AC 2011-720: STEM SENIORS: STRONG CONNECTIONS TO COMMUNITY ARE ASSOCIATED WITH IDENTITY AND POSITIVE AFFECT IN THE CLASSROOM

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STEM Seniors: Strong Connections to Community Are Associated with Identity and Positive Affect in the Classroom

Abstract

We recently developed a conceptual model that emphasized that STEM students' connections to campus communities mediate (facilitate) academic engagement and subsequently influence the students' identification with their discipline and positive affect (feelings) toward it. Thus, the model suggests that a student's connection to community indirectly links to identification and affect. The links are indirect but important as the engineering education community discusses what is necessary in educating engineers. It has been shown elsewhere that if we want our graduates to contribute to the engineering community of practice then we must consider the interdependencies among community, learning and identity. This conceptual model will aid in that consideration.

We have just completed the first year of a multi-year, multi-university study to develop, test and understand the implications of this conceptual model. In the first year, we developed a pilot survey tool and surveyed a total of 287 students, most of whom were seniors, majoring in engineering, math and computer science at five disparate universities. The goal of the pilot survey was to test the survey tool and to accomplish preliminary assessment of the indirect impact of connection to community on both identification with the discipline and affect toward learning it. Thus, the survey included items to measure the STEM students' sense of professional identity, affect toward learning their discipline and their connection to community (sense of belonging, support, etc.) at the following levels: individual courses, academic major and the larger institution. This paper presents these survey items and the relevant results from our pilot survey.

Our pilot survey results indicate which measures of professional identity and affect are most relevant for this effort. Further, these preliminary results reveal a strong Pearson correlation ($r = 0.50$) between career identity and connection to academic major as well as between affect and connection to academic major ($r = 0.56$). There are somewhat smaller correlations to a specific classroom community ($r = 0.41$ and $r = 0.39$), and still significant, but even smaller, correlations to the larger institution ($r = 0.32$ and $r = 0.25$). Thus, students connections to academic major communities and classrooms appears to be related to the students' professional identities and affect toward learning those professions.

In subsequent years, our team will modify our survey instrument based on these preliminary findings and seek to validate the various interconnections in our conceptual model. We will look for trends corresponding to institution type as well as gender and ethnic diversity. At the same time, we will determine the qualities of the communities that best facilitate academic engagement. Eventually, we will determine how to create communities with these qualities across the broad range of higher education institutions involved in engineering education.

Introduction

A primary goal of engineering education is to prepare students for engineering practice. To be well prepared, though, students need to engage in the learning process. Engagement is fostered by positive interactions between students and their campus communities. The engagement, in turn, contributes to the students' positive affect (feelings) about their learning and supports the development of engineering identity. These hypotheses are a subset of a conceptual model that we have developed that proposes that STEM students' connections to campus communities will impact their engagement in their studies which will subsequently impact their affect toward (feelings about) and identification with the their chosen discipline (Floyd-Smith et al.)[1] This paper will discuss portions of a pilot survey instrument developed to test this model and the pilot survey results relevant to the role of connections to community in students' affect toward learning in their chosen discipline and their identification with their discipline.

At the outset we should describe what we mean by the phrase 'connection to community'. First, the community can be any community affiliated with the academic institution. Many of the relevant communities will be academic in nature, but some will be non-academic such as athletics, residence life, etc. Further, connection to community implies a sense of belonging and support in that community. Formally, in our usage, the term connection includes both belonging (a highly local sense of connection to community) and psychological sense of community (a broader connection). Both belonging and psychological sense of community (PSC or PSoC) have established measures and acceptance in the literature.

We should also discuss our use of the term 'identity'. We are specifically interested in the student's perceptions of being a part of his/her chosen discipline and the possible correlations between those perceptions and his/her connections to the classroom, major and broader university. We consider what we call professional or career identity, which corresponds to the students identification with the discipline, as well as at what we call self identity, which is the degree to which the student's sense of self is intertwined with his/her chosen discipline.

