Turn-Taking Behaviors in the Physics Classroom

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ABSTRACT

This study adds to the literature on the persisting gender gap in STEM by examining the participation trends of women and men undergraduate students in the physics classroom. Specifically, this study builds on the existing literature of proportions in group interaction originally theorized by Kanter (1977) and investigates the turn-taking behaviors of women and men in classes that differ in their relative levels of gender representation. This study posed four hypotheses: That women will average less oral participation in the physics classroom than men, that more highly skewed classes will result in greater differences in men's and women's participation, that there will be an observable tipping point in women's participation, and that women's average participation will go up with the proportion of women in the classroom. These hypotheses were tested in 10 physics classrooms over the course of one class period each. The student-initiated turns during these class periods were coded by individual turn-taker. These data were analyzed to determine differences between men and women students' turn-taking behaviors in the physics classroom in relation to the proportion of women and men in the classroom. Findings indicate that women did average less participation than men in the physics classroom. However, the data do not point to a consistent relationship between increases in proportions of women in the physics class and increases in women's participation in the class.

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GENERAL AUDIENCE ABSTRACT

This study looked to understand the differences in women's and men's in-class volunteered participation in the college physics classroom. Specifically, this study builds on the existing literature on the effects of group gender proportion in interaction, or how the proportion of women to men in a group shapes women's interactions, originally developed by Kanter (1977) and investigates the turn-taking behaviors, or how speech in conversation is initiated, of women and men in classes that differ in their gender compositions. This study had four hypotheses: 1) That women will have less volunteered participation in the physics classroom than men 2) That more highly skewed classes, or classes with high proportions of men and low proportions of women, will result in greater differences in men's and women's participation 3) That there will be an observable tipping point, a point when an increase in women in the classroom will cause an increase in women's participation 4) That women's participation will go up with the number of women in the classroom. These hypotheses were tested in 10 physics classrooms over the course of one class period each. The voluntary, student-initiated participation during these class periods were looked at by individual student. The information gathered was analyzed to understand if there were differences between men and women students' amount of participation in the physics classroom in relation to the composition of women and men in the classroom. The study found that women did average less participation than men in the physics classroom. However, the information gathered did not point to a relationship between the increases in the proportion of women in the physics class and increases in women's participation in the class.

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PROBLEM STATEMENT

The purpose of this study is to understand the gendered participatory behaviors of students within a physics education setting within a large university. To accomplish this, four questions about women's turn-taking behaviors in the physics classroom will be examined. 1. Do men and women in the physics classroom exhibit the same average rate of turns at conversation? 2. Do men and women in the physics classroom exhibit the same average rate of unsolicited turns at conversation? 3. Are the average lengths of turns taken by men and women in the physics class equal? 4. Do women and men in the physics classroom overlap their turns at the same average rate? This study will utilize status characteristics theory with conversation analysis to offer a new perspective on the gendered behaviors exhibited within the physics classroom. The quantitative data for this study were collected using classroom observations which were conducted on University S's campus within current, undergraduate physics classes that allow for some amount of in-class oral participation, and which were recorded and transcribed over the course of ten class periods. These recordings were analyzed quantitatively by noting the frequency of turn-taking, the length of the turns, the types of turns taken and then comparisons were made between the men and women in the class.

This study builds upon several existing areas of sociological and linguistic research which have focused on gender differences and gender inequality. Thus far, less attention has been paid to the social behaviors within STEM classrooms in regards to academic outcomes and retention within majors despite the high turnover of women within STEM fields (Eide 1994, Ma 2011, Sadler et al. 2012, Viadero 2009). What happens inside of the STEM classroom often has been ignored by much of the literature on the STEM gender gap. This lack of attention is concerning because classroom engagement and participation historically have been linked to academic achievement and retention (Bennett 2014, Ing and Victorino 2016, O'Connor et al. 2017, Oros 2007, Russell 2012). In particular, classroom dialogue can strongly relate to students' retention and is an area where further research may help to broaden our understanding of students' learning outcomes (Van Der Veen and Van Oers 2017). This study seeks to shed light on the behaviors of students inside of the STEM classroom that might contribute to the current discussion on the gender gap in physics. Previous literature has proposed that the observed conversational behaviors exhibited by students within the classroom can reflect the cultural conditions from which they have learned to communicate in a classroom setting (Russell 2012). These behaviors are thought to be the result of the socialization processes through which children learn what behaviors are expected and acceptable for boys and what behaviors are expected and acceptable for girls (Howard and Hollander 1997, Kimmel 2008, Poulin-Dubois et al. 2002). The conversational behaviors exhibited in the physics classroom may then give us insight into how women and men position themselves within physics education.

LITERATURE REVIEW

Classroom Discourse and Learning outcomes

There has been much research done on how classroom discourse, participation and engagement can affect students' learning outcomes. Studies have found that active learning, in which an emphasis is placed on student involvement in class discussion and activities, can help with students' retention of information and comprehension of course materials (Bennett 2014, Oros 2007). It is this investigation into the benefits of active learning which has led social science research into the investigation of students' participation trends and discourse within a classroom setting. In the areas of developing and implementing active learning types, argumentation in the classroom has been examined by Marta Civil and Roberta Hunter (2015) in regards to students' development of mathematical reasoning. Civil and Hunter (2015) examined how engagement in classroom-based argumentation can be encouraged in underrepresented mathematics students. Their research showed that both the relationships that students develop in the classroom and building a classroom atmosphere in which students feel their cultures can be included and appreciated contribute greatly to students' development of argumentation and participation (Civil and Hunter 2015). A number of studies have also supported the conclusion that developing an inclusive classroom environment can encourage higher rates of participation in the classroom by underrepresented students (Bennett 2014, Clarke et al. 2016, Howard, Short and Clark 1996). Similar research has found that differences can be found in classroom engagement between specific subpopulations of underrepresented groups, as was found in Ing and Victorino's (2016) study of Asian

American engineering students which found differences in the participation trends of different Asian American ethnic groups (Ing and Victorino 2016). For this reason, researchers have concluded that it cannot be enough only to monitor general student engagement and participation: It is also important to examine the differences in who participates and who does not, and in what situations (Howard, Short and Clark 1996, Russell 2012).

Equally important to students' development of critical reasoning and argumentation, researchers have proposed that the classroom also serves as an important resource for students to build a positive professional identity (Russell 2012). Classroom discourse can build students' confidence in both academic language and the professional language skills that they will need to both persist within their subject and within their chosen professional field (Russell 2012). Eddy, Brownell and Wenderoth's (2014) study found that female biology students tended to have less confidence in their ability and that they participated much less frequently in classroom discussions and activities. This study suggested that this missed opportunity to contribute to class activities may contribute to a lowered sense of belonging to the professional and academic community (Eddy, Brownell and Wenderoth 2014). Similarly, Cech et al. (2011) found that women in engineering had less confidence in their expertise and in their career fit than did men in engineering. This study also found that women's professional role confidence was correlated with their continuation in the engineering profession (Cech et al. 2011). More recent research done by Seron et al. (2016) looked at the ways in which the informal socialization processes in engineering education might contribute to the continued segregation of the field. Their findings suggest that rather than encourage persistence, because of the male-dominated culture of engineering, immersion in the field may cause women to feel estranged from the profession (Seron et al. 2016). In particular, Seron et al. (2016) noted that it was often the informal socialization processes in engineering, such as collaborative work or interaction with male peers and colleagues, that led women to doubt their professional fit within the culture of engineering. These same interactions with male peers in collaborative work and in internships were often positive contributors to men's confidence in their own professional fit within engineering (Seron et al. 2016). Many studies looking at female persistence in academic and career fields have also focused on the lack of belonging to the discipline, professional role confidence and professional identity that women develop in their classes and careers (Cech 2015, Miller 2016, Niemi 2005, Wilson et al. 2015, Witt and Wood 2010, Wolffram 2009).

Conversation Analysis and Sociology

Conversation Analysis (CA) arose in the 1960s in the works of Harvey Sacks and colleagues Gail Jefferson and Emanuel Schegloff. While CA was unique in its efforts to develop a scientific method of analysis for what they termed 'talk-in-interaction', CA was also heavily influenced by the arising interest within the sociological field in micro-social interaction. Conversation Analysis came about at the same time that many ethnomethodological practices were gaining attention. Erving Goffman's interest in the micro-level social interactions which support social institutions and practices was popular among young scholars at the time (Forster 2013, Heritage and Stives 2013, Watson

1992). Similarly, Harold Garfinkel was exploring micro-level interaction which he saw as being guided by intrinsic shared knowledge systems making interaction possible and stable (Forster 2013, Heritage and Stives 2013, Watson 1992). Harvey Sacks took this micro analysis a step further by tackling language-in-interaction. Prior to Sacks' work, talk was mostly seen as a secondary feature in interaction, a byproduct of other processes that was not explored on its own (Forester 2013). Central to Sacks' work and CA was how categorical identities, what we call each other and what we call ourselves, shape interaction. Not that these categorical identities provide us with different knowledge sets but that they provide us with different situational obligations which we and those we interact with both understand and expect (Zimmerman 2005). Sacks' approach was not immediately popular within sociology and CA can still be considered a young field of investigation (Heritage and Stives 2013). This was probably because of the prevalence of positivist ideologies within sociology at the time (Heritage and Stives 2013).

Awareness of CA has, however, maintained a steady growth since Sacks' (Sacks, Schegloff and Jefferson 1974) foundational work, "A Simplest Systematics for the Organization of Turn-Taking for Conversation" (Forster 2013). This foundational work (Sacks, Schegloff and Jefferson 1974) explored how turn-taking can indicate organizations of power, an idea that has since been taken up in many subsequent sociological works. Sociology, however, has not been its most prominent practitioner. Sacks' foundational turn-taking paper has been cited 5 times more in Linguistic academic papers than in Sociology (Forster 2013). That is not to say that Sacks' work has not been embraced by the sociological field. Many of the methods Sacks proposed and developed can still be seen in practice today. Sacks believed that to properly examine language-in-interaction, the interactions must be recorded as they happen so that they may be examined repeatedly and can be available to other researchers wishing to make their own analyses of the interactions (West 1996, Heritage and Stives 2013). In addition, the detailed process of transcribing field observations has been taken up by many researchers including Candace West who has emphasized the need for, and advantages of, transcription (West 1996). Furthermore, Sociologists have taken up Sacks' CA approach in exploring how it can be used to examine social problems (Zimmerman 2005).

