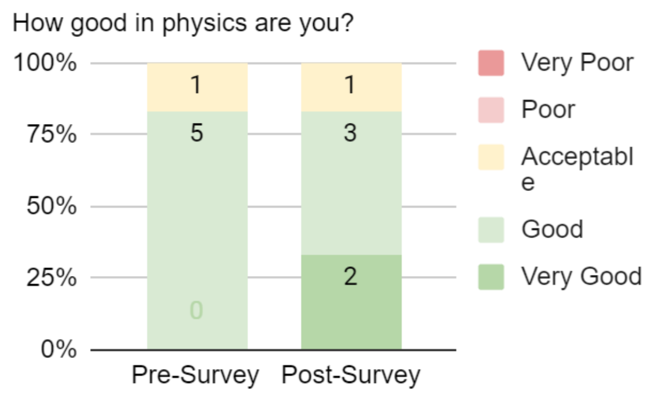
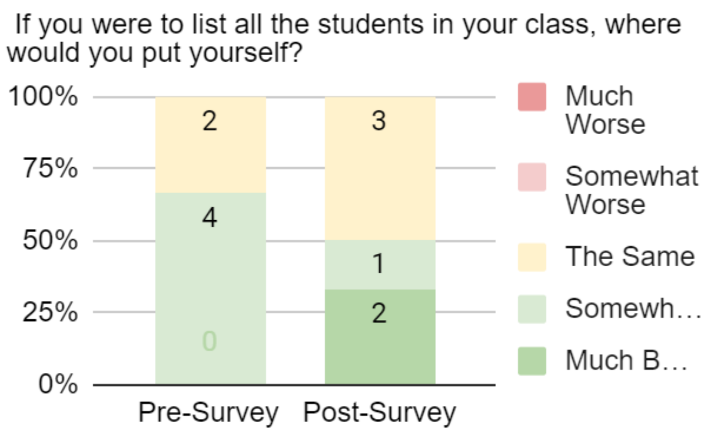


Figure J14, shows that all transfer and regular-admit status across the pre- and post-survey expect to be "acceptable, good, or very good" as related to physics ability. These initial ability beliefs varied between the pre- and post-survey, as 1 of 6 transfer student respondents stated that they expect to perform "acceptable" and the remaining 5 of 6 responded that they are "good" in physics. The distribution of ability responses for the post-survey was slightly higher as 1 of 6 regular-admit students reported that they are "acceptable" in physics, and 3 of 6 students stated they are "good," and 2 of 6 respondents stated that they are "very good" in physics. The pre-survey and post-survey distributions of transfer and regular-admit students show slight, but insignificant increases as related to individual ability belief across the academic semester.

Figure J15

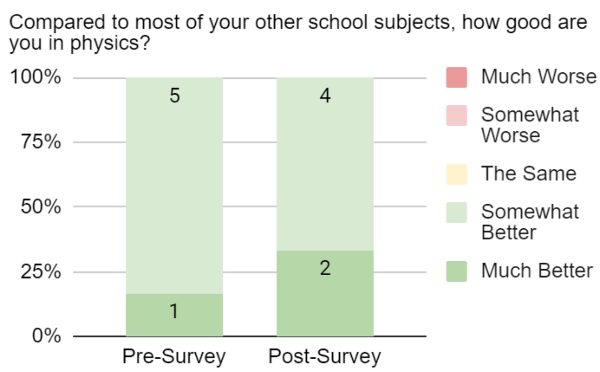
Pre-Survey and Post-Survey Responses for Transfer Physics Majors' Ability Belief Survey Questions.



From Figure 15, the data shows that all transfer physics major participants across the pre- and post-survey rank their ability compared to all of the students in their class as "the same" through "much better" at physics than all the students in their class. On the pre-survey, 2 of 6 transfer students stated their relative ability was "the same" as other students and 4 of 6 students stated their relative ability was "somewhat better." The post-survey distribution of ability-based responses for transfer student shifted as 1 of 6 respondents stated that they were "the same," 1 of 6 ranked their ability as "somewhat better," and 1 of 6 responded "much better" at physics compared to other students in class. Changes in the distribution of responses demonstrated slight increases and slight decreases in students' ability beliefs across the span of the academic semester.

Figure J16

Pre-Survey and Post-Survey Responses for Transfer Physics Majors' Ability Belief Survey Questions.



From Figure J16, the data shows that all transfer physics major participants across the pre- and post-survey rank their ability compared to all of the students in their class as "somewhat better" through "much better" at physics compared to other school subjects. On the pre-survey, 5 of 6 transfer students stated their relative ability was "somewhat better" than other students and 1 of 6 students stated their relative ability was "somewhat better." On the post-survey, the distribution of ability responses for transfer student shifted as 4 of 6 respondents stated that they were "somewhat better" and 2 of 6 ranked their ability as "much better" at physics compared to other school subjects. The subtle shifts suggest that student ability beliefs as related to relative content ability between students is stable.

Task value. The task value related survey questions required students to indicate : (a) In general, how useful is what you learn in physics?; (b) Compared to most of your other activities, how useful is what you learn in physics?; (c) How important is being good in physics?; (d) Compared to most of your other activities, how important is it for you to be good at physics?; (e) n general,[do] I find working on physics assignments interesting [fun]?; and (f) How much do you like doing physics? The aggregate pre-survey and post-survey transfer physics majors' responses to the above task value (i.e., utility, impotence, and interest) belief questions are presented below in Tables J17-J22.

Figure J17

Pre-Survey and Post-Survey Responses for Transfer Physics Majors' Utility Belief Survey Questions