The interactions between community and identification, and, to a much lesser extent, between community and affect, are discussed in several literature sources. In the engineering education literature, the interaction between community and identification is alluded to in Sheppard et al.'s *Educating Engineers: Designing for the Future of the Field* [2]. Among other topics, Sheppard discusses the apprenticeship role of engineering education and the need for engineering students to learn by doing, to learn through teaming and interacting, and to develop their engineering identities as they engage in these activities. Although Sheppard's team does not specifically discuss affect, they do imply the importance of affect as they speak in terms of a student becoming motivated to learn. In the social science literature, psychologists Deci and Ryan[3] discuss a circular process in which a person's feelings (affect) of involvement in a group facilitate his/her capacity to internalize the values and behaviors of that group. Further, feelings of competence, support and encouragement in the group may facilitate identification with the group, thus furthering individual internalization of the group's values and behaviors. Also in the social science literature, Wenger[4] argues that the development of identity and meaning as well as knowledge formation (and learning) happen in community. Speaking to the strong interplay between community and identity, Wenger offers:

> Identity is itself an educational resource. It… address(es) a paradox of learning: if one needs an identity of participation in order to learn, yet needs to learn in order to acquire an identity of participation, then there seems to be no way to start. Addressing this most fundamental paradox is what, in the last analysis, education is all about… it is almost a theorem of love that we can open our practices and communities to others (newcomers, outsiders), invite them into our own identities of participation, let them be what they are not, and thus start what cannot be started. (p. 277)

Wenger addresses affect specifically as he discusses the emotions of participants in a community of practice. Affect is also tangential to Wenger's emphasis on 'experience as meaning in everyday life'. Taken together, the literature indicates that as students interact in communities associated with their disciplines, they most certainly begin to form their identification with the discipline; as this process continues, they become motivated by a sense that their learning and interactions are meaningful, and thus become more strongly connected to the community, resulting in a cycle whereby identity and connection to community reinforce each other within specific communities.

While the literature above clearly associates connection to community with identity in that community, other literature sources focus on the specific role of identity in engagement and learning. Sfard and Prusak[5] discuss the role of identity in learning by saying that identity enables students to tie their learning to past experiences and enables them to prepare for future ones. Because of this, Sfard and Prusak go on to conjecture that identity may in fact be necessary for learning. Their work indicates that identity development and learning interact as students develop into the 'engineer' title that they begin to adopt for themselves while students. In the engineering education literature, the Academic Pathways Study (APS) of engineering students has provided survey items for assessing student engineering identity in four areas: centrality (of engineering in the person's self image), private regard (for engineers and for being an engineer), public regard (for engineers), and identification with engineers as a group (Chachra et al.[6]). These survey items are therefore available for others interested in measuring engineering student identity.

Still other research focuses on the correlation between affect and connections to community. According to Connell[7], regardless of field, students require perceptions of competence, autonomy, and relatedness to develop successfully as individuals. These perceptions result, in large part, from the student's interactions in the classroom and curricular environments. To fundamentally nourish the development of self and sustainable identity, a student's (affective) perception of his/her competence and autonomy must be positive. These affective perceptions are developed via student engagement or relatedness to his or her social context (Connell[7]). Lee et al.[8] studied affect in an introductory electrical engineering class at a major Northwest university. They found that positive affect and positive relationships with others correlated highly to positive classroom experiences. Also, they found that students with a positive classroom experience have a more positive career outlook. Their work provides survey items for measuring overall affect, both positive and negative.

In addition to the identity survey items that have been provided by Chachra et al.[6] and affect items provided by Lee et al.[8], items corresponding to connections to community are also available in the literature. Anderson-Butcher and Conroy[9] carried out a study of community and belonging focused on youth development programs for K-12 students. The authors began with a tool used by the Boys and Girls Club of America and modified it based on statistical analysis, resulting in validated items for measuring belonging in a community. In their study, they found that belonging scores positively correlated to actual program attendance for a six month period, self reported attendance in the last week and protective factors found in communities. Belonging scores were moderately and negatively related to community-based risk factors. Lounsbury and DeNeui[10] studied psychological sense of community (PSC) at the university level. Based on data from psychology students, they developed and validated a 14-item instrument. Their study concluded that students from colleges with enrollments of less than 10,000 had higher PSC scores than students from larger institutions. Also, members of sororities or fraternities had higher PSC. Goodenow[11] developed an 18 item instrument to measure belonging, targeting early adolescents. PSC was found to substantially correlate with self-reported school motivation and to a lesser degree with grades. Thus, the literature clearly supports the importance of belonging and broader connection to community in influencing academic engagement and performance; previous research also provides validated survey items for studying multiple connections to community, which we use in the methods for this study. However, belonging and connections to community have not been specifically studied for students in STEM majors. Lack of community, though, has been associated with students leaving STEM majors: for instance, Brainard and Carlin[12] found "isolation" to be a primary reason for women to leave engineering.