Men's and Women's Language Use

Historically, much of the analysis of men's and women's language use has utilized a deficit perspective which frames men's speech as the standard and any deviations are considered a deficit (West 1995). This, however, presupposes what language is *supposed* to do rather than what it actually does in interaction. Such an approach largely ignores the context of language use and makes assumptions about women's language use that are not supported upon examination (West 1995). Conversation analysis, in contrast to historical approaches to examining gendered language use, seeks to analyze competences of language participates, what they do with language and how they interpret the behaviors of others (West 1995). This approach, in contrast to a deficit approach, assumes that all participants are masters of language use and that they possess the full competences that their social interactions demand of them.

Language, then, serves to fulfill the expectations of social interactions and that language use differs between men and women insofar as it is trying to *do* something different.

West and Zimmerman (1987), propose that gender is a constant feature of social interaction, an identity that cannot be picked up or put down in social situations. How we participate in social interactions, even in the most mundane ways, reflect a claim to gender, and our interactions with others are interpreted based upon this claim (West and Zimmerman 1987). Gender, in this way, is seen as being constituted through interaction and is evaluated through interaction, an ongoing activity that is often taken for granted (West and Zimmerman 1987). These embedded knowledges and expectations of gender in interaction serve not only to reflect gender claims but also to reinforce existing social organizations (West and Zimmerman 1987). Women have been found to be effective in transitioning between topics of conversation and at maintaining polite interactions (West 1995). It is important to note that these competencies are situational and do not come at the expense of other competencies. In one example from West's (1995) study on doctor-patient interactions, a female doctor effectively escalated from polite to impolite when her authority as a doctor was repeatedly challenged by the patient (as cited in West 1995). Such exceptions lend support to theories of situational social competencies as gendered behavior is not inherent but called upon in interaction, gendered behavior may then seek to maintain the existing social order. However, in maintaining the existing social order through gendered behavior, participants may also be lending legitimacy to that social order and the differences that gendered behavior assumes (West and Zimmerman 1987). Thus, if situational behavioral competences call upon women to express their claims to gender through polite deference while men make claims to their gender through assertive and dominant behavior, then these gendered behaviors are seeking to legitimize existing organizational hierarchies (West and Zimmerman 1987).

According to status characteristics theory because of females' lowered status within the broader society, girls in the classroom are likely to make fewer power grabs in conversation through interruptions. In addition, because of their unequal status, women will take a more passive role in the classroom and in male-stereotyped tasks. Not only will male members of a task group expect females to underperform in these tasks, so will the female members themselves (Johnson, Clay-Warner and Funk 1996). The stereotypes that exist within our society dictate our expectations of male and female language patterns. When an individual displays masculine or feminine language patterns, they make a claim of power and authority levels which can be legitimated by the recipients or questioned through unsolicited commentary such as interruptions or counterarguments (Burke, Stets and Cerven 2007). While male students and male participants in conversations are given more liberties to initiate turn-taking as well as interrupt and overlap with prior speakers, female students and female participants are often not validated when engaging in similar turn-taking behaviors.

Developing Turn-Taking Behaviors

There has been over the last three decades, an increasing interest in the reasons that drive men into high-income occupations such as those in the STEM fields while women, despite marked progress in gender equality and equity in pay, are still driven into lower paying positions at higher rates (Viadero 2009). Some research has highlighted connections between college major choice and occupational outcomes (Viadero 2009). While some research has looked at the effects of individual differences in creating gendered major choices, with a few exceptions, these studies have mostly ignored one of the most fundamental elements of developing academic interests and career goals, the classroom. Numerous studies have shown the immediate as well as long-term effects of classroom interaction on students' aptitude, retention and learning (Ayers et al 1994, Bleicher et al. 2003, Edwards and Westgate 1994, Flanders 1982, Russell 2012, and Wilkinson and Marrett 1985). These studies have identified a number of influences which affect an individual's ability to succeed in the classroom and to translate that success into retention of material, interest in the subject and professional identity building through classroom participation (Auster and MacRone 1994, Bleicher et al. 2003, Russell 2012, Van Der Veen and Van Oers 2017).

Flanders (as cited in Tsui, 2011) developed one of the first tools for observing classroom behaviors with the Flanders' Interaction Analysis Categories. This method identifies seven behaviors of teachers that can impact an individual's ability to learn in the classroom (Flanders 1982). Flanders identifies three of these as direct influences of the classroom structure or how a teacher chooses to conduct a class, and how it relates to student interactions. These three direct influences were identified as; lecturing, giving directions, and criticizing or justifying authority (Flanders 1982). Around the same time that Flanders (1982) introduced his method for interaction analysis, many other researchers introduced similar categories that largely followed this same scheme

(Kumaravadivelu 1999). It is easy to see how these behaviors may influence a student's ability to engage with and enjoy a lesson. Less clear-cut are the indirect influences which deal with the classroom atmosphere and how a teacher interacts with students at a more one-on-one level. These influences are: whether a teacher accepts feelings, praises or encourages, accepts or uses ideas of students, and asks questions (Flanders 1982). Positive and negative interactions with a teacher can affect a student's ability to engage directly with the material and can affect their future interaction with the subject matter (Bleicher et al. 2003, Tatum et al. 2013, Younger et al. 1999). All of these influences have a common element to them, and that is the amount of engagement and autonomy they allow a student in the classroom. This emphasis on student autonomy, however, denotes one of the main shortcomings of Flanders' observational method and that is its exclusion of student-driven interactions (Kumaravadivelu 1999). Subsequent classroom observational methods would correct for this, such as the Communicative Orientation of Language Teaching (Allen, Frohlich and Spada 1984), developed for second language classrooms, which expanded classroom observational categories to included student-driven interactions as well as many others (Kumaravadivelu 1999).

Much existing research on classroom interactions has shown that male and female students behave and interact differently from each other and also experience different treatment from instructors, often unknowingly (Auster and MacRone 1994, Aukrust 2008, Consuegra and Engels 2016, Emilson et al. 2016, Orr 2011, Tatum et al. 2013, Younger et al. 1999). While the behavioral differences in the classroom seem to arise sometime after the first grade (Aukrust 2008), awareness of these gender differences arise long before school-age interactions. In Poulin-Dubois et al.'s (2002) study on toddlers' understanding of gender roles, children between the ages of two and three years old demonstrated a knowledge of stereotyped masculine and feminine behavior. In addition to these findings, it was concluded that female children became aware of these roles at the youngest age, two years old (Poulin-Dubois et al. 2002). What this means for classroom interaction is that it is unlikely that this phenomenon is due to the institution of education, which most children enter into between the ages of five and six years old, and instead is likely a perpetuation of broader societal patterns (Emilson et al. 2016, Howard and Hollander 1997, Karakowsky, McBey and Miller 2004, Kimmel 2008). What makes an understanding of classroom talk in schools important, then, is the ways in which they work to perpetuate existing inequalities and affect student motivation.

Historically many studies in this area have focused on the effects of teacher-led interactions within the classroom. More recent studies have looked at differences in student-initiated interaction in the classroom (Aukrust 2008). The historical context of the analysis of classroom interaction are widely acknowledged as inconclusive due to inconsistent findings which researchers have largely been unable to explain (Wilkinson and Marrett 1985). Some researchers have put forth the importance of controlling for class inequalities in classroom analysis while others have pointed to the importance of the context of the interactions. Aukrust (2008) offers a different explanation one that incorporates the students' own behavioral differences rather than differences in the teacher's linguistic performance or differences in the classroom structure and atmosphere. What Aukrust (2008) found in a study of turn-taking procedures in the classroom across grade levels was that the main differences lay in student-initiated contact and not in teacher-initiated contact. This means that although differences in individual teaching styles and linguistic behaviors do exist, there is a stronger relationship between student-initiated contact such as comments and overlapping, than with teacher-initiated contact. Therefore, the real differences may occur in who is ‘taking the floor’ in classroom interactions rather than who is ‘being given the floor’ (Aukrust 2008). Male students are more likely to offer unsolicited commentary and overlap their turn with the teacher than are female students (Aukrust 2008). This seems to reflect gendered language patterns that exist outside of the classroom, as researchers have proposed that overlaps, or interruptions, are a kind of power display (Karakowsky, McBey and Miller 2004). This reflects the gender inequalities within the broader society and may have a hand in perpetuating them as the classroom acts as an introductory arena for public speaking (Aukrust 2008).

Other Forms of Conversational Differences

Power relations are one proposed explanation for linguistic differences between males and females by some researchers (Burke, Stets and Cerven 2007, Johnson, Clay-Warner and Funk 1996, Karakowsky, McBey and Miller 2004). These differences arise due to the inequality of power distribution within society which places females in a subordinate position to males and for this reason are allocated less active roles in conversation. From these differences arise certain gendered conversational cues which distinguish what behavior is perceived as masculine against what behavior is perceived as feminine. What is perceived as the appropriate behavior for an individual's gender role can then not only affect how they act in a given situation but also how they are evaluated by their fellow participants (Karakowsky, McBey and Miller 2004). Individuals are judged more harshly when they are breaking a perceived gender role than when they are abiding by gender norms. In particular, females who break their gender role are evaluated more harshly than males who break their gender role (Karakowsky, McBey and Miller 2004). In addition, the power relations can be manipulated by changing the gender representation within the conversation group. Therefore, when women are in the majority, they will exercise more power and influence than their counterparts in a male majority setting (Karakowsky, McBey and Miller 2004).

Another key consideration when looking at gendered interaction patterns are the perceived expertise of individuals in task-specific activities (Karakowsky, McBey and Miller 2004). Individuals in groups make assumptions about their own and their group members' abilities in certain tasks based off of external status characteristics which assign ability levels based upon the stereotypes surrounding genders and races (Karakowsky, McBey and Miller 2004). These expectations can then directly affect the individual's actual performance in a task as well as their behavior in the group setting (Karakowsky, McBey and Miller 2004). One potential consequence of these perceived abilities is that an individual may exercise less power and authority than they might otherwise, meaning that it is possible that women in masculine-stereotyped tasks may take fewer turns in conversation and make fewer unsolicited comments or overlaps than when in feminine-stereotyped tasks (Karakowsky, McBey and Miller 2004). This relates to the authority structures which make up typical task groups. Within these task groups, a kind of authoritative hierarchy will emerge based off of similar characteristics as those found in Karakowsky, McBey and Miller (2004) and within this hierarchy there are differences in male and female response structures (Johnson, Clay-Warner and Funk 1996). Here, the primary difference between male and female conversational patterns was not in turn allocation but in response types; that is, women gave more positive responses of agreement whereas men were more likely to offer counterarguments as a response (Johnson, Clay-Warner and Funk 1996). This reflects the conclusions made by Poulin-Dubois et al. (2002), which found that the differences in male and female conversational patterns lay not in the turn allocation but in the students own linguistic behaviors. Both of these examples reflect a status characteristic approach to the gender differences between male and female linguistic behavior, with the genesis of that behavior being found in women's diminished status in comparison to men (Johnson, Clay-Warner and Funk 1996).

