

Persistence in STEM: An Analysis of Achievement Goals, Gender, and Class Belonging

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Objectives / Purposes

The purpose of this study was to investigate what factors contribute to motivational engagement, and, specifically, persistence on coursework, for students in collegiate physics courses. Overall, participation in Science, Technology, Engineering, and Math (STEM) careers continues to be a national concern (NSF, 2018), and the rate at which students persist, or continue working through difficulties, both within their coursework and within this field, is thus crucial to understand.

Within this broad field of investigation, this paper also seeks to analyze the impact of performance-avoidance goal orientations on students' persistence in physics coursework. Research in Achievement Goal Theory has been prevalent in higher education for decades (e.g. Elliott & McGregor, 2001; Elliot & Murayama, 2008) and, within this framework, scholarship has consistently shown performance-avoidance orientations to be maladaptive (e.g., Pintrich, 2000; Hornstra et al., 2017). Students who adopt this orientation prioritize avoiding looking unintelligent, often by not persisting in their coursework. This goal orientation is of particular interest to me given my prior teaching experience, in which students often exhibited maladaptive behaviors associated with this goal orientation, and, particularly, a lack of persistence. Given the maladaptive tendencies of students with this personal goal orientation, it would be expected that performance-avoidance would relate negatively to persistence within the physics classes studied here.

Sense of class belonging is an important predictor of interest within this study. A myriad of studies have demonstrated the importance of belonging in terms of students' overall well-being and academic success (Allen et al, 2018). While this has often been demonstrated in terms

of institutional or social belonging within higher education studies (e.g., Wolters, 2004), the class belonging variable is nonetheless an important component of measuring students' persistence within their coursework and in terms of their general academic outcomes.

Overall, the persistence and participation of women in STEM is also of critical importance within these fields, as only 24% of college-bound females declare STEM majors, and also tend to persist in STEM domains at lower rates than their male peers (NSF, 2018; NCES, 2014). It is well established that women tend to feel a lower sense of belonging within STEM courses (e.g. Good et al., 2012, Lewis et al., 2017; Seyranian et al., 2018). Additionally, a study of freshmen women engineering students conducted by Jagacinski (2013) also suggests that women may be more likely to adopt avoidance goals within STEM settings as a result of their competence perceptions. Taken together, it is clear that gender may also serve to impact students' motivational engagement and persistence within STEM courses and major programs.

Theoretical Framework

Achievement Goal Theory

Achievement Goal Theory (AGT) provides the primary lens for this investigation. Broadly speaking, an achievement goal is “the purpose for engaging in competence-relevant behavior” (Elliot & Hulleman, 2017, pp. 43). Within this theoretical framework, students adopt personal goal orientations, which are the result of many possible influences, including the focus of their teacher(s) within the classroom and personal characteristics. These goal orientations subsequently impact students' use of academic strategies, as well as their academic outcomes (e.g., Elliot & Murayama, 2008). While the original framework for AGT was dichotomous in nature, it has now grown to reflect a bifurcated, four-goal orientation model, of which three are of primary interest in most recent studies (Elliot & Hulleman, 2017).

A mastery-approach goal orientation is widely considered to be the most adaptive and strategic of all of the goal orientations (Pintrich, 2000; Hornstra et al., 2017). Students who adopt this goal orientation are primarily concerned with mastering the content of the course, and are thus focused on their own learning and achievements in this regard (Elliot & Hulleman, 2017). A mastery-approach goal orientation has also been shown to be related to persistence in prior AGT research within the field of Educational Psychology (e.g. Wolters, 2004).