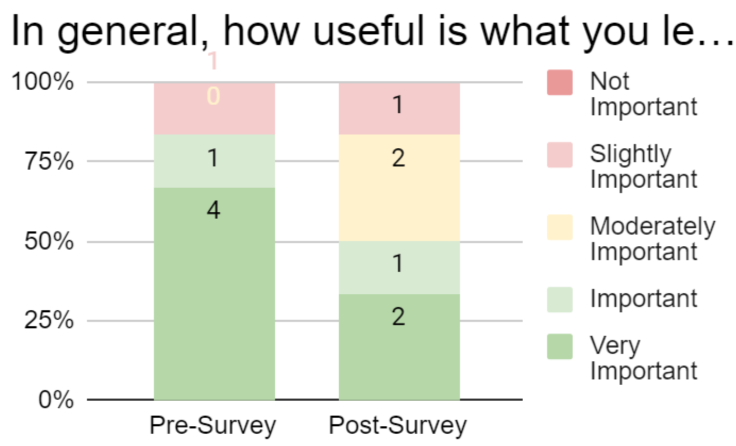


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Figure J17, shows that when asked about the utility of what students learn in physics, the range of responses varied across all participants from "slightly important" through "very important." Pre-survey transfer student respondents showed that 1 of 6 stated what they learn in physics is "slightly important," 1 of 6 stated "moderately important," and 4 of 6 responded "very important." Post survey findings show that 1 of 6 responded that what they learn in physics is "slightly important," 2 of 6 stated "moderately important," 1 of 6 stated "important," and 2 of 6 reported that the utility value of what they learn in physics class is "very important." Several respondents' changes between the pre- and post-survey responses require explanation. Tucker, a transfer student, initially reported that physics content learned in class was "important," however, he indicated that physics showed a change in perceived utility stating "slightly important" on the post-survey. A follow-up question regarding the accuracy of these response changes revealed that Tucker did not feel that physics content learned in class was useful because at the time of the post-survey due to the fact that he was unable to participate with in-person instruction. He stated that "the lab experiences were not as meaningful since I wasn't able to do the experiments." At the time of the follow-up question (during a later academic semester), in-person classes resumed, Tucker's perceived utility of physics content increased. Changes across the pre- and post-survey show a slight, but insignificant decrease in students' perceived utility in what they learn in physics class.

Figure J18

Pre-Survey and Post-Survey Responses for Transfer Physics Majors' Utility Belief Survey Questions.

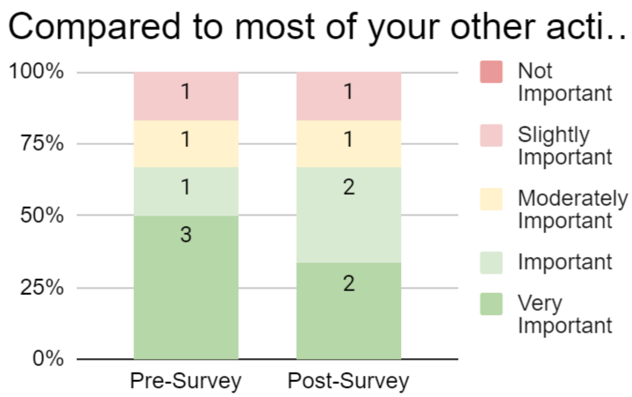

Figure J18, shows that when asked about the utility of what students learn in physics, compared to other activities, the range of responses varied across all participants from "slightly important" through "very important." Pre-survey transfer student respondents showed 1 of 6 stated that what they learn in physics is "slightly important," 1 of 6 stated "moderately important," 1 of 6 responded " important," and 3 of 6 stated "very important." Post survey findings show that 1 of 6 responded that what they learn in physics is "slightly important," 1 of 6 stated "moderately important," 2 of 6 stated "important," and 2 of 6 reported that what they learn in physics class, compared to other activities, is "very important." One student who reported "moderately important" on the pre-survey responded "slightly important" on the post-survey. A different student who reported "slightly important" on the pre-survey responded "moderately important" on the post-survey. The responses regarding the transfer students' perceived relative utility of physics, compared to other activities, were stable across the academic semester.

Figure J19

Pre-Survey and Post-Survey Responses for Transfer Physics Majors' Importance Belief Survey Questions

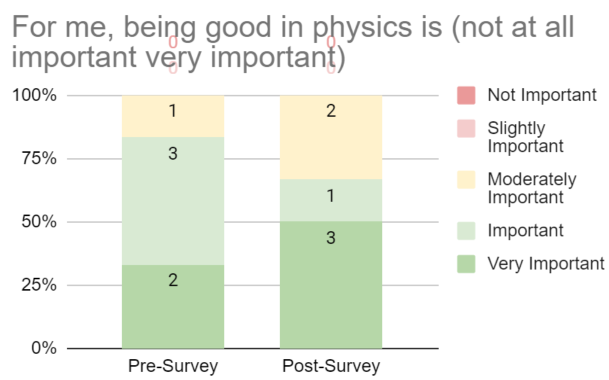

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Figure J19, shows that when asked about the importance of being in physics, compared to other activities, the range of responses varied across all participants from "moderately important" through "very important." Pre-survey transfer student respondents showed 1 of 6 stated that what they learn in physics is "moderately important," 3 of 6 stated "important" and 2 of 6 responded "very important." Post survey findings show that 2 of 6 responded that being good in physics is "moderately important," 1 of 6 stated "important," and 3 of 6 stated "very important" at being good in physics. The responses regarding the transfer students' perceived importance of being good at physics were stable across the academic semester.

Figure J20

Pre-Survey and Post-Survey Responses or Transfer Physics Majors' Importance Belief Survey Questions

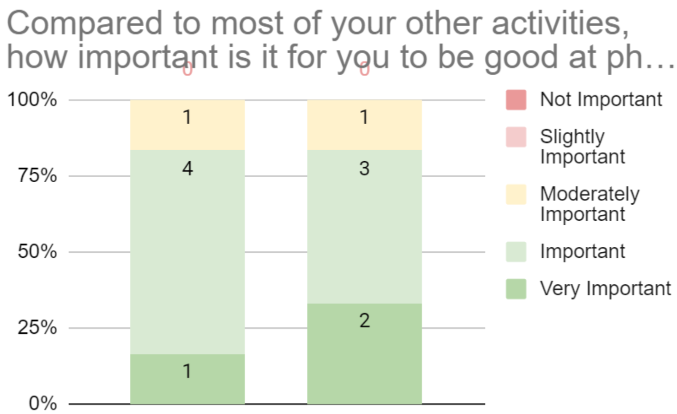


Figure J20 shows that when asked about the importance of being good at physics, compared to other activities, the range of responses varied across all participants from "moderately important" through "very important". Pre-survey transfer student respondents showed 1 of 6 stated that what they learn in physics is "moderately important," 4 of 6 stated "moderately important" and 1 of 6 responded "very important." Post survey findings show that 1 of 6 responded that being good in physics is "moderately important," 3 of 6 stated "important," and 2 of 6 stated "very important" at being good in physics. The responses regarding the transfer students' perceived importance of being good at physics, compared to other activities was stable across the academic semester.

Figure J21

Pre-Survey and Post-Survey Responses for Transfer Physics Majors' Interest Belief Survey Questions.

