Gender and Ethnic Differences in Classroom Engagement and Knowledge Building in Engineering Energy Science Courses

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Abstract

Research is clear that women and under-represented ethnic and racial minorities experience engineering classroom climates differently than their male and predominantly white peers. However, little research has investigated differences in engagement and knowledge building between dominant and non-dominant groups in engineering contexts. In this study we examine gender and ethnic differences in student engagement and knowledge building in engineering energy science classrooms. Results indicated that there were significant group differences in students' perception of support for question asking, affective engagement, and behavioral-effortful class participation. Follow up comparisons of gender-ethnicity combinations revealed insight into the differences among women and under-represented racial and ethnic minorities. White males consistently self-reported significantly higher levels of question asking, affective engagement, and effortful engagement than students from many UREM groups. White females, multiracial females, and multiracial males consistently self-reported lower levels of question asking, affective engagement, and effortful engagement than students from many other backgrounds. Follow up comparisons of gender-ethnicity combinations revealed insight into the differences among women and under-represented racial and ethnic minorities. This material is based upon work supported by the National Science Foundation under Grant Number NSF DUE #1245018.

Keywords: Engagement, Knowledge Building, Gender, Ethnicity

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Introduction

Women and Under-represented Ethnic and Racial Minorities (UERM's) come to engineering programs qualified and motivated to succeed; all too often, however, as they progress through engineering programs their attitudes may change and their achievement may falter (e.g. Felder, et al., 1995; Ohland, et al., 2011 NSF NCES, 2013). Classroom experiences of women and UREM's in engineering and computer science are different from dominant groups, often to their disadvantage (Seymour & Hewitt, 1997; Steele & Aronson, 1995). However, although engagement and knowledge building are foundational constructs in the study of classroom learning (i.e. Corno, 2004; Scardamalia & Bereiter, 1992), little is known about gender and ethnic differences in the ways students' engage and build knowledge engineering contexts.

Post-secondary engineering classrooms should support UERM and women's positive motivational beliefs and engagement (Laffey et al., 2016). Further examination of differences in engagement and knowledge building between dominant and non-dominant groups can help to advance this cause. In this study we examine gender and ethnic differences in student engagement (Wang, et al., 2014) and classroom knowledge-building (Nelson, et al., 2015) in a large sample of undergraduate students enrolled in engineering science classrooms at two research institutions. We examine students' perceptions of the degree to which classrooms supported behavioral, cognitive, and affective engagement, as well as six classroom knowledge building cognitions and behaviors.

We approach the data with a general hypothesis that the experiences of women and ethnic minorities would be different from dominant groups, and then explore the data to determine the nature of these differences and how large they might be. The purpose of the study is to produce evidence for areas where engineering courses can be more supportive of engagement and knowledge building for UERM and female students. The findings may be used by engineering educators to make empirically informed choices to support women and UREM's in classroom learning contexts.

Supportive Classroom Environments in Engineering Education

Engineering classroom climates can be unsupportive of women and UREM's. Grounded in foundational work conducted by Felder and colleagues (1995) and Seymour and Hewitt (1997), research, spanning the last several decades, has uncovered a plethora of evidence related to the differential experiences of UREM's in engineering (NSF NCES, 2013). Current research has described a culture of engineering in post-secondary environs that restrict motivational expression and deep student engagement (i.e. Benson, Kirn, & Faber, 2016), and others have examined ways the experiences of UREM's can be improved (Laffey, et al, 2016). Furthermore, various interventions have been conducted to examine how instructional support and strategies can improve student motivation and engagement (i.e. Hilpert & Husman, 2016; Husman et al., 2014; Nelson et al., 2015).

However, few studies we found sought to examine differences in student engagement (i.e. Wang, et al., 2014) and knowledge building (i.e. Nelson, et al., 2015) at a fine enough grain to target possible avenues for improved instruction for UREM's. Because engagement and knowledge building are multifaceted constructs, it is hard to know which facets should be targeted for instructional support or improvement. Below we address student engagement and knowledge building, describing the various subcomponents of each theory. These descriptions set the stage for our analysis of gender and UREM differences in self-reported levels of each construct. We conclude with a discussion of the social and cultural sources of differences in each construct, as well as some suggestions for instructional strategies that may improve student engagement and knowledge building grounded in existing literature.