Coalescing identity, affect, community and other constructs from the literature, we developed the conceptual model mentioned earlier of the pathways between a student's connection to his/her communities, his/her engagement in the learning process, and various outcomes[1]. Portions relevant to this paper are included in Fig. 1. In our model, we hypothesize that connections to community ripple outward and that strong localized sense of belonging (to class and major) tend to boost psychological sense of community (PSC). It goes outward but not inward (belonging and PSC go up together, but strong PSC does not guarantee strong belonging). Details of the development of this conceptual model can be found in Floyd-Smith et al.[1] As mentioned earlier, here in this paper we discuss portions of our initial survey tool that we are developing in order to test this model, and we include some results from our initial pilot survey of graduating STEM majors. Here we look specifically at the pilot survey items and results relevant to the pathways among connection to community, affect, and identity.

Methods

To begin validating our conceptual model, we surveyed a total of 292 STEM students among our five very disparate universities in the United States. These include a large R1 urban university in the Northwest; a rural comprehensive research university in the Midwest; a small, historically Black university in the South; a small, faith-based university in the Northwest; and a small, all-women's college in the Northeast. The students were primarily graduating seniors studying the following majors: engineering, computer science, and math. At two of the small schools, participants were recruited from the entire population of graduating seniors in the majors of interest. The two largest schools recruited graduating seniors exclusively from computer science and engineering. The fifth school recruited only from engineering. When possible, we oversampled for ethnic minorities and women.

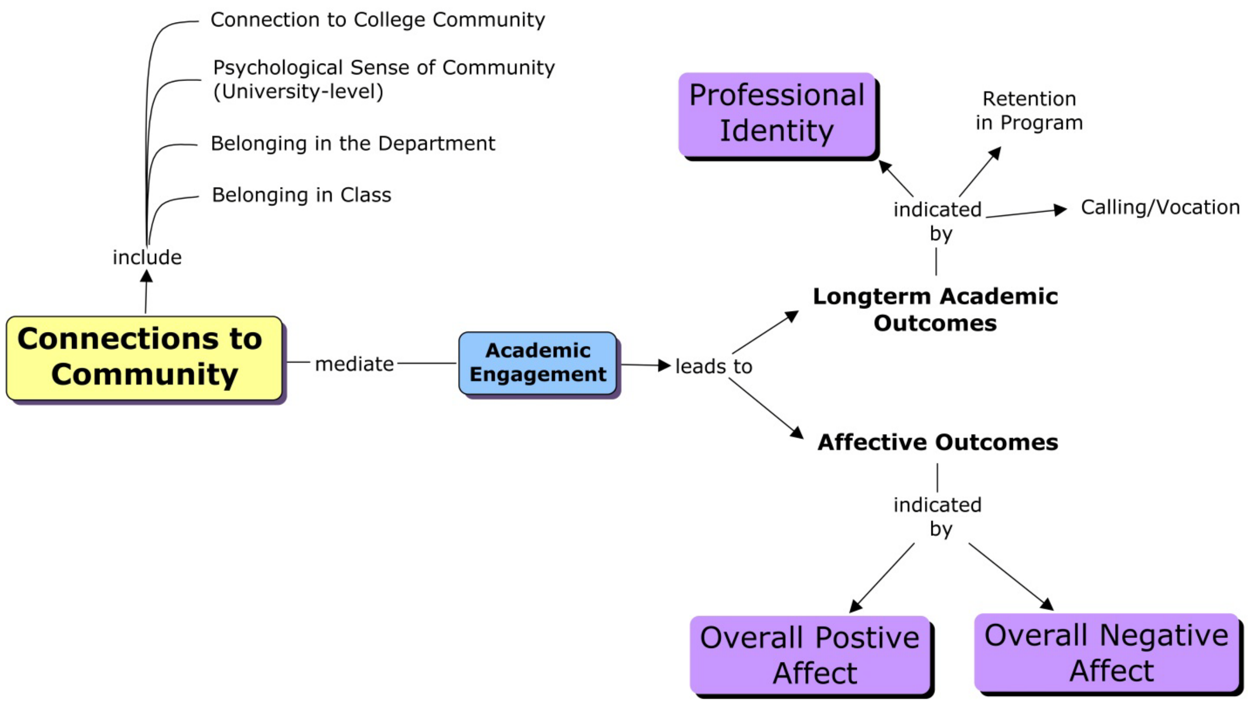

Fig 1. Relevant aspects of the conceptual model (adapted from Floyd-Smith et al.[1])