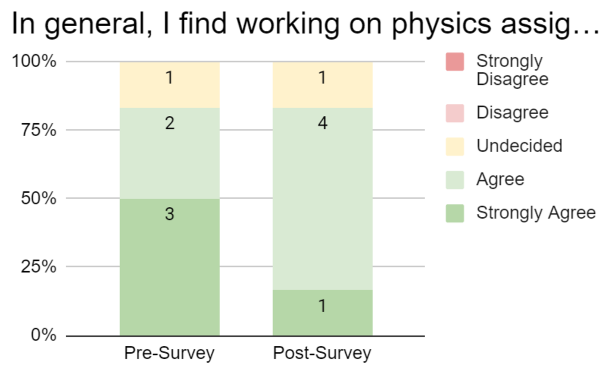


Figure J21, shows that when asked about the self-perceived interest in working on physics assignments, the range of responses varied across all participants from "undecided" through "strongly agree." Of the pre-survey of transfer student respondents, 1 of 6 stated "undecided," 2 of 6 responded "agree," and 3 of 6 stated "strongly agree." On post-survey transfer student responses, 1 of 6 stated "undecided," 4 of 6 "agreed," and similar to the transfer respondents a significant proportion, 1 of 6 responded "strongly agreed" that working on physics assignments is fun. Both the transfer students' responses had similar distributions and span a similar range of the response values, indicating that similar beliefs in terms of the interest in working on physics assignments across the span of the academic semester.

Figure J22

Pre-Survey and Post-Survey Responses for Transfer Physics Majors' Interest Belief Survey Questions.

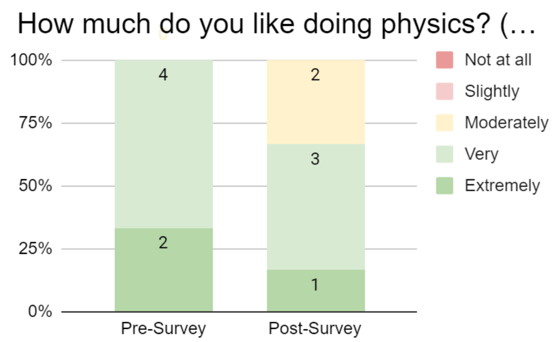


Figure J22, shows that when asked how much you like doing physics, the range of responses varied across all participants from "moderately" through "extremely." Of the pre-survey transfer student respondents, 4 of 7 stated that "very" and 2 of 6 students stated "extremely," when asked if they like doing physics. On the post-survey 2 of 6 stated "moderately," 3 of 6 stated "very," and 1 of 6 stated that they like doing physics "extremely." Both the transfer students' responses had similar distributions and span a similar range of the response values, indicating that similar beliefs in terms of the interest in doing physics

Table J23

Individual student pre-survey and post-survey responses to the question, "How good in physics are you?"

Transfer Student	Pre-Survey	Post-Survey	Likert Change
Tucker	Acceptable	Good	1
Theodore	Good	Very Good	1
Tyson	Acceptable	-	-
Tanner	Good	Good	0
Thatcher	Good	Good	0
Tyrell	Good	Very Good	1
Trenton	Good	Acceptable	-1

Note: Range of Likert response choices (Very Poor, Poor, Acceptable, Good, Very Good)

Table J24

Individual Student Pre-survey and Post-survey Responses to the Question, "If you were to list all the students in your class from the worst to the best in physics, where would you put yourself? (one of the worst one of the best)"

Transfer Student	Pre-Survey	Post-Survey	Likert Change
Tucker	The Same	The Same	0
Theodore	Somewhat Better	Somewhat Better	0
Tyson	Somewhat Worse	-	-
Tanner	The Same	The Same	0
Thatcher	Somewhat Better	Much Better	2
Tyrell	Somewhat Better	Much Better	1
Trenton	Somewhat Better	The Same	1

Note: Range of Likert response choices (Much Worse, Somewhat Worse, The Same, Better, Much Better)

Table J25

Individual Student Pre-survey and Post-Survey Responses to the Question, "Some kids are better in one subject than in another. For example, you might be better in math than in reading. Compared to most of your other school subjects, how good are you in physics? (a lot worse in physics than in other subjects a lot better in physics than in other subjects)"

Transfer Student	Pre-Survey	Post-Survey	Likert Change
Tucker	Somewhat Better	Somewhat Better	0
Theodore	Somewhat Better	Somewhat Better	0
Tyson	Much Worse	-	-
Tanner	Much Better	Much Better	0
Thatcher	Somewhat Better	Much Better	2
Tyrell	Somewhat Better	Somewhat Better	0
Trenton	Somewhat Better	Somewhat Better	0

Note: Range of Likert response choices ((Much Worse, Somewhat Worse, The Same, Better, Much Better)

Table J26

Individual Student Pre-Survey and Post-Survey Responses to the Question, "How good would you be at learning something new in physics? (not at all good very good)"

Transfer Student	Pre-Survey	Post-Survey	Likert Change
Tucker	Good	Good	0
Theodore	Acceptable	Very Good	2
Tyson	Acceptable	-	-
Tanner	Good	Good	0
Thatcher	Acceptable	Acceptable	0
Tyrell	Very Good	Very Good	0
Trenton	Acceptable	Acceptable	0

Note: Range of Likert response choices (Very Poor, Poor, Acceptable, Good, Very Good)

Table J27

Individual Student Pre-Survey and Post-Survey Responses to the Question, "Some things that you learn in school help you do things better outside of class, that is, they are useful. For example, learning about plants might help you grow a garden. In general, how useful is what you learn in physics? (not at all useful very useful)"

Transfer Student	Pre-Survey	Post-Survey	Likert Change
Tucker	Important	Slightly Important	-2
Theodore	Very Important	Important	-1
Tyson	Moderately Important	-	-
Tanner	Very Important	Very Important	0
Thatcher	Slightly Important	Moderately Important	1
Tyrell	Very Important	Very Important	0
Trenton	Very Important	Moderately Important	-2

Note: Range of Likert response choices (Not Important, Slightly Important, Moderately Important, Important, Very Important)

Table J28

Individual Student Pre-Survey and Post-Survey Responses to the Question, "Compared to most of your other activities, how useful is what you learn in physics? (not at all useful very useful)"

Transfer Student	Pre-Survey	Post-Survey	Likert Change
Tucker	Moderately Important	Slightly Important	-1
Theodore	Important	Important	0
Tyson	Slightly Important	-	-
Tanner	Very Important	Very Important	0
Thatcher	Slightly Important	Moderately Important	1
Tyrell	Very Important	Very Important	0
Trenton	Very Important	Important	-1