Meanwhile, performance goals and their levels of adaptivity are somewhat contested within the literature (e.g. Harackiewicz et al, 2002; Senko, 2019) and may vary considerably depending on the approach or avoidance valence of the students' goal orientation. For example, some literature has shown that a performance-approach goal orientation may be adaptive in certain circumstances (Senko, 2019). Although students who adopt this goal orientation are concerned with their own performance relative to others', it is their goal to outperform others, and thus can result in positive striving and success within the classroom (Senko, 2019). On the other hand, a performance-avoidance goal orientation has been consistently characterized as maladaptive for students' academic well-being (Pintrich, 2000; Hornstra et al., 2017). Students who adopt this goal orientation are concerned about their performance relative to others'; however, their primary motivation is to avoid performing worse than their peers (Elliot & Hulleman, 2017). Instead of working to obtain the highest grade in the class, a student with this goal orientation may be simply attempting to avoid receiving the lowest grade in the class, or looking unintelligent as compared to their classmates (Elliot & Hulleman, 2017).

Sense of Belonging

Students' perceptions of belonging, or feeling accepted and encouraged by others, within an institution, academic domain, or within social structures, have been widely studied within the

Educational Psychology literature (e.g., Allen et al., 2017). Numerous studies have shown that a high sense of belonging is related to students' effort, achievement and intentions to persist (Goodenow, 1993; Allen et al., 2017; Won et al., 2018). While class belongingness has not been as widely studied at the collegiate level, it seems especially pertinent to use a smaller unit of measure for belongingness when conducting studies at large universities. The ability to implement interventions on belonging at the classroom level is also perhaps more practical than at the domain or institutional level.

Recent studies have also shown that institutional or social sense of belonging is related to persistence through students' achievement goal orientations (Won et al., 2018). Sense of belonging has also been identified as a significant predictor of motivational engagement, with persistence as one of its sub-constructs (Won et al., 2018). While these mediated results do not use a perception of class belonging as a measure, it is likely that class belonging, as used in this study, would function in a similar manner, and thus have a significant impact on students' persistence within their physics courses.

Women in STEM. While belonging has been shown to be an important construct in predicting academic persistence, myriad studies have identified a consistent lack of belonging for females in STEM (e.g., Good et al., 2012; Lewis et al., 2017). Studies of females in STEM classes have repeatedly shown that women experience stereotype threat, a phenomenon in which students may perform below their actual ability level once a salient stereotype has been activated (e.g., Dasgupta, 2011; Dennehy et al., 2017). Despite some progress in increasing the number of women in STEM fields (NSF, 2018), stereotypes regarding females as less able in these fields still persist. The presence of stereotype threat can negatively impact female students and their sense of belonging, even when females are objectively outperforming their male counterparts

within their STEM courses (Voyer & Voyer, 2014; Lewis et al., 2017). The impact of this stereotype threat and low levels of belongingness are also related to low levels of domain persistence within STEM fields for females (NCES, 2014). Thus, understanding females' belonging is especially important in providing a complete picture of what may impact students' motivational engagement and persistence in STEM courses.

Persistence

The persistence variable, like belongingness, can also be measured in a variety of ways for STEM students, including: their persistence in coursework; their persistence within an academic domain; or, their overall persistence in collegiate studies. For the purposes of this study, persistence on course work, or the completion of course work even when facing distractions, difficulty, or boredom (Wolters, 2004), serve as the outcome of interest. Persistence has been shown to be related to students' motivational beliefs, as well as their cognitive and self-regulated learning strategies (Wolters, 2004). Therefore, it is likely that persistence would be a reliable indicator of a student's overall academic success within a given course or domain.

Aims of this Study

This study thus seeks to examine how personal goal orientations and class belonging impact persistence and what factors contribute to motivational engagement. Additionally, this work investigates whether the relation of class belonging to persistence is dependent on students' gender, given the low levels of domain persistence in STEM for females (NCES, 2014). Several hypotheses were advanced in the service of this study. First, it is expected that performance-avoidance will negatively relate to persistence, while mastery-approach will significantly and positively relate to persistence. No a priori hypotheses have been identified for the relation of performance-approach to persistence, given the primary interest in explicitly adaptive and

maladaptive orientations (e.g., mastery-approach goal orientation and performance-avoidance goal orientation; Pintrich, 2000; Hornstra et al., 2017). It is further expected that class belonging will significantly and positively relate to persistence, and that gender will moderate the relation between class belonging and persistence.