Of the 292 completed surveys, five were incomplete and thus dropped from the sample. Of the remaining 287, there were a minimum of 26 surveys at each institution and a maximum of 157. The average age of the entire sample was 23 years old. Overall there were more male (N=200) than female (N=80) participants, while seven left this (gender) item blank. Engineering majors were the most represented (N=217), followed by computer science majors (N=39), math majors (N=10), and physics majors (N=3). For the entire sample, the two most common majors were chemical engineering (N=79) and electrical engineering (N=59), and the mean self-reported GPA was 3.4. The largest ethnic group participating was White (N=183) followed by African American (N=46) and Asian (N=38). With regard to parental education, the majority of mothers and fathers were reported as having a college degree.

The pilot survey contained items (survey questions) selected for measuring students' connections to campus communities, identification with their disciplines and their positive and negative affect toward classroom learning in their disciplines. Items pertaining to Belonging to Class and Major were taken from previous studies by Anderson and Butcher[10] (reliability and validity confirmed) (and reliability again tested for STEM students by Wilson et al.[13]) The subscale items relating to Psychological Sense of Community (connection to the university community) were taken from previous studies by Lounsbury and DeNeui[10]. These items are summarized in Table I as our primary constructs (Connections to Community). Table II includes items from Self and Career Identity subscales taken from identity analyses by Chachra et al.[6] Finally, Table III, lists items for measuring overall affect, both positive and negative, as used by Lee et al.[8] to study fulfillment in engineering undergraduates. [Some items in Tables I and II were negatively worded (e.g., "I often regret that I chose to be an engineer/computer scientist"). These were appropriately reverse coded before analyzing them with the positively worded items.] We used multiple items per scale since a primary goal of this survey analysis was to assess the psychometric properties of each of the scales using factor analysis, reliability coefficients, and concurrent and construct validity estimations.

Table I. Connection to Community scales and items

a. Belonging in the Classroom

Four items selected from Anderson-Butcher and Conroy[9]	**Scale**
1. I feel comfortable in this class.	**Belong Class**
2. I feel that I am a part of this class.	**Belong Class**
3. I feel that I am supported in this class.	**Belong Class**
4. I feel that I am accepted in this class.	**Belong Class**

b. Belonging in the Academic Major

Four items selected from Anderson-Butcher and Conroy[9]	**Scale**
1. I feel comfortable in this major.	**Belong Major**
2. I feel that I am a part of this major.	**Belong Major**
3. I feel that I am supported in this major.	**Belong Major**
4. I feel that I am accepted in this major.	**Belong Major**

c. Belonging at the University

Five items selected from Lounsbury and DeNeui[10]; Two items selected from Goodenow[11]	**Scale**
1. I feel like I really belong at this university/college.	**Belong Univ**
2. I wish I had gone to another university/college instead of this one.	**Belong Univ**
3. I feel like there is a strong feeling of togetherness on campus.	**Univ Commun**
4. I really enjoy going to school at this university/college.	**Belong Univ**
5. I feel that there is a real sense of community at this university/college.	**Univ Commun**
6. People at this school are friendly to me.	**Univ Commun**
7. I wish I were in a different school.	**Belong Univ**

Table II. Identity items

Five items adapted from Chachra et al.[6]	Scale
1. Overall, being an engineer/computer scientist has very little to do with how I feel about myself.	**Self Identity**
2. In general, being an engineer/computer scientist is an important part of my self-image.	**Self Identity**
3. I am happy to be an engineer/computer scientist.	**Career Identity**
4. I often regret that I chose to be an engineer/computer scientist.	**Career Identity**
5. I identify with engineers/computer scientists.	**Career Identity**

Table III. Affect items

Eight items selected from Lee et al.[8]	Scale
How often do you feel the following in your major classes?	
1. Frustrated	**Neg. Affect**
2. Angry	**Neg. Affect**
3. Overworked	**Neg. Affect**
4. Happy	**Pos. Affect**
5. Enthusiastic	**Pos. Affect**
6. Insecure	**Neg. Affect**
7. Fulfilled	**Pos. Affect**
8. Intrigued	**Pos. Affect**