Note: Range of Likert response choices (Not Important, Slightly Important, Moderately Important, Important, Very Important)

Table J29

Individual Student Pre-Survey and Post-Survey Responses to the Question, "For me, being good in physics is (not at all important very important)"

Transfer Student	Pre-Survey	Post-Survey	Likert Change
Tucker	Moderately Important	Moderately Important	0
Theodore	Very Important	Very Important	0
Tyson	Important	-	-
Tanner	Important	Important	0
Thatcher	Important	Very Important	1
Tyrell	Very Important	Very Important	0
Trenton	Important	Moderately Important	-1

Note: Range of Likert response choices (Not Important, Slightly Important, Moderately Important, Important, Very Important)

Table J30

Individual Student Pre-Survey and Post-Survey Responses to the Question, "Compared to most of your other activities, how important is it for you to be good at physics? (not at all important very important)"

Transfer Student	Pre-Survey	Post-Survey	Likert Change
Tucker	Moderately Important	Important	1
Theodore	Important	Very Important	1
Tyson	Not Important	-	-
Tanner	Important	Important	0
Thatcher	Important	Very Important	1
Tyrell	Very Important	Important	-1
Trenton	Important	Moderately Important	-1

Note: Range of Likert response choices (Not Important, Slightly Important, Moderately Important, Important, Very Important)

Table J31

Individual Student Pre-Survey and Post-Survey Responses to the Question, "In general, I find working on physics assignments interesting [fun]."

Transfer Student	Pre-Survey	Post-Survey	Likert Change
Tucker	Undecided	Agree	1
Theodore	Agree	Agree	0
Tyson	Undecided		-
Tanner	Strongly Agree	Agree	-1
Thatcher	Agree	Agree	0
Tyrell	Strongly Agree	Strongly Agree	0
Trenton	Strongly Agree	Undecided	-2

Note: Range of Likert response choices (Strongly Disagree, Disagree, Undecided, Agree, Strongly Agree)

Table J32

Individual Student Pre-Survey and Post-Survey Responses to the Question, "How much do you like doing physics? (not at all very much)"

Transfer Student	Pre-Survey	Post-Survey	Likert Change
Tucker	Very	Moderately	-1
Theodore	Very	Very	0
Tyson	Moderately	-	-
Tanner	Extremely	Extremely	0
Thatcher	Very	Very	0
Tyrell	Extremely	Very	-1
Trenton	Very	Moderately	-1

Note: Range of Likert response choices (Not At All, Slightly, Moderately, Very, Extremely)

Appendix K

Classroom Observation Data

***Time on-topic metric*.** Group interactions (e.g., verbal communication) were observed during each minute of group work and categorized as on-topic or off-topic. Since the total number, and duration or small group sessions varied during each of the observed class sessions, the on-topic conversations were presented as the percentage of the total time of each small group session. The percentage of on-topic time for each group and the aggregate data (e.g., average percentage of the on-topic conversations) is displayed below in Table K1.

Table K1

Percentage of On-topic Conversation Time for Groups in Small Group Settings

Student ID		2/12	2/17	2/19	3/2	3/11	Average%
Group A	Theodore, Tucker and Frank	61	67	76	36	63	60.6
Group B	Tanner and Trenton	100	100	100	98	100	99.6
Group C	Floyd and Thatcher	65	59	100	47	100	74.2

On-topic utterance metric. Since multiple communication exchanges across participants occurred within each minute of observation, the time on-topic metric failed to provide precise observations of language required to gain an understanding of the students' social language distribution, development and adaptations in the small group settings. The analysis of student communication at the group and the individual level necessitated the use of utterances as a standard metric for communication. As related to this study, an utterance is defined as an uninterrupted chain of spoken or written language. The total number of on-topic and off-topic student utterances for each group session across the five observation dates were counted and tabulated. The total number of student utterances, including both on-topic and off-topic conversation is displayed below in Table K2.

Table K2

Total Number of Student Utterances Spoken During Small Group Sessions

Group ID	Group Members	2/12	2/17	2/19	3/2	3/11	Total Average
Table A	Theodore, Tucker, Frank	315	140	303	284	175	243
Table B	Tanner, Trenton	692	414	342	817	589	571
Table C	Floyd, Thatcher	466	380	275	452	261	367

The total number of utterances each group spoke during each class session varied across groups on and across small group session dates. Differences in these values across dates can be accounted for by considering differing periods of time allotted for small group sessions and differences in the numbers of members across groups. The total number of on-topic individual participant's utterances during each minute of instruction during the five class sessions were counted and tabulated. The total number of each individual's (including the instructor) on-topic utterances for each of the small group sessions are displayed below in Table K3.

Table K3

Total Number of Individual's On-Topic Utterances for Small Group Sessions

Table	Student ID	Dates				
		2/12	2/17	2/19	3/2	3/11
Table A	Frank	169	151	70	239	125
Table A	Tucker	134	88	105	232	117
Table A	Theodore	75	36	36	50	54
Table A	Instructor	3	1	9	3	6
Table B	Tanner	185	67	80	121	73
Table B	Trenton	60	34	64	128	43
Table B	Instructor	73	19	24	16	20
Table C	Thatcher	178	74	131	31	168
Table C	Floyd	134	76	99	20	107
Table C	Instructor	51	27	7	5	29

The total number of on-topic utterances were calculated for each date to serve as a reference to determine the distribution and development of on-topic utterances and critical thinking measures of groups and individuals. The total number of on-topic utterances observed during small group settings are displayed below in Table K4.

Table K4

Total Number of On-Topic Group Utterances

	2/12	2/17	2/19	3/2	3/11
Table A	378	276	220	524	302
Table B	317	120	168	265	136
Table C	363	177	237	56	304

The proportion of on-topic utterances to the total number of utterances spoken during small group sessions on each date provide frequencies of on-topic talk which offer utility in the determination of language distribution and development during each of a) individual students and b) groups of physics students, participating in small group settings among group members within groups during specific class sessions, among groups across class sessions (e.g., as a function of time), and of individuals within the context of the group sessions.

Table K5

The Frequency of Teacher-Initiated or Student Initiated Interactions in Large Group Settings.

