AC 2007-2076: EXPANDING UNDERSTANDING OF FIRST-YEAR ENGINEERING STUDENT RETENTION AND TEAM EFFECTIVENESS THROUGH SOCIAL STYLES ASSESSMENT

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Expanding Understanding of First-Year Engineering Student Retention and Team Effectiveness through Social Styles Assessment

The retention of first-year engineering students and the development of their teamwork skills are both important concerns in engineering education.[1, 2] Factors that have been found to help predict retention and success in teams are student characteristics known as "style" (e.g., learning style, cognitive style). [3-5] One criticism of these types of assessment is that they are potentially inaccurate due to their self-reporting format. [6] The authors seek to deepen understanding of the relationship between student style, retention and team effectiveness through peer assessments of students' social styles. To that end, social style assessment and team training are discussed within the context of a first-year engineering projects course. Student retention of assessed students is also tracked into their third semester.

Previous engineering education research on style has focused primarily on learning style and cognitive style with applications in team development, student retention and the integration of teaching and learning. For example, Jouaneh reports on a study performed over a four-year period in which the performance of undergraduate mechanical engineering students on team projects was correlated with their learning styles as measured by the Brain Dominance Model. [3] Similarly, Ivy and colleagues examined the correlation between learning style and attrition in the first year. [4] Jablokow and Parker describe an investigation of the relationships between the cognitive style of undergraduate engineering students and learning preferences in the classroom.[5]

Theoretical Framework

The present investigation examines social style, which differs from the more prevalent learning style research by focusing on one's typical communications behavior in social settings. [7] Social style describes ways of *speaking and doing* in interpersonal communications — and excludes cognition, intention and private behavior. Social style theory describes communications behavior along three axes — assertiveness, responsiveness and versatility. The dimensions of assertiveness and responsiveness are displayed on a grid with versatility independently measured as a third dimension (see Figure 1).

The horizontal axis describes assertive behavior in social settings, while the vertical axis describes responsive behavior. The high (right) end of the assertiveness axis describes "telling" behavior that is bold or forceful in action and confident in opinion, while the low end of the axis describes "asking" behavior that is more hesitant in action and inquisitive in opinion. On the responsiveness (vertical) axis, the high (upper) end describes "task-oriented" behavior in which one is controlled in the expression of feelings, while the lower end of the axis describes "people-oriented" behavior that is more open or emotive in the expression of feelings. Taken together, an individual's assertiveness and responsiveness differentiate into one of four social styles:

- **Driving social style** — typically assertive and more task-oriented in teams and often described by peers as strong-willed, decisive and efficient,
- **Expressive social style** — typically assertive and more people-oriented in teams and described by peers as enthusiastic, warm and communicative,
- **Amiable social style** — less assertive and more people-oriented in teams and described by peers as agreeable, dependable and supportive of others,
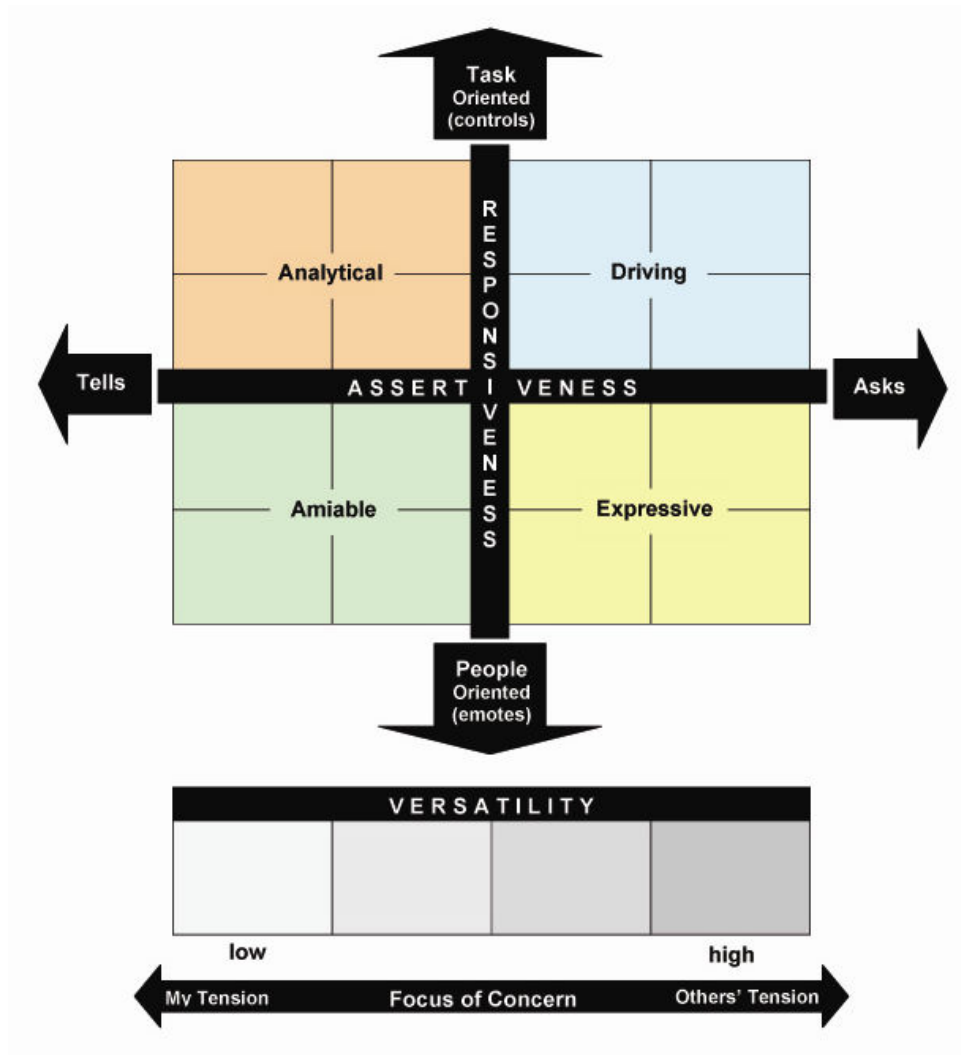
Figure 1. Social style and versatility grids.

- **Analytical social style** — less assertive and more task-oriented in teams and described by peers as serious, logical and exacting.

Social style theory incorporates two additional factors to further describe variability in interpersonal communications behavior — the dimension of versatility and the differentiation of social style into sub-quadrants to further describe an individual's secondary (or back-up) social style. For example, in Figure 1, behavior in the upper right sub-quadrant of the Expressive style is described as Driving-Expressive to indicate a person who operates primarily in the Expressive style, but displays Driving behavior in certain situations, such as when under stress.

Versatility refers to the extent to which an individual relies upon communication approaches associated with a style other than his/her own primary style to reduce the tension of other team members. For example, a person most comfortable employing a calm, amiable social style who organizes the team and drives them toward the completion of an urgent deadline would be displaying high versatility. Research has found versatility to be the social style dimension that is the most easily changed through education — and the most related to success in leadership

positions. [7] With this understanding, we have chosen to explore the social style of first-year engineering students, with the belief that awareness of one's own style, coupled with knowledge of the impact one's style can have in collaborative team situations arms students with a powerful tool to promote effective teams.

Social Style Applications in Engineering Education

Social style theory potentially has several applications in engineering education — including the areas of teamwork, diversity and assessment. The team has become an important learning mechanism in engineering education, with Capstone senior design project teams common across engineering programs and Cornerstone first-year team-based courses ubiquitous[8, 9] If teams are adopted as an engineering learning mechanism, students must be taught how to work in project teams, as success is far from assured when five first-year students are assigned a design project.[9, 10] Our experience, gained though teaching a first-year projects course during the past 12 years to more than 400 students annually [11], is that course time must be invested early in formally educating students about collaborative team behavior, and that instructors must reinforce theoretical knowledge with real-time relevant examples as students become more aware of the impact of their own behavior and communication approaches on team effectiveness.