To address this goal, we generated several sets of analyses. We first used factor analysis to determine the specific items (survey questions) that were significant for each construct (i.e., connection to community, identity and affect) and scale (e.g., belonging to the university, positive affect, etc.). (See Appendix A for more details on the statistical methods and Appendix B for a glossary of terms, e.g., factor analysis.) It is standard practice to treat survey data as interval level data and use Pearson product-moment correlations to assess relationships among variables. Therefore, Pearson product-moment correlations were calculated to determine the strength of the univariate relationships between the connection to community scales and those of both identity and affect. To further understand these univariate relationships, we calculated Pearson product-moment correlations specific to engineering and computer science majors. (We did not have enough math or science majors in our sample to consider them separately.) Finally, multiple regression analyses were calculated to determine the unique contribution each variable contributed to the specified relationships (See Appendix A).

Results

Pearson correlations for the Connection to Community scales and the Identity and Affect scales are given in Table IV for the entire sample. Higher values indicate stronger relationships with the sign indicating the direction of the relationship. These reveal that the Career Identity scale is positively correlated with a student's sense of belonging to his/her major ($r = 0.50$, $p<0.001$) and to his/her sense of Belonging in the Classroom ($r = 0.41$, $p<0.001$) indicating that the higher a student's sense of belonging is in his/her major or classroom, the higher the student's career identity. The relationship was less strong but significant between Career Identity and a student's sense of Belonging at the University ($r = 0.32$, $p<0.001$), and to the student's sense of a community atmosphere at the university ($r = 0.18$, $p<0.01$). These results suggest that when a student's sense of belonging at the university or his/her sense of a community atmosphere at the university are high, the student's career identity is also higher. The Positive Affect scale correlation levels were similar with the strongest relationships being between a sense of belonging in a student's major ($r = 0.56$, $p< 0.001$) and in a student's class ($r = 0.39$, $p<0.001$) indicating that students with higher levels of positive affect also have higher levels of belonging to his/her major or class. The correlations between the Negative Affect and community connection scores were lower, but were still significantly correlated, suggesting that higher levels of negative affect were related to lower levels of belonging to the university, major or class. Self Identity had low correlation coefficients for both University Community and Belonging at the University, indicating no relationship to them. Self Identity correlations to belonging in the major and in the classroom were slightly higher but were indicative of a weak relationship between a student's belonging in the major or classroom and self identity.

Table IV. Pearson Correlation Coefficients for the entire sample

Connection to Community	Career Identity	Self Identity	Negative Affect	Positive Affect
Belonging at the University	0.32^{a}	0.04	-0.22^{a}	0.25^{a}
University Community	0.18^{b}	-0.01	-0.22^{a}	0.18^{b}
Belonging in the Major	0.50^{a}	0.13^{c}	-0.34^{a}	0.56^{a}
Belonging in the Classroom	0.41^{a}	0.10	-0.30^{a}	0.39^{a}

^{a} $p < .001$, ^{b} $p < .01$, ^{c} $p < .05$

These correlations indicate, then, that a graduating senior's sense of being an engineer or computer-scientist, identifying with engineering or computer science, and feeling positively in classes are all strongly tied to his/her sense of belonging in his/her major, in his/her classes and somewhat in his/her university. Negative feelings in classes had weaker, but significant ties to connections to communities indicating that a lack of connections in the classroom, major and university, as well as a lack of sense of campus community, correlate to more anger, frustration, etc. in the classroom. Table IV also tells us that there was not a correlation between the students' connectedness and the degree to which their chosen discipline was intertwined with their self image (Self Identity). [Multiple regression analyses revealed that, in fact, Self Identity does not uniquely contribute to the Connection to Community scales, though the other scales (Career Identity, Positive Affect and Negative Affect) do contribute uniquely to them.]