ORIGINAL STUDY DESIGN

Key Points from the Literature

Much of the existing research in classroom talk and classroom interaction has been done on grade school children. Researchers have found that gender differences become more pronounced the older children get and because of this, by the time students reach the university level, their gendered patterns of language use have become ossified. This is one reason that the majority of classroom analyses have been done at the grade school level, as researchers seek to trace the process of gendered socialization. However, when introducing new elements to the topic of classroom talk, there are distinct benefits to having students who are not in a transitionary period of their language use and development. Several studies have used university level students as participants because of the multitude of conversational areas to test within (Burke, Stets and Cerven 2007, Johnson, Clay-Warner and Funk 1996, Karakowsky, McBey and Miller 2004). In addition, the fact that language patterns are relatively set means that age differences at this level will have less of an effect on conversational patterns than at the grade school level. The difference between a 19 and 22-year-old adult's conversational patterns are not as pronounced as the differences between a 9 and 12-year-old child's conversational patterns (Aukrust 2008). Therefore, when incorporating an additional variable into the analysis, such as class subject, observing at the university level gives a closer approximation of broader societal patterns and age-specific patterns are not as significant as they would be at the grade school level.

Analyses of classroom talk have focused on a great number of variables including age, teacher's gender, classroom structure, and socio-economic status of students. However, far less attention has been paid to the variances within academic subjects. Despite an apparent lack of focus on the variances of language use within specific disciplines, the status characteristics theory makes an excellent argument for why this area should be researched. The theory states that gender stereotypes about what constitutes a masculine versus a feminine task can have an effect on the subsequent turn-taking and interactional behaviors of the group members (Johnson, Clay-Warner and Funk 1996). While this theory has been applied to business settings, both at the corporate and university level, the studies have been largely inconclusive (Karakowsky, McBey and Miller 2004). One possible reason for this is the changing gender dynamic occurring within business as more and more women major in business, causing the previously unbalanced field to shift to more equal representation of male and female students, if not shifting to female dominated. In contrast, many of the STEM fields still remain densely populated by male students despite increasing advocacy targeted towards increasing female participation in STEM (Shein 2018). Additionally, the gender gap within STEM careers is even wider than it is within college majors (Sadler et al. 2012, Viadero 2009). What this may imply in terms of the status characteristics theory is that if STEM fields are viewed as masculine, then female students within STEM courses would be evaluated as having less power and less able to contribute to group discussions. This should be evident in turn-taking behavior exhibited by female and male students, with males taking more student-initiated turns and more unsolicited turns than females.

There are several types of turn-taking behavior that are necessary to document in order to fully understand the classroom dynamic. Aukrust (2008) differentiates the different kinds of turn-taking employed by students in grade school classrooms. One of the first things that is necessary to differentiate in terms of turn-taking is turn allocation. A turn is considered an allocated turn if a student is somehow identified by the teacher as being given the turn, this can mean both verbal and nonverbal ways of allocating a turn (Aukrust 2008, Clarke et al. 2016). Another type of turn can be classified as an unsolicited comment from a student that has not had a turn allocated to them by the teacher (Aukrust 2008, Clarke et al. 2016). This type of turn is especially important because it is where Aukrust (2008) found the majority of gendered differences in turn-taking behavior. Male students are more likely to initiate a turn than female students. The final type of turn-taking that Aukrust (2008) distinguished as a unique and valuable data source is overlapping utterances. This type of turn occurs when a student initiates a turn before the previous speaker has stopped speaking or if two individuals, in this case it can be both a student and a student or a student and the teacher, begin a turn at the same time (Aukrust 2008). Type of turn taken is important to measure because of the differences found by Aukrust (2008) in the differences between male and female use of unsolicited comments and overlapping utterances. Therefore, the aspects of turns which need to be measured in a classroom talk analysis for individual students differentiating by gender are: type of turn taken, frequency of turns taken, and length of turns taken.

Restatement of the Research Problem

The purpose of this study is to compare the different turn-taking habits of men and women undergraduate students within a physics education setting at University S. Four specific questions about men's and women's turn-taking behaviors in the physics classroom will be examined in order to understand the full turn-taking dynamics in the classroom. 1. Do men and women in the physics classroom exhibit the same rate of turns at conversation? 2. Do men and women in the physics classroom exhibit the same rate of unsolicited turns at conversation? 3. Are the average lengths of turns taken by men and women in the physics classroom equal? 4. Do women and men in the physics classroom overlap their turns at the same rate? Recently, there has been a lot of discussion in both the academic community and within political and economic circles about the gender gap in STEM. Of particular interest has been what drives women both into and out of the STEM fields at the university level. While much research has gone into investigating life circumstances and gender stereotype biases, one area that has had less attention paid to it is the gender differences inside the classroom.

The teaching community generally holds that oral participation within a classroom can help improve a learner's understanding of the material as well as their confidence in the topic area. Greater or lesser levels of oral participation can be linked to differing levels of success and retention within a discipline. By understanding and documenting the classroom talk occurring within university level physics courses, a better understanding of the women's experiences within physics and STEM can be achieved and with this, perhaps, a better understanding of why women might stay in these fields or why they might choose to leave these fields. This new study will shed light on whether there exist any behavioral differences between men and women within the physics classrooms that can help us to understand how the physics environment contributes to or does not contribute to, the retention of women. The data collected for this study were the student-initiated turns taken in the classroom setting due to the higher significance of student-led differences in comparison to teacher-led differences. This study was a deductive, quantitative analysis of turn-taking which examines the data through an interpretive approach. The primary theory that is being applied in this research is that of the status characteristics theory. This theory holds that gender stereotypes influence the perceived abilities of individual participants based upon the cultural understanding of masculine and feminine roles within society.

Data Collection

This study was a quantitative analysis using direct observations of gendered turn-taking behaviors in physics classrooms. The data were collected over a two-day period from ten individual class sessions, each session being observed only once. These class periods were both recorded and videotaped in order to obtain the most accurate data. Recording of the class periods is to ensure that turns are not missed due to observer error and video recording to help distinguish who is saying what during an interaction so that individual learners are not mistakenly coded in the wrong gender category. In the case that a gender could not be clearly assigned between both the audio and visual recording, the instructor was to be consulted on the students' preferred pronouns for address. If the student’s gender still could not be definitively identified, or if the instructor did not wish to disclose the student’s preferred form of address, then the data involving that student were to be excluded from the study. This approach to identifying gender did not become necessary over the course of this study. As the data included a measure by the individual learner, it was especially important to be monitoring who was saying what in the classroom. The recordings were then transcribed and subsequently coded, looking for student-initiated turns. Student initiated turns is defined as any verbal commentary offered by an individual learner that was not directly solicited by the teacher to the individual learner. This can take the form of an individual learner offering up an answer that was asked to the entire class, an individual learner taking a turn during open discussion without being designated by the previous turn-taker, and an individual learner giving commentary that is not directly offered to class discussion but instead is targeted towards those around them. In essence, a student-initiated turn can be any turn that was not ‘given’ to the individual learner by the previous turn-taker or the teacher.

Methods

The independent variable in this study is the speaker’s gender. Gender is defined for the purposes of this study as an individual’s self-presentation of being either a man or a woman. I have chosen to designate gender as the independent variable rather than sex because as this study will primarily focus on student-initiated turns taken, self-presentation would be the most important variable in determining gendered discourse patterns. The dependent variable in this case is the turn-taking behaviors of the men and women populations of the classes. Turn-taking has three dimensions which are the primary measures of this study: frequency, duration, and type. For the purposes of this study, a turn was defined as any audible commentary made during the class period and directed at the entire class, whether it was on-topic or not. The frequency of turns taken was measured as the number of instances of unique turns that could be distinguished as having a clear beginning and end and the frequency with which a man or woman initiates uninterrupted speech. A turn, if interrupted, was coded as either a single turn or multiple turns, depending on if the original turn-taker surrenders their turn to the interrupter or if they continue speaking over the interruption. If the individual learner surrendered their turn to the interrupter, then any subsequent speech from the original turn taker was coded as a new turn. If the individual learner did not surrender their turn to the interrupter and continues speaking, then the turn was coded as only one turn. The interrupter's turn was coded for the full length of continuous speech that they engaged in, whether or not all or only part of that turn overlapped with another turn-taker. The duration of the turn was defined as the amount of time that an individual learner engages in continuous speech and was coded to the nearest millisecond.

Turn-taking type is used to restrict the form of student-initiated turns for which frequency can be examined further, it is defined, slightly differently from Aukrust (2008), as whether the individual exhibits: a solicited response, an unsolicited comment, or an overlapping utterance. All of these turns are classified as student-initiated because the individual student must volunteer a turn or 'take the floor' (Aukrust 2008), rather than the individual being specified for a turn or be 'given the floor' by the teacher (Aukrust 2008).

Student-initiated turns, as indicated by the literature, are likely to be the most fruitful data that can be collected about turn-taking. There are three types of turns that were coded and analyzed in this study. The first type of turn that was coded was a solicited response. This type of turn arises when a teacher or another student opens discussion to the entire class without specifying who should take the next turn. This could be done by asking a question to the entire class and having a student volunteer an answer. The second type of turn that was coded is an unsolicited comment. This type of turn happens when no turn is explicitly given to either the individual learner or the class in general. This type of turn could take the form of a student asking a question of the teacher, without the teacher soliciting for questions, or could occur during an open discussion in which there is no clear designation that someone should take the next turn. The third and final type of turn that was coded is an overlapping utterance. In this case, an individual begins their turn before the prior speaker has ended their own turn or when two individuals have simultaneous utterances that cannot easily be defined by which speaker took the first turn. Several control variables were also accounted for including course instructor, course length, and whether the course included group work.