Method and Procedures

Participants were 994 students from 1000 and 2000-level undergraduate Physics courses during the spring semester of 2019 at a major university. Data was collected via two waves of an online survey as part of a larger study on student motivation and retention. Students received assignment credit within their physics classes for completing the surveys. While persistence on coursework, and not persistence within the major, is the outcome of interest in this work, it is important to note that only 12% of the study participants had declared a physics major at the time of the surveys.

Demographic information was also collected from all participants. Overall, 69% of the participants were male, while 30% were female. Females were coded as one (1) and males were coded as zero (0) for data analysis purposes. In regard to racial demographics, 67% of the study participants identified as Caucasian/White; 22% Asian-American Asian; 5% multi-racial; 3% African-American/Black; and 2% Hispanic/Latino/Latina. Finally, the academic make-up of these physics courses included 47% Freshmen, 37% Sophomores, 12% Juniors, and 3% Seniors.

Class Belonging was assessed using an adapted Psychological Sense of School Membership scale (Goodenow, 1993), which included 18 Likert-type items rated 1-5 and then averaged to form a composite score. Students were asked to rate how much each statement reflected their own feelings; e.g., “I feel like a real part of this physics class.” The adapted scale showed strong reliability at $\alpha = .91$.

Achievement Goal Orientations were assessed using the revised Achievement Goal Questionnaire (Elliot & Murayama, 2008). Three Likert-type items rated 1-5 for each orientation were assessed and averaged to form separate composite scores for each goal orientation. Example items included rating statements such as, “In this physics class, my goal is to learn as much as possible” (mastery-approach goal orientation). Each sub-scale showed good reliability levels, respectively: Mastery-Approach Goal Orientation, $\alpha = .85$; Performance-Approach Goal Orientation, $\alpha = .88$; Performance-Avoidance Goal Orientation, $\alpha = .89$.

Finally, Persistence was measured via Wolters’s (2004) scale of motivational engagement. Four items were assessed from 1-7 and then averaged to form a single score. Statements measuring student persistence included items such as: “Even if my physics work in this class is dull or boring, I keep at it until I am finished.” This scale also exhibited reasonable reliability at $\alpha = .71$.

All Likert-type items were centered to include 0 as a meaningful response on the scale. Multiple linear regression was then employed to predict persistence from the variables of interest and to investigate an interaction between class belonging and gender. All individual predictors and control variables were entered as a first level block, and the interaction term was then added to measure the change in proportion of variance accounted for by the interaction term, following guidelines established by Cohen (1978) and still used widely in studies today (e.g., Lagacé-Séguin & Case, 2010).

Results

Multiple regression analysis was performed to model how personal goal orientations, class belonging, and gender predict students’ persistence on coursework in physics classes. Contrary to predictions, in the initial block of predictors, performance-avoidance did not

negatively relate to persistence ($b = -.012, t = -.249, p = .803$), even when other goal orientations were controlled for in the model. Performance-approach also had a minimal impact on persistence when other goal orientations were held constant ($b = .042, t = .606, p = .545$). As expected, mastery-approach was significantly and positively related to persistence ($b = .199, t = 4.303, p < .000$) when other goal orientations were held at zero. Class belonging emerged as the only other significant relation in the initial model ($b = .594, t = 8.947, p < .000$), and was positively and significantly related to persistence, as was predicted. Overall, the model itself was significant ($F_{(992)} = 32.290, p < .000$) and accounted for 14% of the overall variance in persistence (see Table 1).