Table	Student	Number of Observed TD	Number of Observed IQ	Number of Observed SQ	Number of Observed SC	Total Number of TII and SII
Table A	Theodore	3	0	1	0	4
Table A	Tucker	7	0	1	0	8
Table A	Frank	0	0	1	0	1
Table B	Trenton	9	0	5	1	15
Table B	Tanner	20	0	6	1	27
Table C	Thatcher	7	0	10	1	18
Table C	Floyd	1	0	0	0	1
Table D	Thomas	8	0	3	11	22
Table D	Fabian	4	4	6	8	22
Table E	Tyson	0	0	0	0	0
Table E	Faraz	5	0	0	0	5
Table F	Fedor	15	0	2	2	19
Table F	Fatima	1	0	0	0	1
Table F	Felix	5	0	0	0	5
Table G	Tobias	0	0	1	1	2
Table G	Tyrell	13	0	1	1	15

Note: Teacher-initiated interactions are shaded green and student-initiated interactions are shaded red.

[a]: Transfer students assigned pseudonyms starting with the letter “T,” i.e., Theodore; Regular-admit students assigned pseudonyms starting with the letter “F,” i.e., Frank.

Table K6

The Frequency of Teacher-Initiated or Student Initiated Interactions in Small Group Settings.

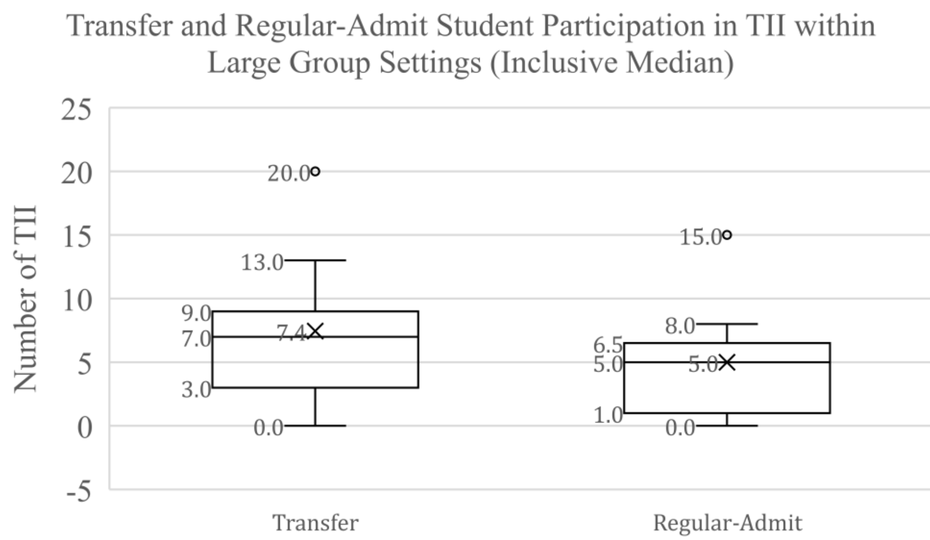
Table	Student	Number of Observed TD	Number of Observed IQ	Number of Observed SQ	Number of Observed SC	Total Number of TII and SII
Table A	Theodore	0	2	6	0	8
Table A	Tucker	0	1	5	0	6
Table A	Frank	0	0	4	0	4
Table B	Trenton	0	0	5	0	5
Table B	Tanner	0	0	14	0	14
Table C	Thatcher	0	0	10	0	10
Table C	Floyd	0	0	3	0	3
Table D	Thomas	0	0	8	0	8
Table D	Fabian	0	0	5	0	5
Table E	Tyson	0	0	1	0	1
Table E	Faraz	0	0	0	0	0
Table F	Fedor	0	0	8	0	8
Table F	Fatima	0	0	0	0	0
Table F	Felix	0	0	3	0	3
Table G	Tobias	0	0	3	1	4
Table G	Tyrell	0	0	3	0	3

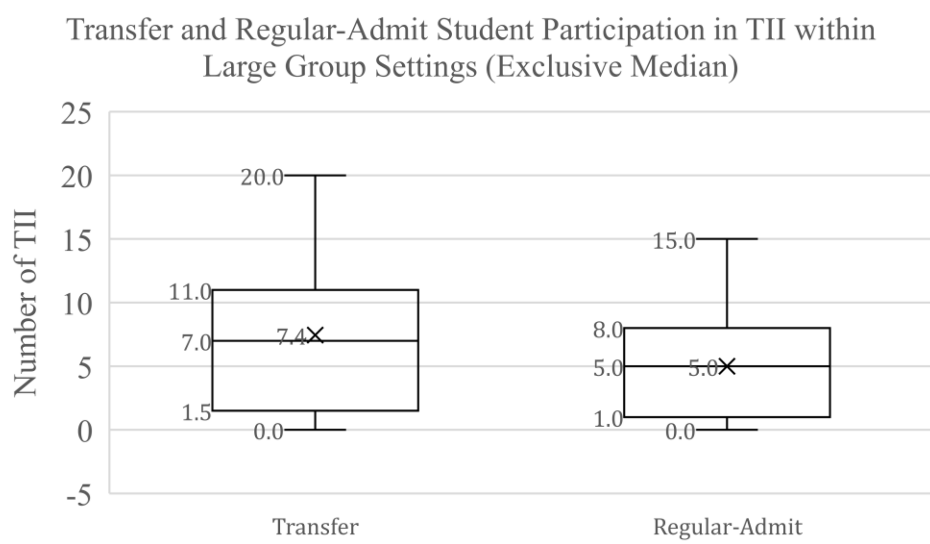
Note: Teacher-initiated interactions are shaded green and student-initiated interactions are shaded red.

[a]: Transfer students assigned pseudonyms starting with the letter "T," i.e., Theodore; Regular-admit students assigned pseudonyms starting with the letter "F," i.e., Frank.