A focus area that helps students achieve success within a team is related to diversity — that of understanding on a deeper level and through personal experience, that people employ diverse styles of working towards goals, and that no style is either right or wrong, or in fact better than others. This can become especially important during the early stage of team development known as "storming" when a team member notices that another team member is going about confronting or accomplishing tasks in the "wrong" way. [12] Another way of interpreting this is that *people like people like themselves*, because it is easy to initially relate to those whose communication style we intrinsically understand. However, just as design is enhanced through diversity of perspectives provided through gender, ethnicity, and cultural differences, we postulate that diversity in social style contributes to design both through providing different perspectives and through strengthening team productivity. Social style theory offers an excellent framework for team members to learn about different communications styles, their strengths and weaknesses, the conflicts that can result from opposing styles (e.g., Analytical vs. Expressive) when lack of understanding drives unfounded or hurtful judgment, and — perhaps most importantly — the need for versatility in adapting one's own style to the style of other team members.

A third area for application of social style in engineering education is in the area of assessment. One criticism of many of the assessment tools common in engineering education is their self-reporting format. Concerns have been raised about the accuracy of self-reports. [6] Social style theory echoes these concerns and encourages peer assessment as the best method for assessing social style. Peer assessments of social style are merged to provide a more accurate assessment of style than a single self rating. Social style researchers have found self-assessments of style to differ from peer assessments half of the time. [7] Social styles assessments were developed in industry settings during the 1960's, and the current peer-assessed format has demonstrated acceptable internal consistency, reliability and evidence of construct validity. [13]

Social Style Training in a First-Year Engineering Projects Course

For the present study, social style training was conducted in the University of Colorado at Boulder's First-Year Engineering Projects (FYEP) course, a large, multi-section, team-based, engineering design projects course for first-year students. The course, taken by more than 400

students annually, is required by the mechanical, aerospace and environmental engineering programs and is an elective for all other programs and "open option" students who have not yet chosen an engineering major. FYEP students are typically assigned to a five-person design team at the beginning of the class for the duration of the semester. Teams work on a brief introductory project and spend the bulk of the semester on a main design project.

While we employed an informal social style self-evaluation in workshops in the First-Year Projects course for 12 years, we did not compile results across course sections and years. Our formal use of *peer assessment* was piloted in Fall 2005, with first-year students' retention into Fall 2006 evaluated. Four sections of the course participated in a team-based social style workshop conducted after the introductory project was completed. Prior to the workshop, students evaluated their team members via an online social style assessment form, with 92 valid peer assessments collected. After peer assessments were completed, the social style dimensions and team results were reviewed during a one hour, in-class social style workshop. During the workshop, individual team members plotted their scores on a blank grid to determine the distribution of social style within their team.

A discussion on versatility followed, and individual versatility scores were distributed to team members. Teams then collectively discussed how versatility could be increased within their team using the following guidelines:
- When working with the Driving style… Stick to business. Be prepared. Keep it brief and to the point. Focus on the here and now.
- When working with the Expressive style… Ask for opinions and ideas. Collaborate and be engaged. Demonstrate emotion. Get it done. Look to the future.
- When working with the Amiable style… Listen and be responsive. Avoid conflict. Be caring. Show respect. Stay with the present.
- When working with the Analytical style… Be clear and concise. Be organized. Avoid emotional arguments and pep rallies. Use historical results to inform decisions.

The final portion of the workshop asked students to complete a worksheet demonstrating successful teamwork through a social style framework. Different components of effective teamwork were presented as follows:
- Driving — Setting goals, meeting deadlines, dividing up the workload,
- Expressive — Brainstorming, communicating with others, assigning roles, action,
- Amiable — Working cohesively, ensuring equal participation, resolving conflict,
- Analytical — Critiquing the design, troubleshooting design problems.

Student teams were asked to use this list to analyze their teamwork and pick the greatest strengths and challenges for their team. Each team had to develop a plan to meet one challenge, and team members reported on how they could be more versatile in helping the team meet the challenge. Plans were turned in to the instructor at the end of the workshop.