Supportive Classrooms and Student Engagement

Student engagement is the energized action produced from motivated, goal directed behavior (i.e. Reeve, 2014; Skinner, 2016). Student engagement is operationalized as a multidimensional construct with behavioral, cognitive, and affective components (Corno, 2004; Fredricks, et al., 2004; Lawsen & Lawsen, 2013; Wang, Bergin, & Bergin, 2014). Behavioral engagement refers to observable behaviors related to classroom participation (e.g. asking questions, time on task). Cognitive engagement refers to cognitive variables and processes related to conscious knowledge construction (e.g. concentration, learning strategies). Affective engagement refers to the emotions students experience during classroom learning (e.g. enjoyment, enthusiasm). Hilpert (2016) demonstrated how student behavioral, cognitive, and affective engagement profiles are statistically related to instructional strategy use in engineering classrooms.

Along these lines, a large body of engagement research in engineering education (i.e. Gasiewski, et al., 2012; Hilpert & Husman, 2016; Kuh, 2007; Lord, et al., 2009; Ohland, et al., 2008) suggests that there is a clear link between supportive classroom instruction and student learning, often stemming from the use of researched based instructional strategies (RBIS; Borrego, et al., 2013). For example, Hilpert and Husman (2016) demonstrated classroom interaction, often in the form of dynamic relationships among instructors and students, can have a positive impact on student motivation, engagement, and learning in post-secondary engineering classrooms. Further, a meta-analysis of the active learning literature is clear that RBIS improves engagement and achievement and prevents dropping out in STEM contexts (Freeman, et al., 2014). However, it remains unclear is if there are patterned differences between dominant and non-dominant groups in engagement that can be targeted to improve instructional support for UREM's.

Supportive Classroom Environments and Student Knowledge Building

In recent years, motivation researchers have focused much time and effort to the study of supportive classroom environments (e.g. Jang, et al., 2010; Soenens & Vansteekiste, 2005). Experimental research suggests that teachers who find ways to incorporate student interests, preferences, choices, and curiosity into classroom instruction produce higher levels of engagement that have been shown to positively influence learning (Reeve, et al., 2004). Within the context of engineering education research, engagement has been measured at a fine grain level as classroom knowledge building (Hilpert & Husman, 2016; Nelson, et al., 2015). Classroom knowledge building is a collection of classroom behaviors and cognitions related to the production of new knowledge as opposed to the route memorization of facts and concepts (Scademalia & Bereiter, 1992). The individual components of knowledge building are described in detail in the measures section below.

In the engineering education literature, Nelson and colleagues (2015) demonstrated that knowledge building components cluster into student motivational profiles, and Hilpert (2016) demonstrated the patterns of relationships between active and passive instruction and classroom knowledge building and engagement. Generally speaking, these results replicate in engineering contexts what has been found in the general education motivation literature: that instructors who support student autonomy facilitate more engaging learning environments, and that motivational profiles that indicate high level of student knowledge building are more adaptive to student learning. These provide the engineering education community with pathways to explore student motivation and knowledge building. Although research in knowledge building and student engagement has mirrored educational research in other contexts, these studies have not explored the experiences of women and UERM specifically. Unlike many foundational educational research contexts (Shell & Husman, 2008) engineering is an environment that traditionally favors white men. A focus on student engagement and knowledge building experiences of women and UREM can provide targeted recommendations for autonomy support unique to engineering contexts.

Study Overview

Using a purposive sampling technique targeting energy science classrooms, a standardized survey containing measures of knowledge building and classroom engagement was distributed to 937 students over three semesters. Exploratory Factor Analysis (EFA) provided evidence for the internal reliability of responses to items for all separate subscales for both instruments. Correlation coefficients provided validity evidence for all subscales within both instruments. After validity and reliability evidence were established, Analysis of Variance (ANOVA) was conducted to examine group differences. F-tests were used to examine omnibus group differences across administered subscales. Based on these findings, follow-up t-tests were conducted for subscales related to question asking, affective engagement, and behavioral-effortful class participation, revealing specific gender-ethnic differences.

Method

Participants

Participants were selected from various post-secondary energy science classes at two research institutions, one in the southeast and one in the southwestern United States. The data were collected on three occasions: in the spring of 2014, fall of 2014 and spring of 2015 at both institutions. See Table 1 for a list of course types from which responses were collected. An analysis of Interclass Correlation Coefficients (ICC) reported elsewhere (Hilpert, Marchand, & Husman, 2017) indicated very little variation between classes for student responses. This provided evidence that classroom data could be aggregated for analysis.