Three classes were selected and checked for the requirements of the study, that is, an introductory level course that is not primarily lecture-based classes and having opportunities in the class period for open discussion. The course, being a first-year level course, provides the best opportunity to observe both students who will go on to persist in their fields and those that will leave their fields. Selecting only three courses to observe does have its limitations, primarily not being able to test for reliability. These parameters limit the population of this study to only undergraduate University S students who were currently enrolled in an introductory level physics course at the time of the study and are able to be identified as either a man or a woman. Students were differentiated based upon their observed gender and their oral participation was then measured for the individual turns and averaged for men and women learners in order to determine any differences in turn-taking behaviors.

Hypotheses

This study poses four hypotheses:

1. Women will take fewer turns in the physics classroom setting than will men.
2. Women will have fewer instances of unsolicited turns in the physics classroom setting than will men. This means that on average, women students in the class will offer unsolicited comments at a less frequent rate than the average for men students in the class.
3. Women will have fewer instances of overlapping utterances in the physics classroom setting than will men. This means that on average, women students in the physics class will have fewer instances in which they begin a turn before another individual ends their own turn or begins a turn at the same time as another individual beginning their own turn.
4. Women, on average, will exhibit shorter turns at talk in the physics classroom setting than will men. This means that on average, women students in the

class will take fewer overall turns including all types of turns, and that these turns will on average be shorter than that of men in the physics classroom.

REVISED STUDY

After the initial proposal of this research, a number of complications arose that resulted in necessary changes to the methods that in turn altered the extent to which the data could address and adequately answer the proposed research questions. The issues encountered were largely due to difficulties in finding a department in which to conduct the classroom observations. The proposal focused on observing the differences in men's and women's oral participation in an introductory engineering course. Unfortunately, the department housing this course was not able to support this research due to their own existing research being conducted in these classes. An alternative option for observing another introductory engineering course at a local community college also did not pan out. After these setbacks, alternative options for what courses to observe for this research where considered. These included sophomore/junior level engineering courses that would have a degree of oral participation in the classroom and looking at introductory level courses in another discipline that was comparatively as male-dominated as engineering. As the upper level courses would likely have already experienced the attrition mentioned in the literature review and course instructors believed that there would be little usable data available per individual class, focusing on an alternative discipline seemed the best direction to take this study. Within the STEM fields, the discipline that was the most comparatively male-dominated to engineering was physics with women taking up 17% of physics jobs (Georgetown University Center on Education and the Workforce, 2018). The introductory level physics course that was selected for observations was a required course specifically open to STEM majors. Subsequent changes to the methods of the research resulted after discussions with the department that housed these courses.

Overview of Changes

The changes made from the initial proposal primarily centered around the classes being observed for the study. The course observed in the final study was an introductory level physics class and not an introductory level engineering class. While the students enrolled in the classes were not all physics majors, most enrolled students were STEM majors. The total number of classroom observations changed from 15 in the initial proposal to 10 in the final study. The class sections being affected by these observations changed from 3 in the initial proposal to 10 in the final study. The number of instructors teaching the class sections being observed changed from 3 in the initial proposal to 5 in the final study. The number of class periods observed per class section changed from 5 in the initial proposal to 1 in the final study. The observation and transcription methods did not change from the initial proposal.

Reasons for Changes Made

The first change made, the discipline which was being observed for this study, was made due to difficulties finding a department which would be willing to host the proposed research. As new departments and colleges were contacted and appraised of the proposed research, time became a major concern. The initial proposed timeline for completion of this study had data collection being completed by mid-February. In actuality, final approval was not obtained for these observations from a new academic department until the end of February after several meetings with department leadership and the teaching committee for the course. Being that this was the most appropriate department to offer it's full and enthusiastic support, cooperating fully with the department's requests was a high priority to seeing the research completed. After IRB approval and time allocation for students to be notified and fully informed of the study taking place, the final observations did not occur until early April. Changes to the scope of the study were made in order to accommodate the realities of the time constraints and the availability of the course now being observed. With fewer course offerings and fewer instructors teaching the course, observing all of the offered class sections seemed the best approach. This also accommodated the course curriculum as well which did not allow for extensive class discussion in each class period but did have time set aside in the specific observed classes for student oral participation.

New Directions

After concerns were raised about the study's ability to address the research questions from the initial proposal given these changes and that there would be not enough evidence to support the study's conclusions given the existing data, it was necessary to reevaluate the literature and see what questions this new data set might be able to answer. There were a number of variables in the resulting data set that could be investigated and provide new insights outside of the initial research questions and hypotheses of this study. These variables included: course instructor; instructor's gender (all men); class size; class time; class length; gender composition of the class; individual turn frequency; turn-taker's gender; turn lengths; turn types; and class structure (group work or no group work). These variables all had varying degrees of interaction with each other, with the individual class sections seeming to have the largest effect on students' oral participation behaviors. This prompted the question which lead the new direction of this study: What factors within the classroom contributed to the differences in turn-taking behavior of the students? Because of the effect that the individual classes seemed to be having on overall student participation, the natural direction for the new research questions to take was to focus in on what differences within these individual classroom environments that may account for higher and lower levels of student participation. To do this, it was necessary to revisit the literature now looking at classroom and group dynamics rather than specific individual and gender differences in language use.

New Literature

While this study's methods are still grounded in the literature highlighted in the original literature review, I have made a few additions to guide the new direction for the research problem. I start with Kanter's (1977) theoretical framework for the effect that token individuals have on social interactions in a skewed group. Kanter (1977) focuses on relative numbers, or proportions, in group interaction rather than absolute numbers in her study examining a sales division of a large Fortune 500 corportion which had recently begun incorporating women into their workforce. In contrast to previous research which had examined the effects of overall group size, Kanter's research looked at how the proportions of the different social types within the overall group effected group dynamics and interactions. In her theoretical framework, four types of proportional groups are identified, the first being a uniform group which is completely homogenous at least in terms of its external status, such as a workforce of all men. A skewed group is one with a proportion of about 85:15, and in which the dominant group largely controls the culture of the group. Tokens are treated not as individuals but as representatives of their demographic category (Kanter 1977). Within a tilted group, which has proportions of roughly 65:35, tokens have a bit more influence on the culture of the group and can form coalitions and be viewed as individuals and not just representatives of a category (Kanter 1977). A balanced group should have proportions between 60:40 to 50:50 and the culture and social interactions of the group should near equality between the dominant group members and the tokens.

Kanter (1977) posits that tokens are susceptible to heightened visibility, polarization, and stereotype assimilation when in a setting where they are proportionally underrepresented. Tokens, which have an observable master status, are an easily identifiable minority and generate an increased awareness of their presence and actions within the group, or a heightened visibility (Kanter 1977). The second phenomenon is polarization, by which the dominant group focus on the assumed differences they have with token individuals as well as the similarities they have amongst themselves (Kanter 1977). The final phenomenon Kanter (1977) identifies is stereotype assimilation, a process by which dominant groups exaggerate certain characteristics of a token individual or individuals in order to fit existing stereotypes of the token group.

These phenomena in turn generate specific responses and coping measures from the token and dominant populations (Kanter 1977). In response to heighted visibility tokens experience heightened performance pressures to which they respond by either overachievement or limiting their visibility. In the case of overachievement, the women in her study responded to the pressures of their increased visibility by taking advantage of every opportunity and making sure others knew how well they were doing. An opposite reaction to this heightened visibility, however, was to try and diminish it by whatever means available, be it taking advantage of plain dress, limiting social interactions or keeping attention off of achievements (Kanter 1977). Polarization of the token group is paralleled by boundary heightening within the dominant group in order to remind both the dominant group and the token group of the separation between them (Kanter 1977). Boundary heightening sometimes took the form of dominant group members reaffirming solidarity with a shared culture in order to overemphasize the differences they have with the token group. In other cases, boundary heightening took the form of almost ritualistic interruptions designed to remind the group of the token member's token status. These interruptions took the form of questions and apologies which reaffirm that the dominant group member's behavior is normal only for the dominant group culture and not for the token group member (Kanter 1977). In some cases, Kanter found that boundary heightening moved social interactions entirely to areas where the token group was expressly not invited so as to keep some interactions private. Boundary heightening may also take the form of loyalty testing by which tokens are required to prove their loyalty to the dominant group in order to gain and maintain access to the group (Kanter 1977).

The final phenomenon, assimilation, occurs through role entrapment by which tokens are 'sorted' into stereotypical roles associated with their category (Kanter 1977). The ways in which tokens handle role entrapment can vary greatly. One mechanism of role entrapment is status leveling in which a token's situational status is brought more in line with their master status in order to more easily align with stereotypical roles more familiar to the dominant group (Kanter 1977). Role entrapment also occurs through stereotype role induction where tokens are 'cast' as caricatures of their category (Kanter 1977). This, similar to status leveling, is done in an attempt to bring the token individual more in line with the dominant groups' preconceived notions of what a person of the token's category 'is'. For women in a male-dominated work environment, this stereotype role induction meant being cast in the role of mother, seductress, pet or iron maiden (Kanter 1977).

The implications of Kanter's (1977) theoretical framework for the new approach to this research may be that the differences in women and men's behaviors within these physics courses are in response to the proportions of the group. Subsequent research has applied Kanter's theory to men's and women's behaviors in academic settings. One such study looked at the effect of these group proportions on participants' experiences at academic conferences. Biggs et al. (2018) surveyed the participants of three academic conferences that varied in proportions of female and male participants, a conference classed as male-dominant (38% women), a conference classed as equally proportioned (53.6% women), and a conference classed as female-dominant (71.6% women). This study looked to examine how the climates of these conferences differed in perceptions of sexist interactions and climate, how participants coped with these perceptions and whether participants intended to persist in conference participation and in their academic field (Biggs et al. 2018). They found that the perception of a sexist climate was strongest in the male-dominant conference and not prevalent in either the equally proportioned or female-dominant conference. This reflects Kanter's (1977) theories on the effect of low proportions on token groups' experiences and social interactions. The study went further, also examining the coping methods women employed in response to sexist climates at these conferences. The coping methods Biggs et al. (2018) examined were the use of either silence or voice and gendered performance. Silence was operationalized as responding to the sexist environment of a conference by not directly confronting it and refraining from participating in public discourse such as in meetings and group discussion (Biggs et al. 2018). Voice was measured by a respondent reporting that they directly confronted the sexist environment of the conference either with individuals that they believed were exhibiting sexist behavior or by raising their concerns with other conference goers (Biggs et al. 2018). Respondents were also asked to report on their gendered performances by the frequency with which they felt they behaved in feminine and masculine ways during the conference (Biggs et al. 2018). In the cases of the coping methods silence and voice, proportions only seemed to have an effect when women were in the minority, in the male-dominant conference (Biggs et al. 2018). Women in the male-dominant conference reported using more voice than women in the other conferences (Biggs et al. 2018).