Table 1
First block of predictors with Persistence serving as outcome variable of interest

Predictor Variables	<i>b</i>	<i>b</i>	<i>p</i>
Mastery-Approach	0.199	0.143	0.000
Performance-Approach	0.042	0.030	0.545
Performance-Avoidance	-0.012	-0.015	0.803
Class Belonging	0.594	0.288	0.000
Gender	-0.030	-0.013	0.672

Females coded as 1; $R_2 = .140$

Given that gender did not emerge as a significant predictor in the initial block ($b = -.030, t = -.423, p = .672$), it is not surprising that the interaction term of Gender X Class Belonging only accounted for .1% of the variability in persistence, and was not statistically significant ($b = .097, t = -.767, p = .443$) when added to the model. The data suggests that the relationship between class belonging and persistence weakened for females as compared to males as class belonging increased; however, there is insufficient evidence to distinguish this moderating effect from zero. As can be seen in the full model results, the R_2 change remains constant at $R_2 = .140$, indicating the relatively negligible effect of adding the interaction term.

Table 2

Full model including block 1 predictors and the interaction term, with Persistence as the outcome

Predictor Variables	<i>b</i>	<i>b</i>	<i>p</i>
Mastery-Approach	0.198	0.143	0.000
Performance-Approach	0.037	0.027	0.590
Performance-Avoidance	-0.012	-0.192	0.848
Class Belonging	0.632	0.306	0.000
Gender	0.206	0.087	0.514
Gender X Class Belonging	-0.097	-0.102	0.443

Females coded as 1; $R_2 = .140$

Conclusions and Implications

This study replicates earlier results indicating a positive relation between a mastery-approach goal orientation, belongingness, and persistence (Pintrich, 2000; Won et al., 2018). And while a performance-avoidance goal orientation did not prove to be a negative predictor of persistence as anticipated, clear differences in performance-avoidance and mastery-approach goal orientations were still apparent. Future work in this area should focus on more concrete measures of student achievement such as persistence within STEM fields, or the students' course grades in an effort to better capture the impact of a performance-avoidance goal orientation. While persistence on coursework, as opposed to persistence in the domain, is certainly important when studying constructs such as performance-avoidance goal orientations, it is not perhaps the strongest or most objective predictor of success within STEM courses. It is possible that a more objective measure may better illuminate the relationship between this maladaptive goal orientation and successive student outcomes.

Future work within these physics courses or within similar collegiate student populations could also examine several different subsets of students or classrooms in order to refine the

relationships that exist between the predictor variables in this study and student outcomes. For example, focusing primarily on introductory-level students, or on pre-major students, might allow for a more accurate picture of how students' levels of belongingness or goal orientations impact their persistence and academic outcomes. Introductory-level students may be more prone to experience lower levels of belonging, or to adopting more maladaptive goals, which may provide for a more insightful account of what deters students from persisting in STEM fields (Jagacinski, 2013).

Furthermore, additional work with this or similar populations could examine class belonging within recitation sections led by Teaching Assistants at the university level. It is possible that students may be able to foster a greater sense of belonging within smaller classes, where opportunities to form meaningful peer and teacher relationships might be more accessible or numerous within these settings (e.g. Anderman, 2002; Allen et al., 2018).

Finally, while gender did not moderate the relation of class belonging on persistence in this study, greater efforts to foster supportive environments for students at large in STEM, and for women in particular, are still needed within collegiate classrooms and environments (e.g. Cheryan et al., 2009). Such support should begin at the classroom level, where class belonging may be an important predictor of academic success for women in STEM. Several examples of relevant intervention programs for female students can be found in the work of Dasgupta, who has studied the positive effects of both female-majority gender grouping (2011; Dasgupta et al., 2015) and female peer mentors within STEM classrooms (Dennehy & Dasgupta, 2017). This work could be further replicated and integrated with an Achievement Goal Theory framework, perhaps through a mediation rather than a direct effects or moderation model. Won et al.'s (2018) work on the mediating effects of sense of belonging could be an important stepping-stone

for linking students' personal goal orientations with positive interventions for all STEM students, and for female STEM students, in particular. This work may also serve to further elucidate the relations between performance-avoidance goal orientations and students' academic persistence or success.

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