- Aerospace Engineering (Aeronautics) 9.6%

- Aerospace Engineering (Astronautics) 3.7%
- Aerospace Engineering (Autonomous Vehicle Systems) 0.2%
- Biomedical Engineering 4.9%
- Civil Engineering 5.5%
- Civil Engineering (Environmental Engineering) 1.6%
- Construction Engineering 0.2%
- Earth and Space Exploration (Exploration Systems Design) 0.5%
- Economics 0.2%
- Renewable Energy 2.1%
- Electrical Engineering 1.8%
- ETP/ME/Mechanical Engineering 0.7%
- Industrial Engineering 1.3%
- Mechanical Engineering 58.9%
- Mechanical Engineering (Computational Mechanics) 0.6%
- Mechanical Engineering (Energy and Environment) 3.6%
- Physics 0.2%
- RETP/CE/Civil Engineering 0.4%
- RETP/ME/Aerospace Engineering 1.4%
- RETP/ME/Biomedical Engineering 0.2%
- RETP/ME/Mechanical Engineering 2.1%
- Other 1.8%

The sample included 937 undergraduate students (752 male, 154 female), and eight ethnic groups: white (556 students), black or African American (109 students), Hispanic (114 students), Asian (66 students), American Indian/Alaska Native (10 students), multiracial (38 students, non-resident (35 students) and unknown (9 students). All possible combinations of race by gender were coded to create sixteen race by gender categories. These categories are described in detail later in the paper as they become pertinent to the analysis.

Apparatus and Measures

An online Qualtrics survey was completed which contained demographic, educational, Student Perceptions of Classroom Knowledge-Building (SPOCK, Nelson, et al., 2015) and Classroom Engagement Inventory (CEI; Wang, Wang, & Bergin, 2012) questions. Students were classified by demographic questions: gender, race/ethnicity and further identified by educational questions: semester, course title, course grade and major.

Student Perception of Classroom Knowledge Building. The SPOCK subscales (Nelson, et al., 2012; Shell & Husman, 2008) were administered to assess students' perceptions of their own knowledge building and intentional learning behavior. Five subscales were administered from the instrument including self-regulation, lack of self-regulation, knowledge-building, question asking, cooperative learning and teacher directedness. The initial subscale focused on general self-regulation ($\alpha = .81$). This 5-item subscale assessed students' tendency to govern or police themselves within the classroom. An example of a self-regulation item is "In this class, I thought about different approaches or strategies I could use for studying." The second subscale focused on lack of regulation ($\alpha = .76$). This 4-item subscale assessed students' tendency to neglect to govern or police themselves within the classroom. An example of a lack-of-regulation item is "In this class, I had difficulty determining how I should be studying the material." The third subscale focused on classroom knowledge-building ($\alpha = .80$). This 5-item subscale assessed students' propensity to construct a unique understanding of classroom material based off of their meaning making style. An example of a knowledge-building item is "In this class, I tried to fully explore the new information I was learning." The fourth subscale focused on question asking ($\alpha = .89$), which was separated into three high items and three low items. The low question asking items focused on the student's propensity to ask questions in order to succeed on assignments and tests. In contrast the high question asking items focused on the student's propensity to ask questions to gain knowledge and self-enrichment. The fifth subscale assessed the level of cooperative learning ($\alpha = .87$). An example of one of the four items from this subscale is, "When I did my work in this class, I got helpful comments about my work from other students." The final SPOCK subscale assessed the extent of teacher directedness ($\alpha = .70$). An example of one of the three items from this subscale is, "In this class, the instructor focused on getting us to learn the right answers to questions." The SPOCK subscales utilized a seven point Likert scale ranging from never, to almost never, to always.

Classroom Engagement Inventory. The CEI (Wang, Wang, & Bergin, 2012) was administered to assess students' affective, behavioral and cognitive engagement dimensions at the classroom level. Four subscales were administered including affective engagement, behavioral-effortful class participation, cognitive engagement, and disengagement. The initial subscale focused on affective engagement ($\alpha = .90$). This 5-item subscale assessed students' general mood within the classroom. An example of an affective engagement item is "In this class I feel excited." The second subscale focused on behavioral-effortful class participation ($\alpha = .83$). This 5-item subscale assessed whether student behaviors were representative of classroom participation. An example of behavioral-effortful class participation is "In this class I actively participate in class discussions." The third subscale focused on cognitive engagement ($\alpha = .81$). The 8-item subscale assessed how often students thought deeply about things during class. An example of cognitive engagement is "In this class I think deeply when I take quizzes." The final subscale focused on disengagement ($\alpha = .76$). An example of one of the three items from this subscale is, "In this class I let my mind wander." The affective, behavioral-effortful, cognitive and disengagement subscales were on a seven point Likert scale like the SPOCK subscales.