Spangler et al. (1978) also tested Kanter's theoretical framework on law school students in two law schools, one which can be described as skewed (20% women) and one tilted (33% women). This study reported that, as predicted by Kanter's work, the numeric proportions of men and women in the law schools was related to differences in their performance and that women's token status at the skewed school may be detrimental to female achievement. Spangler et al. (1978) also found support for two coping strategies Kanter proposed would be utilized by women in male-dominant groups, overachievement and underachievement (Spangler et al. 1978). Women in the skewed law school tended to underachieve in the classroom, including test schools and oral participation while overachieving in social integration (Spangler et al. 1978).

What these studies highlight is the effect of numeric proportions on women's integration into male-dominated settings in academia. Higher proportions of women in the setting should lead to increased integration into the group culture and increased influence over that culture (Kanter 1977). Briefly highlighted in both of these studies is women's oral contribution in the group setting. For Biggs et al. (2018) this was assessed as a composite of oral responses or lack thereof to sexist interactions and oral participation in the various conference settings. Meanwhile, For Spangler et al. (1978) analysis of women's oral participation was confined to volunteering to contribute in class.

A final piece of research that contributes to shaping the new direction of this study is Taylor et al.'s (2019) analysis of gender proportions in the workplace and their effect on women's inclusion in management. In this study, Taylor et al. put to the test a number of tipping points, or the point at which a token group has gained enough proportional power within a group to influence its culture (Taylor et al. 2019). Looking at tipping points at 15%, 35%, and 50% while also looking at the effects of a female-dominated workplace on management appointments (65% and 85%), the study found that increased introduction of women into the workplace coincided with increased share of management positions (Taylor et al. 2019). However, this work was not able to find a specific tipping point after which advancement begins. To the contrary, it concluded that at all levels increases of women in the workplace was reflected with increases of women in management and that proportional increases of women in the workplace had a larger effect on women's portion of management positions below the lowest tipping point of 15% (Taylor et al. 2019). The findings of Taylor et al. (2019) lend itself to further exploration of specific numeric proportions on the experiences and social interactions of numeric minorities. Is there a tipping point only after which gains can be seen? Or are benefits of increased token proportions felt at all numbers as Taylor et al. (2019) found? These questions warrant further analysis.

Research Questions

This research examines one aspect of these gendered differences within a physics education setting, turn-taking behaviors. The purpose of this study is to determine how men's and women's turn-taking behaviors differ within these introductory physics classes at University S. To do this, it begins by asking the question: Do the differences in student's speaking behaviors in the introductory physics classroom reflect the expected behaviors of women token groups in a space and a field that is largely dominated by men? To approach this question, a number of aspects of men's and women's speaking behaviors in the introductory physics classroom will be scrutinized. Four specific questions about these behaviors are first addressed. 1) Do men's and women's overall speaking participation in the physics classroom differ? 2) Is there a greater difference in men's and women's speaking participation in physics classes whose gender proportions are more highly skewed? 3) Is there a tipping point in the proportion of women in the physics classroom necessary to increase speaking participation? 4) Does women's speaking participation in the physics classroom go up as the proportion of women in the classroom increases? Given the existing literature on the importance of student participation in the classroom to achievement and retention, all factors that may affect students' willingness and ability to participation are worth further examining. There is also an extensive literature on how women and men position themselves in social interactions. This study will utilize Kanter's theory of proportions and conversational analysis in order to examine the application of proportions on actual and not reported, student participation. The quantitative data for this study were collected using classroom observations which were conducted on University S's campus within current, undergraduate physics classes that allow for some amount of in-class oral participation, and which were recorded and transcribed over the course of ten class periods. These recordings were analyzed quantitatively by noting the frequency of turn-taking, the length of the turns, the types of turns taken and then comparisons were made between the men and women in the class.

In the first part of this study, the literature review covered many areas of existing research which this study sought to build upon. This included student performance and persistence in academia and men's and women's differences both in language and in the classroom. In addition to these areas of research, this now also looks to add to the existing literature on the effect of proportions in group interaction. Several studies have examined the relationship between proportional representation in the workplace and women's integration into historically male-dominated spaces (Kanter 1977, Spangler et al. 1978, Biggs et al. 2018, Taylor et al. 2019). Studies have also looked at how proportional representation might relate to persistence in a given field (Biggs et al. 2019). These theories have also been applied to the field of academia both in and outside of the classroom (Spangler et al. 1978, Biggs et al. 2018). While previous research has looked at how reported participation of students relates to men's and women's positionality within the group culture, less clear is how their observed behaviors within the classroom might relate to their group membership. As previous research has posited that decreased reported participation of token groups reflects their limited power in skewed and tilted group settings, similar conclusions might be made of observed behaviors. This study will add to the existing literature on proportional representation of token groups by observing the participatory behaviors of introductory physics students. As physics represents one of the most persistently male-dominated of the STEM fields, this seems ripe for observation as Kanter (1977) posits that a token group must both be physically obvious and not only unique but relatively new to the group (Kanter 1977). The behaviors of men and women in the introductory physics classroom may then, give us insight into the status of women's integration into the field of physics.

Restatement of Research Questions

The purpose of this research is to examine whether there are differences in men and women undergraduate's oral participation in the introductory physics classroom in relation to men's and women's proportional representation within those classes. In order to do this, four hypotheses will be tested.

1. The average oral participation of women will be less than the average oral participation of men in the introductory physics classroom.
2. There will be a greater difference in men's and women's average speaking participation in introductory physics classes whose gender proportions are more highly skewed.
3. There is an observable tipping point in the proportion of women in the introductory physics classroom necessary to increase speaking participation.
4. Women's average speaking participation in the classroom will go up as the proportion of women in the classroom increases.

DATA ANALYSIS

Descriptive Results for Turns at Talk

Classroom observations of 10 introductory College level physics courses being taught by five professors were done over the course of two days in the late spring semester. All of the instructors teaching the class were men. All of the courses being observed were covering the same curriculum, with lesson plans developed cooperatively among the five professors. Five of these courses were seventy-five minutes in length while five of them were fifty minutes in length. Five of the class periods were seventy-five-minute classes and the other five were fifty-minute classes. This produced a total of ten hours and twenty-five minutes' worth of observations, that could be transcribed and coded for gender of turn-taker, turn type and turn length. After the transcription process, these observations revealed a total of 183 separate turns at talk from a total of 79 different students, 24 women and 55 men, over the course of these 10 class periods. The average number of turns taken per class period was 18.3 unique turns. For a comparison, Aukrust et al. (2008) had an average of 35.2 unique turns at talk per class period for their grade school study, which spanned multiple course subjects.

Table 1: Frequency Distributions for Turns

Gender		Frequency	Percent
	Woman	38	20.8
	Man	145	79.2
	Total	183	100.0
Turn Type			
	Solicited Response	134	73.2
	Unsolicited Comment	38	20.8
	Overlapping Utterance	11	6.0
	Total	183	100.0

Class Period			
	Lecture 1	13	7.1
	Lecture 2	20	10.9
	Lecture 3	42	23.0
	Lecture 4	21	11.5
	Lecture 5	25	13.7
	Lecture 6	14	7.7
	Lecture 7	11	6.0
	Lecture 8	21	11.5
	Lecture 9	10	5.5
	Lecture 10	6	3.3
	Total	183	100.0
Group Work			
	Yes	58	31.7
	No	125	68.3
	Total	183	100.0
Class Length			
	50 Minutes	62	33.9
	75 Minutes	121	66.1
	Total	183	100.0
Instructor			
	Lecturer 1	59	32.2
	Lecturer 2	20	10.9
	Lecturer 3	42	23.0
	Lecturer 4	46	25.1
	Lecturer 5	16	8.7
	Total	183	100.0

Looking at Table 1, women comprise a much smaller percentage of the overall turns at talk taken (20.8%) than men (79.2%) and the majority of turns taken were solicited responses (73.2). Additional information was coded to better situate the data including: class period, group work, class length and instructor. The rate of turns taken varied widely (see Table 1), with the fewest turns at talk occurring in Lecture 10 (6) and comprised only 3.3% of the overall data, and the greatest number of turns at talk occurring in Lecture 3 (42) and comprised 23% of the overall data. Some of the classes allotted time for group work to discuss and solve problems. This time was largely conducted like a recitation session with instructors walking throughout the class and speaking directly with these small groups. Three (3) of the observed classes included in-class group work sessions. Interestingly these classes contributed both the highest (Lecture 3) and the lowest (Lecture 9 and 10) rates of turn-taking. As stated above, there were five fifty minute and five seventy-five-minute classes that were observed. The five fifty-minute classes contributed 33.9% of the overall turns at talk observed while the five seventy-five-minute classes contributed 66.1% of the overall turns at talk observed. The instructors teaching the courses garnered different rates of student turn-taking, however, several instructors taught multiple class periods. Lecturers 1 and 4 taught three class periods each, Lecturer 5 taught two class periods and Lecturers 2 and 3 each taught only one class period. Initial analyses of these variables found only Class period to have a significant relationship with the gender of a turn-taker (X2=26.43, df=9, p=.002). This further supports this study's investigation into the proportional differences for gender in these classes which is one way the individual classes may differ even when some retain the same instructor or teaching pedagogy. See Appendix C, Table C1 for a complete table of variable relationships with the gender of a turn-taker. For a further breakdown of the variables by class period, see Appendix C, Table C2.

Hypothesis 1: The average oral participation of women will be less than the average oral participation of men in the introductory physics classroom.