Fisher's z transformation tests of significant difference were used to evaluate possible differences between the correlational coefficients of engineering and non-engineering students as well as computer science majors and non-computer science majors. Bonferroni's correction was used to control for Type 1 error. When comparing non-engineering Pearson product-moment coefficients to those from engineering majors, many pairs were similar, however, a few were notably different (Table V). The strongest significant difference arose in the relationship between a sense of community at the university (University Community) and Career Identity $r = 0.37$ ($p < .01$) for non-engineers and $r = 0.10$ (ns) for engineers. This difference indicates a potential variation in the pattern of relationships for engineering majors as compared to non-engineering majors; a sense of community at the university correlates to a sense of career identity for non-engineers, but is inconclusive for engineering majors. This indicates that unlike the other graduating seniors, the engineering students' identification as engineers was not significantly correlated with their sense of a university-level community atmosphere. Further, the strength of a non-engineering major's self image is intertwined with his/her discipline (Self Identity) in a manner correlated to his/her sense of Belonging in the Major ($r = 0.28$, $p<0.5$), but no such correlation exists for engineering majors ($r = 0.07$, ns). On the other hand, there is a strong negative correlation between Negative Affect in the classroom and a student's sense of Belonging in the Classroom for engineering majors ($r = -.31$, $p<0.001$), but the correlation is inconclusive for non-engineers ($r = -0.15$, ns). Thus, an engineering major who feels as if s/he belongs in his/her classroom was less likely to report negative feelings (frustration, anger etc. – see neg. affect items in Table III) about the class, and vice versa. This trend holds to a lesser extent for the university level belonging and sense of community scales. Although these pattern differences are intriguing, they are very preliminary since these differences were not significant when Bonferonni's correction was used to control for Type 1 error.

Pattern differences of the Pearson product-moment coefficients for computer science majors and non-computer science majors appear in different categories than those of engineers and non-engineers (Table VI). Notably, for computer science majors, the only significant correlations for affect were the correlations between senses of belonging in the classroom and the major to positive affect, unlike the non-computer science majors in which all connections to community correlated to both positive and negative affect. Thus, for computer science majors, a strong local sense of belonging related to more positive feelings regarding the classroom experience, but did not relate to reduced negative feelings about the classroom experience. And, university level connections to community did not relate to classroom related feelings at all. In contrast, for non-computer science majors, classroom related feelings, both positive and negative, were related to both local and university-level connections to community. Again, the pattern differences in Table VI are preliminary; these differences were not significant after controlling for Type 1 error.

Table V. Pearson Correlation Coefficients for engineers (N=217) and non-engineers (N=68) (highlighted results are discussed in text)

Connection to Community	Career Identity		Self Identity		Negative Affect		Positive Affect	
	Engineers	Non-engineers	Engineers	Non-engineers	Engineers	Non-engineers	Engineers	Non-engineers
Belonging at the University	0.31[a]	0.32[b]	-0.01	0.18	-0.24[a]	-0.12	0.25[a]	0.23
University Community	0.10	0.37[b]	-0.05	0.08	-0.22[a]	-0.16	0.19[b]	0.09
Belonging in the Major	0.50[a]	0.48[a]	0.07	0.28[c]	-0.34[a]	-0.28[c]	0.55[a]	0.55[a]
Belonging in the Classroom	0.39[a]	0.48[a]	0.08	0.12	-0.31[a]	-0.15	0.36[a]	0.36 [b]

[a] $p < .001$, [b] $p < .01$, [c] $p < .05$

Table VI. Pearson Correlation Coefficients for computer science majors (N=39) and non-computer science majors (N=246) (highlighted results are discussed in text)

Connection to Community	Career Identity		Self Identity		Negative Affect		Positive Affect	
	Computer scientists	Non-computer scientists	Computer scientists	Non-computer scientists	Computer scientists	Non-computer scientists	Computer scientists	Non-computer scientists
Belonging at the University	0.16	0.32[a]	-0.04	0.04	0.04	-0.23[a]	0.03	0.26[a]
University Community	0.27	0.16[c]	0.00	-0.01	-0.15	-0.23[a]	0.05	0.20[a]
Belonging in the Major	0.59[a]	0.48[a]	0.06	0.13[c]	-0.05	-0.36[a]	0.45[b]	0.57[a]
Belonging in the Classroom	0.60[a]	0.38[a]	0.16	0.08	-0.17	-0.29[a]	0.39[c]	0.37[b]

[a] $p < .001$, [b] $p < .01$, [c] $p < .05$

Conclusion, Discussion and Next Steps

Taken together, our results indicate that a senior STEM student's connections to his/her classroom, major and university do correlate with his/her career identity and classroom affect. Further, our data indicates that the specific links and the strengths of the correlations may vary according to the discipline. Table VII summarizes the major findings from our preliminary data. The last item in the table is intriguing. From Hewitt and Seymour's Talking about Leaving (p.