Procedure

If the students read and digitally signed the informed consent page of the Qualtrics survey, the survey process began. The students began the survey by entering their student ID number. After entering their ID, the survey moved on to educational questions. After the educational questions, twenty-seven SPOCK questions were given. After the SPOCK questions, twenty-four Classroom Engagement Inventory questions were given. Once the CEI questions were completed the students were debriefed and the survey ceased. Student ID number were used later to obtain pertinent demographic information.

Results

Exploratory Factor Analysis

To produce evidence for the internal reliability of student responses to the survey items, an Exploratory Factor Analysis (EFA) was calculated for data from both the study instruments. Analyses were conducted following the recommendation of Green & Salkind (2010). The dimensionality of the six subscales from the SPOCK scale, and the 4 subscales from CEI, were analyzed separately using principal axis factor analysis. Three criteria were used to determine the number of factors to rotate: the a priori hypothesis that the measure was unidimensional, the scree test, and the interpretability of the factor solution.

The scree plot indicated that our initial hypothesis for the SPOCK scale was correct. The rotated six – factor SPOCK model solution, as shown in Table 1, yielded six interpretable (>.4) factors: question asking, general self-regulation, cooperative learning, lack of regulation, knowledge building and teacher directed classroom. No items loaded on multiple factors. The scree plot indicated that our initial hypothesis for the CEI was correct. The rotated four-item EFA model solution, as shown in Table 2, yielded four interpretable (>.4) factors: affective, cognitive, behavioral-effortful and disengagement. No items loaded on multiple factors.

Descriptive Statistics and Bivariate Correlations

After the EFA's were calculated for data from both the study instruments, descriptive statistics and correlation coefficients were calculated for the six subscales (fifteen correlations) in the SPOCK and the four subscales (six correlations) in the CEI. Analysis of the descriptive statistics indicate all variables were univariately normal and analyses proceeded as planned.

Correlation coefficients were first computed among the six-factor SPOCK model. Using the Bonferroni approach to control for Type 1 error across the fifteen correlations, a p value of less than .0033 (.05 / 15 = .0033) was required for significance. The results of the correlational analyses presented in Table 3 show that thirteen out of the fifteen potential correlations were statistically significant at the 0.01 level and were greater than or equal to .40. The correlation between lack of regulation and question asking (.039) as well as lack of regulation and general self-regulation (-.058) were not significant.

Correlation coefficients were also computed among the four-factor CEI model. Using the Bonferroni approach to control for Type 1 error across the six correlations, a p value of less than .0071 (.05 / 6 = .0083) was required for significance. The results of the correlational analyses presented in Table 4 show that five out of the six potential correlations were statistically significant at the 0.01 level and were great than or equal to .40. The correlation of disengagement with behavioral effortful class participation (-.052) was not significant.

Analysis of Variance

Six separate one-way ANOVA's were conducted to evaluate the relationship between race and responses to the SPOCK subscales. Again, type one error was considered when interpreting the results. The independent variables for each analysis included: white, black, Hispanic, Asian, Alaskan Native, multiracial, non-resident and unknown. The dependent variables, scores on the SPOCK model, included six levels: question asking, self-regulation, cooperative learning, lack of regulation, knowledge building, and teacher directed class. Of the dependent variables presented in Table 5, only question asking was significant $F(7, 933) = 2.59$, $p = .012$. These results show that there was a significant difference between race by gender categories for the question asking SPOCK category.

A similar set of one-way ANOVA's were conducted on the CEI data as well. Again, type one error was considered when interpreting the results. The independent variable included: white, black, Hispanic, Asian, Alaskan Native, multiracial, non-resident and unknown. The dependent variable, responses to the CEI, included four levels: affective engagement, cognitive engagement, behavioral-effortful class participation, and disengagement. Of the dependent variables presented in Table 6, two were significant: affective engagement $F(7, 933) = 3.40$, $p = .001$ and behavioral-effortful class participation $F(7,933) = 2.72$, $p = .008$. These results show that there were significant differences in scores between race by gender categories for affective engagement and behavioral-effortful class participation.