To first test hypothesis 1, the overall averages of oral participation for both men and women must be examined for these 10 classes. Overall, turn-takers averaged a mean of M=2.32 (SD=2.1) turns per individual speaker, with the fewest number of turns being

1 and the greatest number of turns being 14. The mean for women was M=1.54 (SD=0.88) turns per speaker while the mean for men was M=2.65 (SD=2.37) turns per speaker, indicating a smaller turn frequency for women. An independent samples *t*-test for gender and number of turns taken was calculated to test if the difference in mean turn frequency for women and men turn-takers was statistically significant. Indeed, there is a statistically significant difference (t=-3.03, df=75.79, p=.003): women turn-takers took fewer turns than men. At the statistical level, the mean frequency of turns contributed by individual turn-takers shows women contributed significantly less frequent turns than men. The empirical evidence supports Hypothesis 1's assertion that women will on average, participate less than men in the physics classroom. The next hypothesis looks briefly at relationship between increases in women in the classroom and women's participation at the general level.

Hypothesis 2: Women's average speaking participation in the classroom will go up as the proportion of women in the classroom increases.

Going back to the data examined in Hypothesis 1, it is evident that the participation levels of men and women in the introductory physics classroom do differ. Now it is necessary to examine whether women's participatory behaviors in these classes behaved in ways that would be expected of a Token group in a skewed or tilted group. In order to examine this question, I look at the differences of men's and women's average participation in these classes in relation to the gender composition of the class. Table 2 highlights the average number of turns taken by both men and women turn-takers in each classroom. The class with the lowest average turns for women (0) is Class 5 which also has one of the lowest proportions of women (17.7%) in the classroom. The class with the highest average turns for women (3.5) is Class 1 which also has one of the highest proportions of women in the classroom (33%). When these numbers are analyzed, however, no significant correlation appears (r=.468, n=10, p=.172). Therefore, Hypothesis 2 is unsupported and there is no evidence to suggest that the rate of women's participation in these introductory physics classes rose with the proportional representation of women.

The next hypothesis, Hypothesis 3, examines the relationship between women's participation and the gender composition of the classroom more closely.

Table 2: Averages and Class Composition

	Men's Averages	Men's Composition	Women's Averages	Women's Composition
Lecture 1	1.5	67%	3.5	33%
Lecture 2	1.5	68%	1.5	32%
Lecture 3	3.25	56.9%	1.5	43.1%
Lecture 4	2.29	82.1%	1.67	17.9%
Lecture 5	8.33	82.3%	0	17.7%
Lecture 6	1.8	78.9%	1.25	21.1%
Lecture 7	2	70.8%	3	29.2%
Lecture 8	2.83	69.2%	1.33	30.8%
Lecture 9	2	77.5%	1	22.5%
Lecture 10	3	84.6%	1	15.4%

Hypothesis 3: There will be a greater difference in men's and women's average speaking participation in introductory physics classes whose gender proportions are more highly skewed.

In order to address Hypothesis 3, it is necessary to examine the observed proportions of the physics classes being observed. Table 3 highlights the proportional breakdowns of each class by the proportions of men and women in the given class, the proportion of turns that were contributed by men and women in the class, the proportion of turn-takers that were men and women in the class and the proportion of the population of both men and women in the class that took turns. First, I examine the proportions of the most highly skewed classes. The class with the lowest proportion of women was class 10 with only 15.4% of the group being women. This matches very closely to Kanter's (1977) definition of a skewed group with tokens making up only 15% of the population. The relationship between women's and men's oral participation and skewed classes can be examined on three levels: the composition of total turns taken in the class, the gender composition of the total turn-takers in the class, and the proportion of men and women who participated in the class.

Looking at the proportions in Table 3 for the most highly skewed classes, Class 10 and Class 5, it is evident that there are two very different relationships with gender occurring. Contrary to the expected outcomes, Class 10 has one of the most equal participation levels in terms of total numbers of turns at talk between men and women in the classroom with both men and women contributing 50% of the total turns in the class. In comparison, Class 5 holds true to the expected behaviors of a skewed group and has the most unequal participation between men and women in the class, with men comprising all of the turns at talk. The least skewed class, Class 3, falls closely behind Class 5 for the greatest differences in participation between men and women, with women comprising only 7.1% of the total turns at talk. These results would imply that as far as turn-taking goes, the data could not conclusively support Hypothesis 3.

Looking at the proportion of women turn-takers in the most skewed classes, there are similar effects as that of total number of turns taken. The most highly skewed classes do not appear to behave in predictable manners. Both classes show the largest differences in the genders of their total turn-takers, but they are not skewed in the same direction. While 0% of Class 5's turn-takers were women, 75% of Class 10's turn-takers were women, only the remaining 25% of students who participated orally in this class were men. Looking at the most equally proportioned classes also does not show the predicted behavior. According to Hypothesis 3, the most equally proportioned classes would also have the most equally proportioned number of turn-takers of these physics classes. However, Class 3, the most equally proportioned class, is once again the second most skewed in terms of participation, with only 14.3% of the total participants in the class being women. These numbers would imply that the data here too, could not support the conclusions of Hypothesis 3.

The final approach to examining the participation levels of men and women in these physics classes is to look at the proportion of total women in the class that participated orally in comparison to the proportion of total men in the class that participated orally. Here, once again, we find that the most skewed class, Class 10, defies expectations with 30% of the total women in the class participating in comparison to only 1.8% of the total men in the class participating. And once again, Class 5, the second most skewed class, has the most skewed proportional participation in favor of men. Similar to the trends found in proportions of total turns taken and the proportions of total turn-takers, the least skewed class is once again one of the most skewed towards men's participation. Class 3 had 6.8% of all men in the class participate and only 3.2% of the total women participate. It is interesting to note, only 4 of the 10 classes had higher levels of proportional participation from the men in the class and that differences in proportions were much more highly skewed when women had higher proportional participation. The results of the proportional participation of men and women in these classes does not lend support to the conclusions of Hypothesis 3.

Hypothesis 4 examines the potential for a tipping point in these classes, after which we might see women's increased participation.

Table 3: Classroom Proportions

	Men Students	Women Students	Total
Lecture 1			
Composition	67 (67%)	33 (33%)	100
Turns at Talk	6 (46.2%)	7 (53.8%)^^	13
Turn-Takers	4 (66.7%)	2 (33.3%)	6
Proportion of Class	5.97%	6.0%	6%
Lecture 2			
Composition	85 (68%)	40 (32%)	125
Turns at Talk	14 (70%)	6 (30%)	20
Turn-Takers	9 (69.2%)	4 (30.8%)	13
Proportion of Class	10.9%	10%	10.4%
Lecture 3			
Composition	82 (56.9%)	62 (43.1%)^^	144
Turns at Talk	39 (92.9%)	3 (7.1%)	42
Turn-Takers	12 (85.7%)	2 (14.3%)	14
Proportion of Class	6.8%	3.2%	9.7%
Lecture 4			
Composition	69 (82.1%)	15 (17.9%)	84
Turns at Talk	16 (76.2%)	5 (23.8%)	21
Turn-Takers	7 (70%)	3 (30%)	10
Proportion of Class	10.2%	20%	11.9%
Lecture 5			
Composition	51 (82.3%)	11 (17.7%)	62
Turns at Talk	25 (100%)^	0 (0.0%)	25
Turn-Takers	3 (100%)^	0 (0.0%)	3
Proportion of Class	5.9%	0%	4.8%
Lecture 6			

Composition	60 (78.9%)	16 (21.1%)	76
Turns at Talk	9 (64.3%)	5 (35.7%)	14
Turn-Takers	5 (55.6%)	4 (44.4%)	9
Proportion of Class	8.3%	25%	11.8%
Lecture 7			
Composition	68 (70.8%)	28 (29.2%)	96
Turns at Talk	8 (72.7%)	3 (27.7%)	11
Turn-Takers	4 (80.0%)	1 (20.0%)	5
Proportion of Class	5.9%	3.6%	5.2%
Lecture 8			
Composition	72 (69.2%)	32 (30.8%)	104
Turns at Talk	17 (81.0%)	4 (19.0%)	21
Turn-Takers	6 (66.7%)	3 (33.3%)	9
Proportion of Class	8.3%	9.4%	8.6%
Lecture 9			
Composition	69 (77.5%)	20 (22.5%)	89
Turns at Talk	8 (80.0%)	2 (20.0%)	10
Turn-Takers	4 (66.7%)	2 (33.3%)	6
Proportion of Class	5.8%	10%	6.7%
Lecture 10			
Composition	55 (84.6%)^	10 (15.4%)	65
Turns at Talk	3 (50.0%)	3 (50.0%)	6
Turn-Takers	1 (25.0%)	3 (75.0%)^^	4
Proportion of Class	1.8%	30%	6.1%

^highest men's percentages
^^highest women's percentages

Hypothesis 4: There is an observable tipping point in the proportion of women in the introductory physics classroom necessary to increase speaking participation.

To answer this question, I examine the differences in participation rates across the classes by the gender composition of the classes. In order for the hypothesis to prove correct, significant increases in participation rates of women would be found only after a tipping point. First, examining the turn-taking rates of women and men in the physics classroom, it is not immediately evident that there may be a tipping point. Looking back to Table 3, the participation trends of women and men vary widely across gender composition levels. As was highlighted in Hypothesis 3, the class with the lowest composition of women also had one of the highest rates of women's participation. And conversely, the class with the highest composition of women had one of the lowest rates of women's participation. Looking more closely at these numbers, a crosstabs and chi-square test was run for the relationship between gender on individual turns by class. I found that the relationship was only significant in four of the classes, the least and most diverse classes. The gender of a turn taker was significant for Class 10 ($X2=3.22$, $df=1$, $p=.043$) which had 15.4% women in it and Class 5 ($X2=7.59$, $df=1$, $p=.006$) which had 17.7% women in it. The gender of a turn taker was also significant for Class 3 ($X2=6.15$, $df=1$, $p=.013$) which had 43.1% women in it and Class 1 ($X2=9.31$, $df=1$, $p=.002$). These numbers might imply that the relationship between gender and turn-taking in the physics classroom is only detectable at the extreme ends of the spectrum when there are very few women in the class or near equal women in the class.

The second approach to examining participation trends in the classroom is by looking at the number of overall turn-takers in the classroom. Once again, looking back at Table 3, it is evident that there are still similar problems in predicting increases in participation by the gender composition of the class. As was found in Hypothesis 3, the class with the smallest proportion of women remains the class with the greatest proportion of turn-takers who are women. The class with the highest proportion of women also has one of the smallest proportions of turn-takers in the class who are women. Looking at the relationship between turn-taker's gender and the individual Class, only Class 10 proved to have a significant relationship between gender and number of turn-takers (X2=3.97, df=1, p=.046). This could mean that gender only plays a significant role in classes that have below 15% of women. This, however, is still not in-line with the propositions of Hypothesis 4 which is still not supported.