Social Style Assessment Results

Our pilot data set of 92 students is small, with results necessarily descriptive and not yet sufficient for statistical analysis. The social style breakdown of students in the first-year projects course is presented in Figure 2. Students with an Expressive style made up the majority (33%), while students with a Driving style were the least frequently represented (17%).
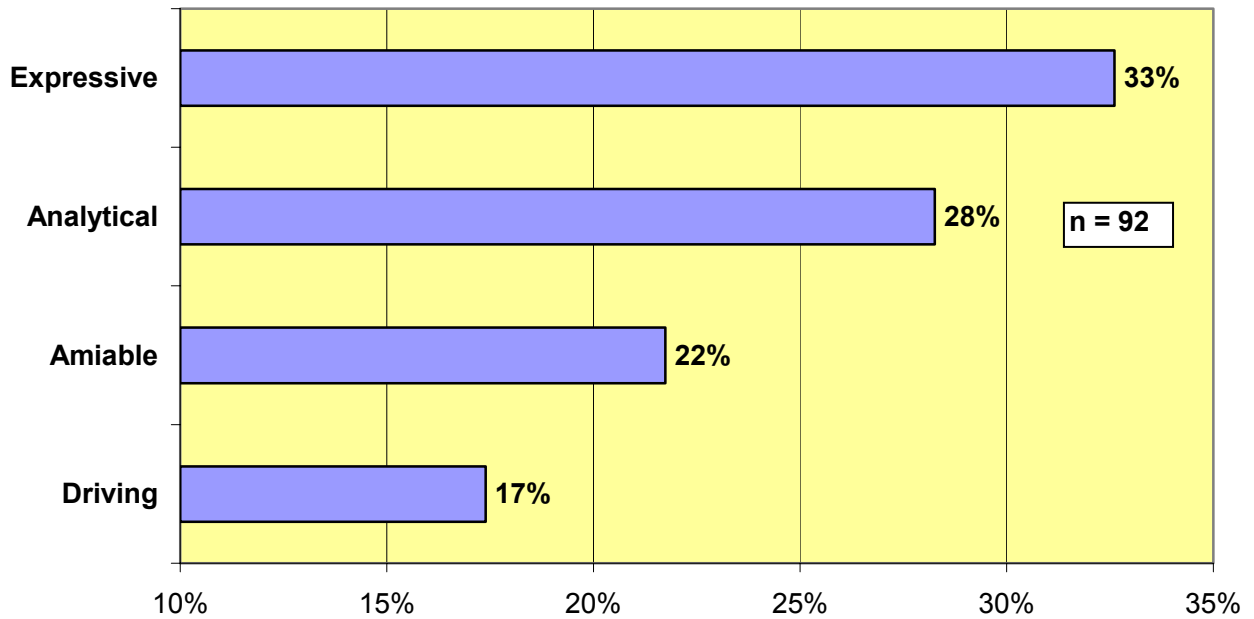
Figure 2. Social style distribution in a sample of First-Year Engineering Projects course students.