Follow up pairwise comparisons for the significant one-way ANOVA's were calculated to examine the specific race by gender differences. The independent variable (race by gender) included sixteen race by gender categories (see Table 1 for a review of these categories).

Question asking. The results of the one-way analysis presented in Table 8 show nine significant race by gender relationships at the 0.05 level for question asking. Three of the nine were also significant at the 0.01 level. Mean responses for white females were significantly lower from white males and black males at the 0.05 level. Mean responses for white females also were significantly lower from non-resident males at the 0.01 level. Mean responses for multiracial females were significantly lower from non-resident males at the 0.05 level. Mean response for Hispanic males were significantly lower from white males and black males at the 0.05 level. Mean responses for Hispanic males also were significantly lower from non-resident males at the 0.01 level. Mean responses for multiracial males were significantly lower from black males at the 0.05 level. Mean responses for multiracial males also were significantly lower from non-resident males at the 0.01 level.

Affective engagement. The results of the one-way analysis presented in Table 9 show twenty-six significant race by gender relationships at the 0.05 level. Twelve of the twenty-six were also significant at the 0.01 level. Mean responses for white females were significantly lower from Asian females, Asian males, and Alaskan Native males at the 0.05 level. Mean responses for white females also were significantly lower from black females, Hispanic females, white males, Hispanic males, and non-resident males at the 0.01 level. Mean responses for multiracial females were significantly lower from black females, Hispanic females, Asian Females, white males Asian males, and Alaskan Native males at the 0.05 level. Mean responses for multiracial females also were significantly lower from Hispanic males and non-resident males at the 0.01 level. Mean responses for Black males were significantly lower from Hispanic males and non-resident males at the 0.05 level. Mean responses for multiracial males were significantly lower from Asian females, Asian males, and Alaskan Native males at the 0.05 level. Mean responses for multiracial males also were significantly lower from black females, Hispanic females, white males, Hispanic males, and non-resident males at the 0.01 level.

Behavioral-effortful classroom engagement. The results of the one-way analysis presented in Table 10 show seventeen significant race by gender relationships at the 0.05 level. Five of the seventeen were also significant at the 0.01 level. Mean responses for white females were significantly lower from non-resident males at the 0.05 level. Mean responses for multiracial females were significantly lower from Hispanic females, Asian females, Hispanic males, Alaskan Native males, and unknown males at the 0.05 level. Mean responses for multiracial females also were significantly lower from black females, white males, black males, Asian males, and non-resident males at the 0.01 level. Mean responses for multiracial males were significantly lower from black females, white males, black males, Hispanic males, and Asian males at the 0.05 level. Mean responses for multiracial males also were significantly lower from non-resident males at the 0.01 level.

Discussion

The results of the current study provide three main forms of evidence that are important to the engineering education community. First, the exploratory factor analyses and the bivariate correlations among the study subscales provide evidence for the internal reliability and external validity of student responses to the instruments. Second, the findings indicate specific forms of engagement that differ between dominant and non-dominant groups in a relatively representative sample of students from engineering science classrooms. Third, the findings allow for speculation about implications, future research, instructional strategies, and classroom autonomy support that can be provided to students that may be worth exploring in engineering education contexts. These three forms of evidence are discussed below.

Reliability and Validity Evidence

The results of the SPOCK EFA model provide evidence for reliable score interpretation of student responses to the instrument. The six hypothesized interpretable factors: question asking, self-regulation, cooperative learning, lack of regulation, knowledge building, and teacher directedness were found. Twenty-seven of the twenty-eight items loaded above .4, and none of the items loaded on multiple factors in meaningful ways. Further, thirteen of the potential fifteen correlations were significant, and the strength and direction of the correlations was theoretically interpretable in in line with previous research (i.e. Nelson, et al., 2015), providing evidence for concurrent validity.

The results of the CEI EFA model provide evidence for reliable score interpretation of student responses to the instrument. The four hypothesized interpretable factors: affective engagement, cognitive engagement, behavioral engagement, and disengagement were found. All twenty-one items loaded, with no items loading on multiple factors in meaningful ways. Further, five of the potential six potential correlations were significant and the strength and direction of the correlations was theoretically interpretable and in line with previous research (i.e. Wang et al., 2014), providing evidence for concurrent validity.