The final examination of participation is the proportional participation of men and women in the class. Going back to Table 3 and Hypothesis 3, there is still a problem in finding a tipping point for participation as there is no obvious steady increase in these proportions. Rather, the proportion of participants varies wildly when looked at from the composition of the classroom. Looking back at Hypothesis 3, Class 3 which previous research would predict to have the highest proportion of women taking turns, has only 3.2% of the total women in the class participating, the second lowest proportion. To compare the statistical significance of these proportions, it is necessary to compare men's and women's proportional participation by lecture. Two-sample t-tests between proportions were run to test the differences in proportions between men and women for each course. Once again, only Class 10 proved to be significant relationship for gender and the proportion of turn-takers (t=3.417, df=63, p=.0011). The only class which observed consistent significant differences in its population was Class 10, however, despite this class meeting the 15% threshold proposed by Kanter (1977) as a potential tipping point, this class is skewed towards women's participation and the remaining classes demonstrate no consistent increases. Because of this, this study cannot find evidence to support Hypothesis 4.

DISCUSSION

Based on the existing literature on proportions and classroom talk, I hypothesized that women would contribute less oral participation in the classroom than men, that increases in the proportion of women in the classroom would result in increases in women's participation, that a greater skew in the gender composition of a class would result in more skewed oral participation and that there would be a tipping point in the proportion of women in the classroom that after which would increase the participation of women. Most of the hypotheses proposed here failed to be supported by the data collected from these introductory physics courses. Only Hypothesis 1, that the average rate of participation for women would be less than men, was supported while Hypotheses 2-4 were not supported. Women's participation did not go up with the proportion of women in these classes, nor was there support to say that greater skewness in the gender proportions of the class resulted in greater differences in men's and women's participation. Finally, there was no evidence to suggest that there was a tipping point for the influence of the proportions on participation.

Interestingly, when looking at the relationships that would support hypotheses grounded in Kanter's (1977) theories on the effect of proportions on tokens, the data do show that there is a relationship between the gender of a turn-taker and the gender composition of the class ($X2=26.43$, $df=9$, $p=.002$). However, looked at more closely by class, this relationship only holds true for 4 of the 10 observed classes. These classes were the least and most skewed of the classes observed, Class 10 (15.4% women) and Class 5 (17.7%) being the most skewed of the classes and Class 1 (33% women) and

Class 3 (43.1%) being the least skewed of the classes. These results reflect some of the findings in Taylor et al. (2019) who examined tipping points in workplace management positions. Taylor et al. (2019) found that that greater compositions of women in the workplace were not only associated with greater shares of management above the proposed tipping points but were also associated with greater shares below those tipping points and that this was an even larger effect for workplaces below Kanter's (1977) original 15% tipping point. While not entirely consistent with these findings, as this study did not find evidence that there was a consistent positive relationship between increases in women's composition of these classes and women's oral participation, there is evidence is evidence to suggest that women's participation in the classes with the smallest proportion of women may be more greatly affected by this proportion than other classes. However, in this study it was observed that this relationship could be both positive and negative.

This study took the approach of introducing Kanter's (1977) theory on proportions to conversational analysis to see how the gender proportions within a classroom might affect women's participation in the classroom. While increased proportions of women in the classroom did not directly correspond to increased women's participation, there did seem to be a relationship between high and low proportions of women in the classroom and women's rates of participation. Kanter's (1977) theories on proportions and tipping points for women's increased influence in the group does not seem to be supported in this environment. Both high and low proportions of women in the physics classroom corresponded with increased participation of women. In addition, as participation did not increase in a predictable manner with increased proportions of women, there was no identifiable tipping point.

There are a number of things to take into consideration when asking why these theories did not hold true in this study. In Kanter's (1977) study one of the requirements for an individual being considered a token is that there must not only be few of their category in the group, but they also must be new to the environment. While women consistently represent only a small part of the physics workforce, they may not be a new introduction to the physics education setting. In addition, this study highlights only a small part of this group environment, turn-taking behaviors. Kanter (1977) also highlighted two contrasting coping methods for token women in response to their heightened visibility in a male-dominated environment. These strategies were to overachieve or to limit their visibility. In the context of oral participation, these coping methods may contribute to the differences between classes' participation rates. Some women may choose to overachieve by increasing their oral participation while others may choose to limit their visibility by remaining silent. Why different coping methods may be overutilized in different classes may then be an area that warrants further examination in future research.

Another aspect of this group environment that has not been touched on in this study is the periods of group work set aside in some of the classes. While all of the classes allocated time for students to solve problems posed to the class, and these problems were common across the classes, only three of the classes (Classes 3, 9 and 10) designated this as group work in which students separated into small groups to solve these problems. During this time professors walked through the class to answer questions and ask about how the group was solving the problem. While the presence of group work in a class did not have a significant relationship with the gender of a turn-taker ($X2=2.51$, $df=1$, $p=.113$), there was also no way for this study to account for the different participatory behaviors of students when in small groups as these classes were conducted in large lecture halls of between 62 and 144 people. Future research might examine how the oral participation of students is affected by proportions in such small groups.

Limitations

One of the greatest limitations of this study is the size. Including more classes or visiting individual classes multiple times might have widened the scope of what this study could examine. In addition, while this study was composed of classes of many different gender compositions, an even wider selection of compositions might have allowed for greater examination of the possible tipping points in classes. However, this might not have been possible within a physics education setting. This study design was structured with a very specific set of questions in mind. While the data obtained was able to accommodate the changed research questions, such a rigid study design did not allow for further exploration of the additional variables which could have been influencing student participation trends. The study design did not accommodate in-class group work and therefore was unable to account for this different type of in-class participation which was observed in 3 of the class periods. The rate of participation was also likely less than that of much of the previous literature as can be seen in comparison to Aukrust et al.'s (2008) study which observed elementary school children over a range of disciplines, which had an average of 35.2 turns at talk per class period in comparison to this study's average of 18.3 turns at talk per class period. Two possible reasons for this difference may be that this study only covered an individual course subject and that the instructors, while conscious of the research taking place, were not given instructions on how much of the class period should comprise of class discussion or conversation.

Another possible limitation is the time period in which these observations were done. These observations were conducted late in the Spring semester over the course of 2 days and can only attest to the student participation trends for that time. Whether these observations can be considered representative of the overall participation trends for these classes cannot be attested to. This study provides only a small snapshot of physics students' participation in these classes. Another limitation of this study is the exclusion of other socio-economic factors that may be influencing students' turn-taking behaviors. Research has shown that factors such as race, ethnicity, and socio-economic status can all have an effect on an individual's turn-taking behaviors and willingness to communicate.

CONCLUSIONS

The purpose of this study was to examine the differences in men's and women's participation trends in the physics classroom at a single University in relation to the gender composition of the classroom. Specifically, it sought to understand if the behaviors of the women in these classrooms reflected the expected behaviors of women in a group and in a field dominated by men. This is an area of research worth examining as physics remains one of the most male-dominated fields in STEM. Previous research has shown that in-class participation can be important for student success and retention as well as for developing professional role confidence and identity (Cech 2015). Kanter (1977) proposed that increasing the proportion of women in a group can increase the amount of power women have to influence the group's culture. Previous literature has used reported participation in group discussion and participation in the classroom as ways to measure women token group's increased influence within a group (Biggs et al. 2018, Spangler et al. 1978). This study went a step further to examine actual observed participation in the classroom to understand the state of women's influence on the group culture of the introductory physics classroom.

The data collected for this study found that women did, on average, participate less in the classroom than did men in these physics classes. However, this study did not find that women's participation went up as the proportion of women went up in the classroom. Nor could it find that the differences in women and men's participation was significantly greater in classes that were more highly skewed. Finally, the data collected from this study were unable to discover a tipping point for women's participation in the class in relation to the proportion of women in the class. Therefore, only Hypothesis 1 was supported by the data collected in this study. What this may contribute to our understanding of the experiences of women in physics and other male-dominated fields is that while overall women do participate less in these classrooms, their behaviors differ vastly between individual classes and may warrant further study. In addition, this study offers no support to the hypothesis that increases in the proportion of women in the physics classroom might produce increased participation.

Future Directions

As this study was conducted on a small scale, future research might test the findings using a larger sample of classes. Future research might also take an interest in the participation rates across the full lifespan of a course, in order to better understand if there is a change in participation rates throughout the semester and if those rates differ between men and women students. In addition, a larger scope of gender proportions within the classroom might help in understanding how these proportions affect women's in-class participation. Future research might examine the differences in participation trends for both men and women dominated academic fields in order to further examine any potential tipping points in the gender composition of the classroom. Additionally, while this study sought to examine just observed participation, pairing these observations with surveying and interviewing of physics students may shed more light on the felt effects of these classroom proportions. Taylor et al. (2019) also found that the gender proportions of external groups, such as the local workforce, could influence the proportional representation of women in management positions. Applying this to the classroom, future research might examine the influence of a University major's gender proportions or the gender proportions of the entire University on classroom participation.

APPENDIX A

Transcription Conventions Abridged from Jefferson (2004).

[ ]	Brackets are used to signify the beginning and ending of an overlap in utterances between two or more speakers. If the utterances end at the same time both utterances may be bracketed at both ends. If one utterance ends before the other, the right bracket is used to signify the point at which the shorter utterance ended within both utterances. In other terms, the full section of overlap within the utterance.
=	A pair of equal signs is used to signify that there is no observable gap between speakers' utterances, without an overlap. This can also be used to signify a break in an utterance that is continued to completion after or simultaneous to an interruption. A single equal sign indicates the lack of a gap between an individual speaker's utterance such as when a speaker does not pause between sentences.
(0.0)	Lengths of time are measured in tenths of seconds and enclosed in parentheses.
(.)	A single tenth of a second between utterances is indicated by a period enclosed in parentheses. This can also be used to indicate a pause of a tenth of a second within an individual utterance.
HUH	Upper case indicates a significantly louder volume than the surrounding speech.
°huh°	Bracketing in degree signs will indicate a significantly lower volume than the surrounding speech.
-	Dashes signify a cut off within an individual utterance.
< >	Carats (right/left) used to bracket an utterance or part of an utterance signifies that the given section was noticeably speed up in comparison to the surrounding speech.
> <	Carats inversed (left/right) are used to bracket an utterance or part of an utterance that is noticeably slowed down in comparison to the surrounding speech.
( )	Empty brackets indicate that an utterance was indiscernible to the researcher.
	An empty bracket in the speaker column indicates that the researcher was unable to identify the speaker of an utterance.
(Ø)	The bracketed null sign indicates that what is being heard might not actually be speech but background noise.
(( ))	Double parentheses indicate the researcher's descriptions.