Table K7

Transfer Student and Regular-Admit Student TII Participation Rates in Large Group Settings

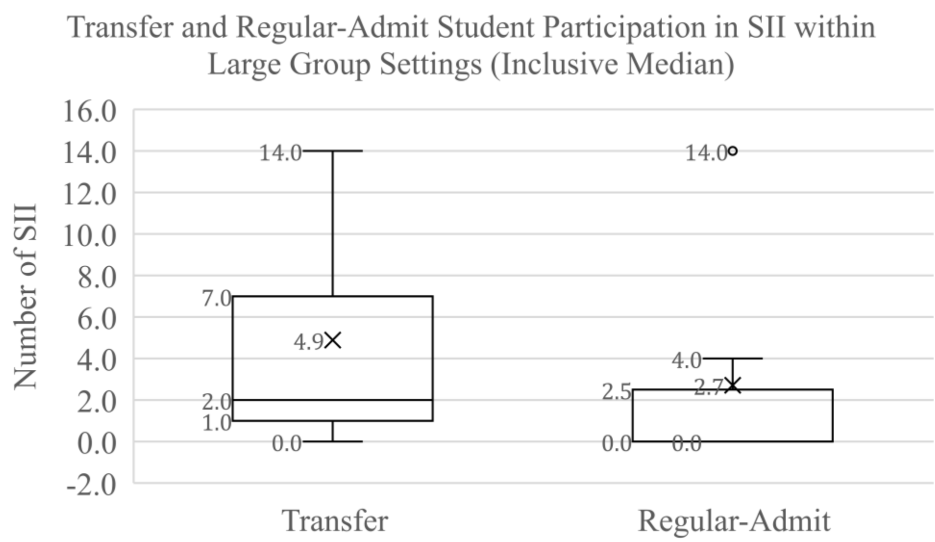


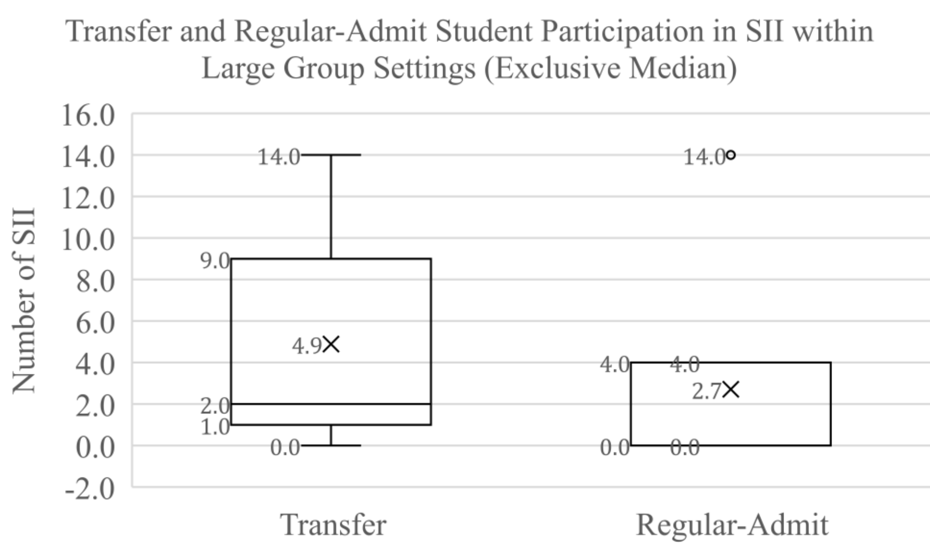


Note: Outlier present in Regular-Admit SII data. The outlier points (n = 20 for Transfer) and (n=15 for Regular-Admit) were excluded for quartile range and median calculations.

Table K8

Transfer student and Regular-Admit Student SII Participation Rates in Large Group Settings

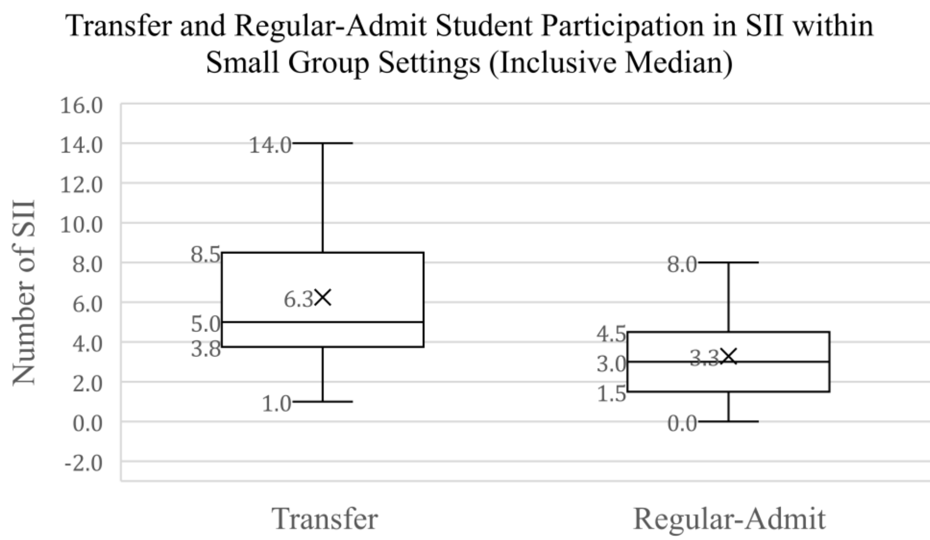


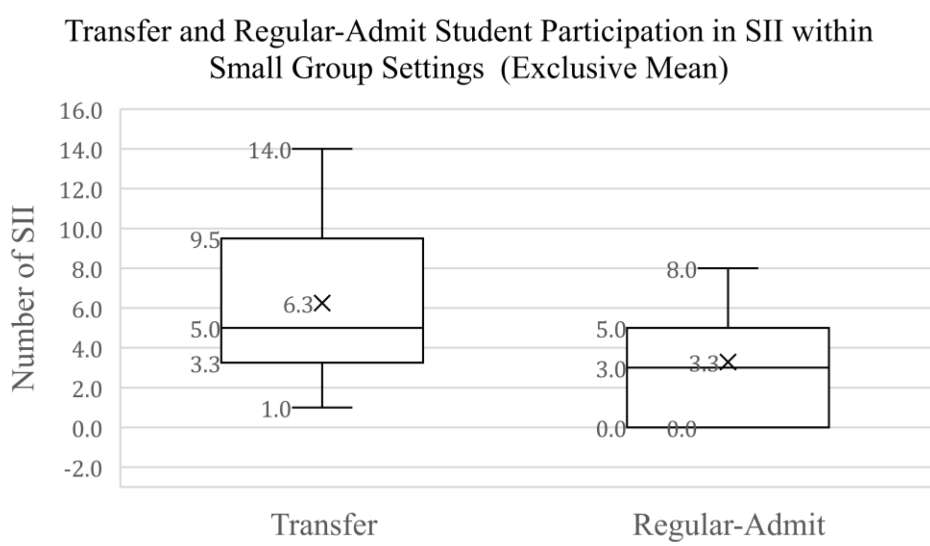


Note: Outlier present in Regular-Admit SII data. The outlier point (n = 14) was excluded for the quartile range and median calculations.