48)[14] and other sources, we know that one of the biggest reasons that engineering students pursue engineering is because they are focused on the job post-graduation rather than the experience of college in general... that would explain, in part, what is going on. Engineers come in with their eyes focused on "out there" (industry) while other students are more likely to integrate into the university. An alternate explanation is that the engineering majors are overwhelmed with their coursework and have very little time to participate in campus activities.

Table VII. Summary of highlighted results

Classroom related affect (feelings)	Sense of belonging at the local levels (classroom and major) correlate to increased positive classroom-related affect (feelings) and to decreased negative classroom-related affect for the for the STEM graduating seniors, but possibly only increased positive affect for computer science majors.
	University level sense of belonging and sense of community correlate to positive classroom-related affect (feelings) for the entire sample, but possibly not at all for computer science majors.
Career Identity (Identification with chosen discipline)	A sense of belonging correlates to a sense of career identity for the STEM graduating seniors. Belonging at the local levels (classroom and major) show the strongest correlations.
	A sense of community at the university correlates to a sense of career identity for non-engineers, but is inconclusive for engineering majors.

We do consider these results to be preliminary. It is important to note that engineering majors dominated the sample and that a large portion of the engineering group was from the largest school. Thus, the pattern differences may be due to institutional differences more so than discipline specific differences. Hence, our next step, along with collecting more data, is to parse our existing data according to gender, ethnicity and institution to look for pattern differences. These should especially illuminate the complexities, such as moderating influences, involved in the data that yielded Pearson product-moment correlation values between 0.10 and 0.20. It is also important to note that these data were collected from graduating seniors. Although, these data were primarily collected for our use in developing the survey instrument for testing our model, the data do provide us substantial insight into the endpoint of our studies.

To further understand the data presented here, we also conducted focus groups with a subset of the students surveyed. We are currently coalescing and analyzing these mixed method results to help us better understand both data sets.

Meanwhile, we are beginning to collect data from sophomores and juniors in order to examine longitudinal pattern changes. The expanded data set will increase our numbers of computer science, math and science majors to improve our comparisons across the disciplines and institutions. We are also conducting focus groups and classroom observations for these sophomores and juniors. Considering the survey and focus group data together will aid us in examining the timeline over which students develop their sense of academic community and the impact that it had on their identity and possibly performance at different time points. Our goal is to first use these mixed methods to determine which communities most enable STEM students to engage their learning and why, and then to determine how to replicate the important aspects of these communities to foster professional identity and persistence.

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Appendix A -- Statistical Methods and Selected Results

The first set of analyses examined the structure of the scale items and the internal reliability of the scales. To that end, we first factor analyzed the scale items to determine if the scales had unidimensional or multidimensional structures. Factor analyses used Varimax rotation with Eigen values set at one (Tabachnick and Fidell[15]). The factor analysis was based on all the items entered simultaneously. Factor loadings were used to determine the specific items included in each construct. Factors were considered acceptable if they had high values (greater than 0.5 and crossloaded with a value of 0.39) on one factor and low values on others. The internal consistency of each scale, based on the outcome of the identified factor structure, was evaluated with Cronbach's alpha.

Factor analyses confirmed a four-factor solution for the Connections to Community scales: Belonging Class Level, Belonging Major Level, Belonging University and University Community (see Table VIII). (A Peer-Lab Group Belonging scale was dropped due to a lack of a coherent set of factor loadings.) Two factors (Positive Affect and Negative Affect) clearly emerged from the factor analysis of the affective domain, and a separate factor for career identity (see Table VIII). The factor loadings and their Cronbach alpha coefficients are presented in Table IX. The Connections to Community and Affect scales demonstrated solid reliability scores (above 0.70). The Career Identity scale was slightly lower, but approached the standard level of acceptance at 0.66.

Finally, multiple regression analyses were calculated to determine the unique contribution each variable contributed to the specified relationships. The multiple regression analyses provide evidence of the relative strength of the multiple indicators of the major constructs and their relationship to the Connections to Community. The objective of the analyses was to identify the variables that were significantly and consistently related to these outcome variables and accounted for unique variance.