Group Differences in Engagement and Knowledge Building

The results of the ANOVA of race indicated that there were significant differences across groups for three constructs worth exploring further with follow up analyses: question asking, affective engagement, and behavioral effortful classroom engagement. Follow up tests to examine the strength and direction of these group differences indicated the areas where UREM's reported significantly lower levels of these three factors than did students from dominant groups or other UREM counter parts. Below we summarize the findings in terms of which groups reported significantly higher levels of the study variables.

For question asking, white males, black males, and non-resident males self-reported higher levels of question asking in comparison to white females, Hispanic males, and multiracial males. For affective engagement, white males, Hispanic males, non-resident males, and black females self-reported higher levels of affective engagement than white females, multiracial females, multiracial males, and black males. For effortful classroom engagement, white males, non-resident males, black females, and black males self-reported higher levels of behavioral effortful classroom engagement than multiracial females and multiracial males.

The pattern of results suggests three important conclusions with regard to race and gender differences in knowledge building and engagement in our sample: 1) white males consistently self-reported significantly higher levels of question asking, affective engagement, and effortful engagement than students from many UREM groups, 2) white females, multiracial females, and multiracial males consistently self-reported lower levels of question asking, affective engagement, and effortful engagement than students from many backgrounds, and 3) there is a complex pattern of results for comparisons among question asking, affective engagement, and effortful engagement between UREM's categories that may be attributable to a contextual factors and cultural and social norms and values.

The first two findings provide support for a long history of research that suggests engineering education contexts privilege white males, adding evidence that this privilege may manifest, among other ways, in increased classroom support for asking questions, affective engagement, and effortful engagement during classroom activities and less support for women and students of color. The third suggests that different cultural and social factors may have very nuanced influences on how and why students from different backgrounds and personal histories engage in classroom knowledge building, indicating that improved autonomy support (i.e. clear expectations for learning and making curriculum relevant to student backgrounds and interests) for individual differences may be key to improving motivation and engagement for UREM's.

Future Directions for Research and Practice

What is clear from our findings is that the engineering classrooms we surveyed were consistently more supportive of question asking, affective engagement, and effortful engagement for white males, and less supportive of these activities for white females, multiracial females, and multiracial males. These results are complicated by a complex combination of findings with regard to engagement patterns for UREM's. Students engage with classroom activities in many ways, and it is unclear what the result of increased autonomy support in classroom environments would be on UREM student engagement. Motivational research is clear that the combination of increased classroom structure and classroom autonomy support significantly contributes to student motivation and engagement (Jang et al., 2010; Reeve, et al., 2004; Soenens & Vansteenkiste, 2005), but future research is needed to determine if this relationship holds in engineering education contexts, and to what degree it improves the experiences of UREM's. Intensity and quality of student engagement, particularly for UREM's with prior experiences different from classmates from dominant groups, may be shaped by cultural norms, peer influences, and contextual factors related to curriculum and the learning environment (in addition to instructional strategies and style). Presumably, improved instructional support would mitigate the damaging impact of negative perceptions such as stereotype threat (Steele & Aronson, 1995) or avoidance orientation (Midgely, 2001) that limit engagement, and at the same time support student tendencies related to cultural norms and practices. Future research that can untangle the complex combination of these factors can provide new insights into how to support UREM's in engineering education contexts.

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Table 1

Pattern Matrix of Promax Six Figure SPOCK Model

	QA	SR	Coop	LSR	KB	TD
Question Asking Item 1	0.90					
Question Asking Item 2	0.82					
Question Asking Item 3	0.76					
Question Asking Item 4	0.73					
Question Asking Item 5	0.71					
Question Asking Item 6	0.54					
Self-Regulation Item 1		0.75				
Self-Regulation Item 2		0.67				
Self-Regulation Item 3		0.57				
Self-Regulation Item 4		0.56				
Self-Regulation Item 5		0.50				
Cooperative Learning Item 1			0.89			
Cooperative Learning Item 2			0.85			
Cooperative Learning Item 3			0.80			
Cooperative Learning Item 4			0.55			
Lack of Regulation Item 1				0.85		
Lack of Regulation Item 2				0.77		
Lack of Regulation Item 3				0.60		
Lack of Regulation Item 4				0.50		
Knowledge Building Item 1					0.63	
Knowledge Building Item 2					0.63	
Knowledge Building Item 3					0.52	
Knowledge Building Item 4					0.48	
Knowledge Building Item 5						
Teacher Directedness Item 1						0.80
Teacher Directedness Item 2						0.69
Teacher Directedness Item 3						0.51

QA = Question Asking, SR = Self-Regulation, Coop = Cooperative Learning, LSR = Lack of Regulation, KB = Knowledge Building, TD = Teacher Directed Classroom.