APPENDIX B

DETAILED RESEARCH INFORMATION

You are being invited to take part in a research study. A person who takes part in a research study is called a research subject, or research participant.

What should I know about this research?

- Someone will explain this research to you.
- This form sums up that explanation.
- Taking part in this research is voluntary. Whether you take part is up to you.
- You can choose not to take part. There will be no penalty or loss of benefits to which you are otherwise entitled.
- You can agree to take part and later change your mind. There will be no penalty or loss of benefits to which you are otherwise entitled.
- If you don't understand, ask questions.
- Ask all the questions you want before you decide.

Why is this research being done?

The purpose of this research is to understand how undergraduate students at your University take turns participating in the Physics classroom. This study will help to inform our understanding of students' experiences in Physics and how these experiences might differ between men and women. This study is part of a thesis research and the results will be available to University students. This study will include 11 of the Foundations of Physics 2305 classes over the course of one class period.

How long will I be in this research?

We expect that your taking part in this research will last 1 class period, either 50 or 75 minutes.

What research will be taking place?

This research will take place in your Physics 2305: Foundations of Physics class during one class period. During this time there will be visual and audio recording equipment in the classroom as well as the researcher.

Could being in this research hurt me?

This study poses few known risks to participants. Possible risks are psychological including:

- Discomfort
- Embarrassment

Participants in this study will be involved for one class session and risks are likely to conclude with the participant's involvement. It is unlikely that risks should be long-lasting.

Will being in this research benefit me?

There are no benefits to you from your taking part in this research. We cannot promise any benefits to others from your taking part in this research. However, possible benefits to others include improved understanding of students' experiences in the physics classroom and women's experiences in physics.

What other choices do I have besides taking part in this research?

This research is not designed to diagnose, treat or prevent any disease. Your alternative is to not take part in the research.

What happens to the information collected for this research?

The information collected from this research will be shared with individuals and organizations that conduct or watch over this research, including:

- The research sponsor
- People who work with the research sponsor
- Government agencies, such as the Food and Drug Administration
- The Institutional Review Board (IRB) that reviewed this research

We may publish the results of this research. However, we will keep your name and other identifying information confidential.

We protect your information from disclosure to others to the extent required by law. We cannot promise complete secrecy.

Who can answer my questions about this research?

If you have questions, concerns, or complaints, or think this research has hurt you or made you sick, talk to the research team at the phone number listed above on the first page.

This research is being overseen by Western IRB (WIRB). WIRB is a group of people who perform independent review of research studies. You may talk to them at (800) 562-4789, help@wirb.com if:

- You have questions, concerns, or complaints that are not being answered by the research team.
- You are not getting answers from the research team.
- You cannot reach the research team.
- You want to talk to someone else about the research.
- You have questions about your rights as a research subject.

What happens if I don’t want to take part in this research or I change my mind later?

If you decide to leave or not take part in this research, contact the research team so that the investigator can:

Inquire about your location in the observed class in order to omit any oral participation from future transcripts.

Will I be paid for taking part in this research?

You will not be paid for taking part in this research.

APPENDIX C

Table C1: Variable Effects on Turn-Taker Gender

		Woman-Initiated	Man-Initiated	Total	Significance Value
Class Period					Chi-Square= .002
	Lecture 1	53.8%	46.2%	100%	
	Lecture 2	30.0%	70.0%	100%	
	Lecture 3	7.1%	92.9%	100%	
	Lecture 4	23.8%	76.2%	100%	
	Lecture 5	0.0%	100.0%	100%	
	Lecture 6	35.7%	64.3%	100%	
	Lecture 7	27.3%	72.7%	100%	
	Lecture 8	19.0%	81.0%	100%	
	Lecture 9	20.0%	80%	100%	
	Lecture 10	50.0%	50.0%	100%	
Group Work					Chi-Square = .113
	Yes	13.8%	86.2%	100%	
	No	24.0%	76.0%	100%	
Class Length					Chi-Square = .112
	Fifty Minutes	27.4%	72.6%	100%	
	Seventy-Five Minutes	17.4%	82.6%	100%	
Instructor					Chi-Square = .106
	Professor 1	20.3%	79.7%	100%	
	Professor 2	30.0%	70.0%	100%	
	Professor 3	7.1%	92.9%	100%	
	Professor 4	26.1%	73.9%	100%	
	Professor 5	31.3%	68.8%	100%	

Turn Length					Independent T-Test = .124
	Means	1.51624	2.27919		
Turn Type					Chi-Square = .976
	Solicited Response	20.9%	79.1%		
	Unsolicited Comment	21.1%	78.9%		
	Overlapping Utterance	18.2%	81.8%		

Table C2: Variables by Class Period

	Men Students	Women Students	Total
Lecture 1			
Composition	67 (67%)	33 (33%)	100
Turns at Talk	6 (46.2%)	7 (53.8%)	13
Solicited	6	7	13
Unsolicited	0	0	0
Overlapping	0	0	0
Turn-Takers	4 (66.7%)	2 (33.3%)	6
Proportion of Class (That took Turns)	5.97%	6.0%	6%
			Group Work (Y/N)
Group Work			N
			Class Length
Class Length			75 minutes
			Instructor
Instructor			A
Lecture 2			
Composition	85 (68%)	40 (32%)	125
Turns at Talk	14 (70%)	6 (30%)	20
Solicited	6	4	10
Unsolicited	7	2	9
Overlapping	1	0	1
Turn-Takers	9 (69.2%)	4 (30.8%)	13
Proportion of Class (That took Turns)	10.9%	10%	10.4%
			Group Work (Y/N)
Group Work			N
			Class Length
Class Length			75 Minutes
			Instructor

Instructor			B
Lecture 3			
Composition	82 (56.9%)	62 (43.1%)	144
Turns at Talk	39 (92.9%)	3 (7.1%)	42
Solicited	30	2	32
Unsolicited	6	0	6
Overlapping	3	1	4
Turn-Takers	12 (85.7%)	2 (14.3%)	14
Proportion of Class (That took Turns)	6.8%	3.2%	9.7%
			Group Work (Y/N)
Group Work			Y
			Class Length
Class Length			75 minutes
			Instructor
Instructor			C
	Men Students	**Women Students**	**Total**
Lecture 4			
Composition	69 (82.1%)	15 (17.9%)	84
Turns at Talk	16 (76.2%)	5 (23.8%)	21
Solicited	12	3	15
Unsolicited	4	2	6
Overlapping	0	0	0
Turn-Takers	7 (70%)	3 (30%)	10
Proportion of Class (That took Turns)	10.2%	20%	11.9%
			Group Work (Y/N)
Group Work			N
			Class Length
Class Length			75 minutes
			Instructor
Instructor			A
Lecture 5			
Composition	51 (82.3%)	11 (17.7%)	62
Turns at Talk	25 (100%)	0 (0.0%)	25
Solicited	18	0	18
Unsolicited	7	0	7
Overlapping	0	0	0
Turn-Takers	3 (100%)	0 (0.0%)	3
Proportion of Class (That took Turns)	5.9%	0%	4.8%
			Group Work (Y/N)
Group Work			N
			Class Length

Class Length			75 minutes
			Instructor
Instructor			A
Lecture 6			
Composition	60 (78.9%)	16 (21.1%)	76
Turns at Talk	9 (64.3%)	5 (35.7%)	14
Solicited	8	4	12
Unsolicited	0	0	0
Overlapping	1	1	2
Turn-Takers	5 (55.6%)	4 (44.4%)	9
Proportion of Class (That took Turns)	8.3%	25%	11.8%
			Group Work (Y/N)
Group Work			N
			Class Length
Class Length			50 minutes
			Instructor
Instructor			D
	Men Students	**Women Students**	**Total**
Lecture 7			
Composition	68 (70.8%)	28 (29.2%)	96
Turns at Talk	8 (72.7%)	3 (27.7%)	11
Solicited	5	3	8
Unsolicited	1	0	1
Overlapping	2	0	2
Turn-Takers	4 (80.0%)	1 (20.0%)	5
Proportion of Class (That took Turns)	5.9%	3.6%	5.2%
			Group Work (Y/N)
Group Work			N
			Class Length
Class Length			50 minutes
			Instructor
Instructor			D
Lecture 8			
Composition	72 (69.2%)	32 (30.8%)	104
Turns at Talk	17 (81.0%)	4 (19.0%)	21
Solicited	15	3	18
Unsolicited	0	1	1
Overlapping	2	0	2
Turn-Takers	6 (66.7%)	3 (33.3%)	9
Proportion of Class (That took Turns)	8.3%	9.4%	8.6%

			Group Work (Y/N)
Group Work			N
			Class Length
Class Length			50 minutes
			Instructor
Instructor			D
Lecture 9			
Composition	69 (77.5%)	20 (22.5%)	89
Turns at Talk	8 (80.0%)	2 (20.0%)	10
Solicited	3	2	5
Unsolicited	5	0	5
Overlapping	0	0	0
Turn-Takers	4 (66.7%)	2 (33.3%)	6
Proportion of Class (That took Turns)	5.8%	10%	6.7%
			Group Work (Y/N)
Group Work			Y
			Class Length
Class Length			50 minutes
			Instructor
Instructor			E
	Men Students	**Women Students**	**Total**
Lecture 10			
Composition	55 (84.6%)	10 (15.4%)	65
Turns at Talk	3 (50.0%)	3 (50.0%)	6
Solicited	3	0	3
Unsolicited	0	3	3
Overlapping	0	0	0
Turn-Takers	1 (25.0%)	3 (75.0%)	4
Proportion of Class (That took Turns)	1.8%	30%	6.1%
			Group Work (Y/N)
Group Work			Y
			Class Length
Class Length			50 minutes
			Instructor
Instructor			E

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