A series of multiple regression analyses were calculated. The subscales for the Connection to Community domain were summed to provide a global assessment of Belonging. The predictor variables in a conceptual domain were entered simultaneously in separate multiple regression models with gender as a control variable. The results are presented in Table IX. The predictor variables are listed in the first column on the left. The dependent variable, Connection to Community is listed on the right. The asterisk indicates a significant relationship between the predictor variable and the dependent measure. Note that the specific items that are included in each scale are listed in Table VIII. As mentioned above, and shown in Table IX, multiple regression analyses revealed that, in fact, Self Identity does not uniquely contribute to the Connection to Community scales, though the other scales (Career Identity, Positive Affect and Negative Affect) do contribute uniquely to the relationship.

Table VIII. Factor loadings of items and alpha coefficients with study constructs
* corresponds to negatively worded items that were reverse coded

		Cronbach's α	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Factor 6	Factor 7
Connections to Community									
BLCl1	Belonging Class Level (4 items)	.94	.781						
BLCl2			.856						
BLCl3			.888						
BLCl4			.872						
BLMaj1	Belonging Major Level (4 items)	.92				.691			
BLMaj2						.778			
BLMaj3						.721			
BLMaj4					.821	.784			
BLUnv1	Belonging University (4 items)	.87			.631				
BLUnv2*					.822				
BLUnv4					.704				
BLUnv8*					.877				
BLUnv3	University Community (3 items)	.79						.869	
BLUnv5								.826	
BLUnv7								.621	
Professional Identity									
Ident3	Career Identity (3 items)	.66							.708
Ident4*									.557
Ident5									.712
Affective Outcomes									
Affect4	Positive Affect (4 items)	.85		.713					
Affect5				.791					
Affect7				.792					
Affect8				.740					
Affect1	Negative Affect (4 items)	.78					.792		
Affect2							.791		
Affect3							.663		
Affect6							.734		

Table IX. Pattern of significance results from multiple regression analyses predicting Connection to Community

Predictor Variables	Dependent Measure: Connections to Community
Identity	
Identity Career	.50*
Identity Self	.06
Affective Outcomes	
Negative Affect	-.21*
Positive Affect	.38*

* = significant relationship, $p < .05$;

Appendix B -- Glossary

- ***Construct:*** A complex psychological concept like belonging, commitment, engagement, intelligence and connectedness. A construct is a theoretical statement concerning some underlying, unobservable aspect of an individual's characteristics or of his internal state. Citation: "construct."[16]
- ***Factor*:** Common underlying dimension of variables in a data set. A factor can be used to explain the underlying structure of multiple variables. A factor is effectively a set of items that cluster or group together.
- ***Item*:** a test/survey question or statement.
- ***Scale*:** a set of survey items representing a construct or factor.
- ***Factor analysis*:** statistical technique that can reduce the number of variables needed to understand a construct by finding groups of variables with similar characteristics. Effectively, factor analysis enables the grouping of items into statistically significant scales.
- ***Cross-loadings*:** an item's/variable's scores for each of the extracted factors in a factor analysis. In other words, it is a measure of the degree to which one factor (grouping of survey items) is correlated to other factors. A goal is for each item to have higher loading with one factor and relatively smaller loadings on other factors.
- ***Structure*:** The way in which items are grouped across one or more factors.
- ***Unidimensional structure*:** a structure that is defined by a single construct or factor.
- ***Multidimensional structure*:** a structure that is defined by multiple constructs or factors.
- ***Cronbach's alpha*:** a statistic that is used as a measure of the internal consistency or reliability of a scale (a set of survey items). In other words, it is a measure of the degree to which each of the items in a group of survey items are known to reliably measure the same construct/phenomenon.

- ***Pearson's product-moment correlation coefficient:*** a measure of the linear association between two variables that ranges between -1 and +1. Magnitudes close to 1 indicate a strong relationship. For surveys, the correlation value must be considered relative to the number of participants. If there are many participants then a lower correlation value can be significant; whereas, for fewer participants, a much larger correlation value is need for statistical significance. Negative values indicate inverse relationships.
- ***Fisher's Z transformation:*** a transformation that converts Pearson's product-moment correlation coefficients r to a normally distributed variable z'. Once r is converted to z', the confidence interval for Pearson's correlation coefficient can then be computed.

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