***Factors <.4 are hidden from data set**

Table 2

Pattern Matrix of Promax Four Factor EFA Model

	Affect	Cog	Beheff	Dis
Affective Engagement Item 1	0.92			
Affective Engagement Item 2	0.90			
Affective Engagement Item 3	0.83			
Affective Engagement Item 4	0.68			
Affective Engagement Item 5	0.61			
Cognitive Engagement Item 1		0.78		
Cognitive Engagement Item 2		0.77		
Cognitive Engagement Item 3		0.70		
Cognitive Engagement Item 4		0.53		
Cognitive Engagement Item 5		0.51		
Cognitive Engagement Item 6		0.47		
Cognitive Engagement Item 7		0.44		
Behavioral Engagment Item 1			0.82	
Behavioral Engagment Item 2			0.79	
Behavioral Engagment Item 3			0.65	
Behavioral Engagment Item 4			0.59	
Behavioral Engagment Item 5			0.48	
Behavioral Engagment Item 6			0.44	
Disengagement Item 1				0.78
Disengagement Item 2				0.75
Disengagement Item 3				0.62

Affect = Affective Engagement, Cog = Cognitive Engagement, Beheff = Behavioral-Effortful Classroom Participation, Dis = Disengagement

***Factors <.4 are hidden from data set**

Table 3

Correlations among the six-factor SPOCK Model

	QA	SR	Coop	LSR	KB
SR	**.600****				
Coop	**.509****	**.305****			
LSR	.039	-.058	**.301****		
KB	**.661****	**.700****	**.350****	**-.167****	
TD	**.439****	**.445****	**.253****	**-.285****	**.480****

**. Correlation is significant at the 0.01 level (2-tailed).

Table 4

Correlations among the four factor EFA Model

	Affect	Cog	Beheff	
Cog	**.594****			
Beheff	**.687****	**.512****		
Dis	**.142****	**-.340****	-0.052	

**. Correlation is significant at the 0.01 level (2-tailed).

Table 5

ANOVA of race for six-factor SPOCK Model

		Sum of Squares	df	Mean Square	F	Sig.
QA	Between Groups	16.457	7	2.351	2.586	**.012**
	Within Groups	848.197	933	.909		
	Total	864.654	940			
SR	Between Groups	4.683	7	.669	.796	.591
	Within Groups	784.655	933	.841		
	Total	789.338	940			
Coop	Between Groups	9.273	7	1.325	1.492	.166
	Within Groups	828.373	933	.888		
	Total	837.645	940			
LSR	Between Groups	10.353	7	1.479	1.763	.091
	Within Groups	782.543	933	.839		
	Total	792.896	940			
KB	Between Groups	4.260	7	.609	.738	.639
	Within Groups	769.053	933	.824		
	Total	773.313	940			
TD	Between Groups	3.092	7	.442	.553	.794
	Within Groups	745.607	933	.799		
	Total	748.699	940			

Table 6

ANOVA of race for four factor EFA Model

		Sum of Squares	df	Mean Square	F	Sig.
Affect	Between Groups	21.643	7	3.092	3.395	**.001**
	Within Groups	849.597	933	.911		
	Total	871.241	940			
Cog	Between Groups	4.961	7	.709	.819	.571
	Within Groups	807.004	933	.865		
	Total	811.966	940			
Beheff	Between Groups	16.403	7	2.343	2.724	**.008**
	Within Groups	802.526	933	.860		
	Total	818.929	940			
Dis	Between Groups	5.922	7	.846	1.069	.381
	Within Groups	738.447	933	.791		
	Total	744.369	940			

Table 7		
Race x Gender Chart		
(1) Female		**(2) Male**
(11) White Female (WF)		(21) White Male (WM)
(12) Black Female (BF)		(22) Black Male (BM)
(13) Hispanic Female (HF)		(23) Hispanic Male (HM)
(14) Asian Female (ASF)		(24) Asian Male (ASM)
(15) American Indian/Alaskan Native Female (AF)		(25) American Indian/Alaskan Native Male (AM)
(16) Multiracial Female (MF)		(26) Multiracial Male (MM)
(17) Non Resident Female (NF)		(27) Non Resident Male (NM)
(18) Unknown Race Female (UF)		(28) Unknown Race Male (UM)