Table K9

Transfer Student and Regular-Admit Student SII Participation Rates in Small Group Settings





Appendix L

Social Language and Critical Thinking Frequencies

Table L1

Percentage of Individual's On-topic Utterances Spoken within Small Group Settings.

		2/12	2/17	2/19	3/2	3/11	Average Unweighted	Average Weighted
Table A	Frank	0.45	0.55	0.32	0.46	0.41	0.44	0.44
Table A	Tucker	0.35	0.32	0.48	0.44	0.39	0.4	0.4
Table A	Theodore	0.2	0.13	0.16	0.1	0.18	0.15	0.17
Table A	Prof	0.01	0	0.04	0.01	0.02	0.02	0
Table B	Tanner	0.58	0.56	0.48	0.46	0.54	0.52	0.52
Table B	Trenton	0.19	0.28	0.38	0.48	0.32	0.33	0.29
Table B	Prof	0.23	0.16	0.14	0.06	0.15	0.15	0.15
Table C	Thatcher	0.49	0.42	0.55	0.55	0.55	0.51	0.51
Table C	Floyd	0.37	0.43	0.42	0.36	0.35	0.39	0.38
Table C	Prof	0.14	0.15	0.03	0.09	0.1	0.1	0.1

Note: The percentage of on-topic utterances are calculated by taking the ratio of the total number of on-topic utterances and the total number of on-topic utterances for each group.

[a]The weighted averages account for variation in the total number of utterances spoken by each group across dates. While the unweighted and weighted averages of the percentage of instructor utterances is zero for Table A, the instructor spoke a total of 22 utterances, representing an insignificant number of the total utterances spoken within the group.

[b]Color scales highlight the relative differences of the average weighted percentage of utterances spoken throughout the observed dates within small group settings.

The first group, Table A, composed of two transfer physics students (Tucker and Theodore) and a regular-admit mathematics major (Frank), showed variation in the distribution of on-topic social language use. Students in Table A, Frank and Tucker's contributed to the majority of on-topic conversations, 44% and 40% respectively and Theodore contributed a disproportionately small fraction, 17% of the total on-topic utterances within the group. While the instructor did interact with Table A within small group settings; between 1% and 4% of the on-topic utterances on various dates, the weighted average of interactions reveals that the instructor's interactions were insignificant representing 0% in the weighted average of utterances within Table A .

The second group, Table B, composed of two transfer students majoring in physics (Tanner and Trenton) contributed to differing amounts of small group session on-topic conversation throughout the data collection. At Table B, Tanner spoke 52% and Trenton spoke 29% of the on-topic utterances throughout the data collection. Consistent with the SII frequency findings in small in the large group settings, the transfer student Tanner also responded to, or initiated the majority of both teacher and student initiated interactions in both the large and small group settings. Although less than Tanner, Trenton's student-instructor interactions in large and small group settings were amongst the highest in the observed across classes. The small group session interaction data revealed disparate on-topic social language use between Tanner and Trenton, although when compared to the class as a whole, both students' on-topic language were well represented, as Tanner and Trenton's' time on task greatly exceeds all other participant groups' time-on-task. Interestingly, the instructor contributed to 15% of the Table B on-topic utterances, while answering a large number of student questions posed by Tanner and Trenton. Student-initiated interaction, or student-instructor interaction questions posed by Tanner and Trenton (i.e., Table B) represented 19 of 91 the total SQs, representing 21% of the total number of student questions posed across all students in the small group settings.

Last, the third group, Group C, composed of a transfer physics major (Thatcher) and a regular-admit physics major (Floyd) also showed variation in the distribution of on-topic social language use in small group settings. While on-topic social language use was closer to par among students within Group C, Thatcher expressed 51%, and Floyd 38% of the group's on-topic social language utterances during small group settings. When comparing SII in small group settings, Thatcher initiated the majority of student questions (10 student-instructor questions) compared to Floyd's (3 student questions) despite these differences. The instructor contributed 15% of Table C's on-topic utterances.

Table L2

Color Scaled Cells Showing Relative Participants' Frequencies of On-Topic Utterances Within Individual Class Sessions.

		2/12	2/17	2/19	3/2	3/11
Table A	Frank	0.45	0.55	0.32	0.46	0.41
Table A	Tucker	0.35	0.32	0.48	0.44	0.39
Table A	Theodore	0.2	0.13	0.16	0.1	0.18
Table A	Prof	0.01	0	0.04	0.01	0.02
Table B	Tanner	0.58	0.56	0.48	0.46	0.54
Table B	Trenton	0.19	0.28	0.38	0.48	0.32
Table B	Prof	0.23	0.16	0.14	0.06	0.15
Table C	Thatcher	0.49	0.42	0.55	0.55	0.55
Table C	Floyd	0.37	0.43	0.42	0.36	0.35
Table C	Prof	0.14	0.15	0.03	0.09	0.1

Note: Color scales were applied across each group on each date providing demonstrating the relative differences in the proportion of on-topic utterances spoken by each group member in small group settings.

Table L3

Examples of Critical Thinking indicators Applied to Transcript Data from Small Group Sessions.

Line	Name	Text	Code
1	Tucker	What wavelength will the galaxy appear to emit?	
2		Moving toward us with a speed of 0.8c	p-clar
3	Frank	Oh And it says in what direction,	
4		The direction would be away? Yeah?	c-assess
5	Tucker	The first one?	
6	Theodore	Yeah. It's receding	c-assess
7	Frank	Yeah. Because it's positive.	ju
8		Positive means away receding negative means towards.	ju

Critical thinking indicators were applied to transcript data for small group sessions across the observed class periods while students were engaged in problem solving as related to content discussed within the large group setting. Since the class time allotted for problem solving in small group sessions varied across the observed classes, the number of critical thinking codes assigned during each session were not useful in representing the extent or development across the observed small group sessions. Rather, the proportion of each critical thinking code in relation to the total number of utterances spoken during small group sessions (both on-topic and off-topic) were used to calculate the frequency of each critical thinking code during each small group session. The table numbers of each critical thinking metric for each group are displayed below in Table L5.