Table 8

Multiple Comparisons of Race by Gender on Question Asking

			Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
Dependent Variable	(I) Group	(J) Group				Lower Bound	Upper Bound
QA	WF	WM	-.276*	.113	**.015**	-.499	-.054
		BM	-.368*	.145	**.011**	-.652	-.084
		NM	-.565**	.192	**.003**	-.941	-.188
	MF	NM	-.761*	.329	**.021**	-1.410	-.115
	HM	WM	-.250*	.109	**.022**	-.464	-.037
		BM	-.342*	.141	**.016**	-.619	-.065
		NM	-.539**	.189	**.005**	-.911	-.167
	MM	BM	-.442*	.209	**.035**	-.851	-.032
		NM	-.638**	.244	**.009**	-1.117	-.159

*. The mean difference is significant at the 0.05 level. **. The mean difference is significant at the 0.01 level.

Table 9

Multiple Comparisons of Race by Gender on Affective Engagement

Dependent Variable	(I) Group	(J) Group	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval Lower Bound	Upper Bound
Affect	WF	BF	-.670**	.246	**.007**	-1.154	-.187
		HF	-.640**	.223	**.004**	-1.079	-.202
		ASF	-.558*	.274	**.042**	-1.095	-.020
		WM	-.408**	.113	**.000**	-.629	-.186
		HM	-.595**	.144	**.000**	-.877	-.312
		ASM	-.412*	.168	**.014**	-.741	-.083
		AM	-.673*	.317	**.034**	-1.295	-.050
		NM	-.672**	.191	**.000**	-1.047	-.297
	MF	BF	-.906*	.363	**.013**	.194	1.617
		HF	-.875*	.347	**.012**	.194	1.557
		ASF	-.793*	.382	**.038**	.044	1.542
		WM	-.643*	.289	**.026**	-1.210	-.076
		HM	-.830**	.303	**.006**	-1.423	-.236
		ASM	-.647*	.315	**.040**	-1.264	-.030
		AM	-.908*	.414	**.029**	-1.721	-.095
		NM	-.907**	.328	**.006**	-1.550	-.264
	BM	HM	-.316*	.141	**.025**	-.592	-.040
		NM	-.394*	.189	**.037**	-.763	-.024
	MM	BF	-.786**	.288	**.007**	.220	1.352
		HF	-.756**	.269	**.005**	.228	1.284
		ASF	-.673*	.312	**.031**	.061	1.286
		WM	-.523**	.188	**.005**	.155	.891
		HM	-.710**	.208	**.001**	.303	1.118
		ASM	-.527*	.225	**.019**	.086	.969
		AM	-.789*	.351	**.025**	.100	1.477
		NM	-.788**	.243	**.001**	-1.264	-.311

*. The mean difference is significant at the 0.05 level. **. The mean difference is significant at the 0.01 level.

Table 10

Multiple Comparisons of Race by Gender on Behavioral Effortful Engagement

			Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
Dependent Variable	(I) Group	(J) Group				Lower Bound	Upper Bound
Beheff	WF	NM	-.461*	.187	**.014**	-.828	-.093
	MF	BF	-0.997**	.356	**.005**	.299	1.694
		HF	-0.800*	.341	**.020**	.127	1.464
		ASF	-0.875*	.374	**.020**	.140	1.609
		WM	-.744**	.283	**.009**	-1.300	-.188
		BM	-.813**	.297	**.006**	-1.395	-.231
		HM	-.736*	.297	**.013**	-1.319	-.154
		ASM	-.859**	.308	**.005**	-1.464	-.254
		AM	-.910*	.406	**.025**	-1.706	-.113
		NM	-1.003**	.321	**.002**	-1.634	-.373
		UM	-.919*	.418	**.028**	-1.738	-.099
	MM	BF	-0.701*	.283	**.013**	.146	1.256
		WM	-0.448*	.184	**.015**	.087	.809
		BM	-0.518*	.204	**.011**	.118	.917
		HM	-0.441*	.204	**.031**	.041	.841
		ASM	-0.564*	.220	**.011**	.131	.996
		NM	-.708**	.238	**.003**	-1.175	-.241

*. The mean difference is significant at the 0.05 level. **. The mean difference is significant at the 0.01 level.