Table L4

The Number of Critical Thinking Codes Assigned to Transcript Data for Small Group Sessions

Date	CT code	2/12	2/17	2/19	3/2	3/11
Group A	p-clar	5	75	48	68	30
	c-assess	59	40	39	70	47
	ju	19	27	32	71	92
	Total On-topic Utterances	378	276	220	524	302
Group B	p-clar	45	30	48	36	28
	c-assess	49	28	41	50	33
	ju	22	15	27	41	64
	Total On-topic Utterances	319	120	168	265	136
Group C	p-clar	65	57	60	41	38
	c-assess	61	40	84	18	49
	ju	52	9	40	15	83
	Total On-topic Utterances	363	177	237	56	304

Appendix M

Codebook

Theme	Description	Sub-theme	Example
Individual Factor	Sociocultural factor attached to individuals		Expectancy Belief; Subjective-Task Value; Previous Educational; Experience
Institutional Factor	Sociocultural factor attached to institution		Interactional structure such as large or small group; socializer belief
Matriculation status	Began studies at institution as freshman	Freshman-Admit	Survey responses: I did not attend another institution, I began my studies at Grand Lakes University (pseudonym)
	Transferred from another institution	Transfer Student	Survey responses: 2-year Community College; 4-year College

Theme	Description	Sub-theme	Example
Expectancies			
	Self-concept about physics ability	Ability-Belief	Survey responses; Interview response "But I know it’s because I can, I’m okay doing the math and doing the actual physics itself"
	Self-concept about success in physics studies	Expectation for Success	
Subjective-Task Value			
	Perceived use of physics studies	Utility Value	Survey responses; Interview response utility belief- “[he] felt it was the most flexible option between engineering and teaching,”
	Importance placed on physics studies	Attainment Value	Survey responses; Interview response attainment belief- "I feel like studying physics is internally important to me, but I don’t feel an external need for validation."
	Interest in physics studies	Intrinsic Interest	Survey responses; Interview response intrinsic interest belief- “the physics classes are important and interesting, but I’m not sure the [physics degree courses] are as good as engineering courses for most jobs I’m looking for.”

Theme	Description	Sub-theme	Example
Previous Experience	Previous experience studying physics		Theodore, stated that he chose a physics major after completing AP coursework in high school and several physics courses at the community college level
Transition Experience	Descriptions of transition experiences during transfer		Interview responses: students characterized their transition experiences as being “seamless” or “not insurmountable”; while others cited “no noticeable differences” between their studies at the transfer-sending and Grand Lakes University.
Perception of Institution	Perceptions of the university as a whole	University-level	Interview responses: “I don’t really look at [Grand Lakes University] as anything else”; while another student, Tyrell said, “I don’t feel like there’s any relationship between giant university complexes and their students, like other than, like the individual level with professors.”
Perception of the Physics Department	Perceptions of the physics department	Department-level	Interview response: He expressed positive experiences regarding Grand Lakes University and the physics department, declaring that “it’s the epitome of a university environment...there’s everything you could want and need.”

Theme	Description	Sub-theme	Example
Meaning of Socialization	Personal meaning of socialization		Interview Response: “something sociocultural that’s passed down from generation to generation.”
Experiences Socialization	Descriptions of how students experience socialization		Interview Response: “people talking about physics...trying to extract physics knowledge or insights from each other, or...by doing physics work.”
Importance of Belonging	The importance students place on experiencing a sense of belonging		Interview Response: “[had] no sense of community and I didn’t feel like there was any opportunity. I didn’t feel like people cared about me, or like wanted to help me out or see me succeed.”
Experiences Belonging	Descriptions of how students experience belonging		Interview Response: “it was the first experience where I truly thought I wasn’t alone,”

Theme	Description	Sub-theme	Example
Interactions	Reciprocal action or influence		
	Large Group or Lecture setting	Large Group	Classroom Observation: Lecture settings
	Small Group or Problem-solving setting	Small Group	Classroom Observation: Problem-Solving; Collaborative settings

Theme	Description	Sub-theme	Example
Interactions	Interaction between student and instructor	Student-Instructor	Classroom Observation: *Instructor:* Hey, in this basement soldering copper pipes and what's the first thing he sees in the poorly lit basement as a heats up the with this propane torch the copper What do you see? *Student*-Light. *Instructor*-No when you heat something up what's the first color you see is red right? So what happens when you're seeing red what what's physically happening the radiation is...
	Interaction between students	Student-Student	Classroom Observation: *Student1:* So then what is conserved with the x-direction, the original photon? *Student2:* The original photon is absorbed. *Student1:*Lght, *Student2:* it's just, the momentum of the first photon needs to equal the momentum of second photon and the momentum of the electron in their x component directions

Theme	Description	Sub-theme	Example
Interaction	Teacher Initiated Interaction	TII	Classroom Observation
	Student Initiated Interaction	SII	Classroom Observation
	Use of Triadic Dialogue	TD	Classroom Observation: *Instructor:* All right, this is a fundamental constant. This is how big the object is and this temperature is in what you units. *Student:* Kelvin *Instructor:* Kelvin, Yep.
	Use of Instructor Question	TQ	Classroom Observation: Did anybody actually plug in the numbers?
	Student Question	SQ	Classroom Observation: *Student:* In the velocity equation the mass is that the mass of the electron? *Instructor: Y*es, because this comes from the quantization of m v r 10 h bar.
	Student Commentary	SC	Classroom Observation: *Student*: now it really was interesting I think momentum thing is kind of cool like I feel like I kind of understand it like two particles coming together and an inelastic collision and creating more energy

Theme	Description	Sub-theme	Example
Social Language			
	Talking about irrelevant subject-matter	Off-topic Utterance	Classroom Observation: *Student:* (discussing religion) hey they try to but then it goes, it strays away from fully a full language teaching to preparing for longer Torah portion.
	Talking about relevant subject-matter	On-topic Utterance	Classroom Observation: *Student:* Oh r is 4 Pi Vo h bar, h bar squared oh yeah, yeah h bar squared n squared over c squared.
Critical Thinking	Process of judging the worth of thinking or other activity		
	identifying/framing aspects of problem-solving	Problem Clarification (p-clar)	Classroom Observation: *Student:* Oh And it says in what direction,
	making judgments about one's own or others' strategy or solution	Critical Assessment (c-asses)	Classroom Observation: *Student:* The direction would be away? Yeah?
	justification for assertion	Justification (ju)	Classroom Observation: *Student:* Yeah. Because it's positive.

Theme	Description	Sub-theme	Example
Achievement-related Behavior			
	activity connected to upper-division or other relevant class spaces	Classroom	Classroom Observation
	activity connected to co-curricular activity	Co-Curricular	Interview Data: (describing) students went to *PhysCon* because they are extremely passionate about physics, so I'm surrounded by like-minded people.