Versatility results for the first-year students are presented in Figure 3. For the most part, our engineering students exhibited low versatility, with 78% in the low and mid-low categories.
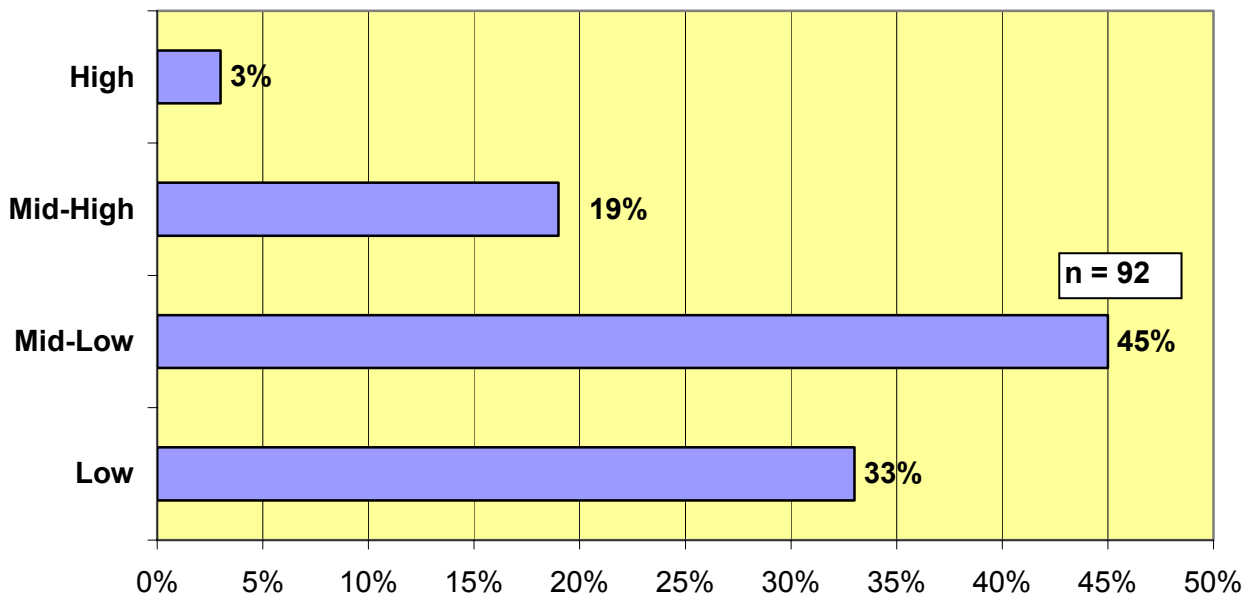

Figure 3. Versatility representation in a sample of First-Year Engineering Projects course students.

Retention Analysis

Students who participated in the social style training were tracked into their third semester to evaluate early retention by both social style and versatility. While our small sample does not inform broad conclusions, the retention results suggest potentially interesting findings. Figure 4 depicts third-semester retention of the 92 first-year students by social style. The largest numbers of retained students were those with a Driving style, while the fewest were those with an Amiable style. Figure 5 depicts third-semester retention of FYEP students by versatility. Larger numbers of the already well represented students with low versatility were retained while greater numbers of students with high versatility left engineering.

Discussion

On average, students in the FYEP course tended to have Expressive and Analytical social styles, coupled with low versatility. The large representation of students with an Expressive style is interesting, as engineering stereotypically attracts more task-oriented individuals. However, these findings reinforce what we have anecdotally observed during the past 12 years of conducting social style workshops within the first-year course — an increasingly more even distribution of social style, with a much larger representation of students employing the people-oriented Expressive social styles. Once an anomaly, the Expressive style is broadly represented. One interpretation of these results is that the interactive, team-oriented nature of the course is more attractive to students with an Expressive style than the typical individual-based engineering course. The low versatility ratings for the FYEP students were expected, as low versatility has been a common complaint about engineering students by engineering employers, and was one factor behind ABET's EC 2000 and the revision of programmatic requirements to include a greater emphasis on professional skills. [8, 10]

In the retention analysis, the more assertive students — those exhibiting the Driving and Expressive styles — had a higher rate of retention (Figure 4). Perhaps this reflects the goal orientation of more assertive people. High retention rates for students with a Driving style were not surprising, as these folks make decisions early and tend to stick by their decisions. Higher retention rates for students with an Expressive style were perhaps somewhat surprising, as these folks are more likely to change courses to follow new dreams. Here again, the interactive nature of the FYEP course may have helped with the retention of students with an Expressive style. Alternatively, those with an Amiable social style — perhaps the most people-oriented of our students — were more likely to leave engineering after their first year. Perhaps the needs of these shy, inquisitive, people-oriented individuals are unmet in the first year and in the FYEP course and lead them to seek other options for their career goals.

Students with lower versatility scores were more likely to be retained into their sophomore year. This may be good news from a numbers perspective, in that our students overwhelmingly were characterized as having low versatility. However, the loss of greater numbers of students exhibiting high communications versatility (already poorly-represented at 22%) is a disturbing finding for engineering, as this would seemingly lead to a less diverse group of students persisting in engineering, possessing fewer of the honed communications skills demanded by the contemporary engineering profession. Furthermore, differential retention of students exhibiting lower versatility in communications style begs the question as to whether this lower versatility
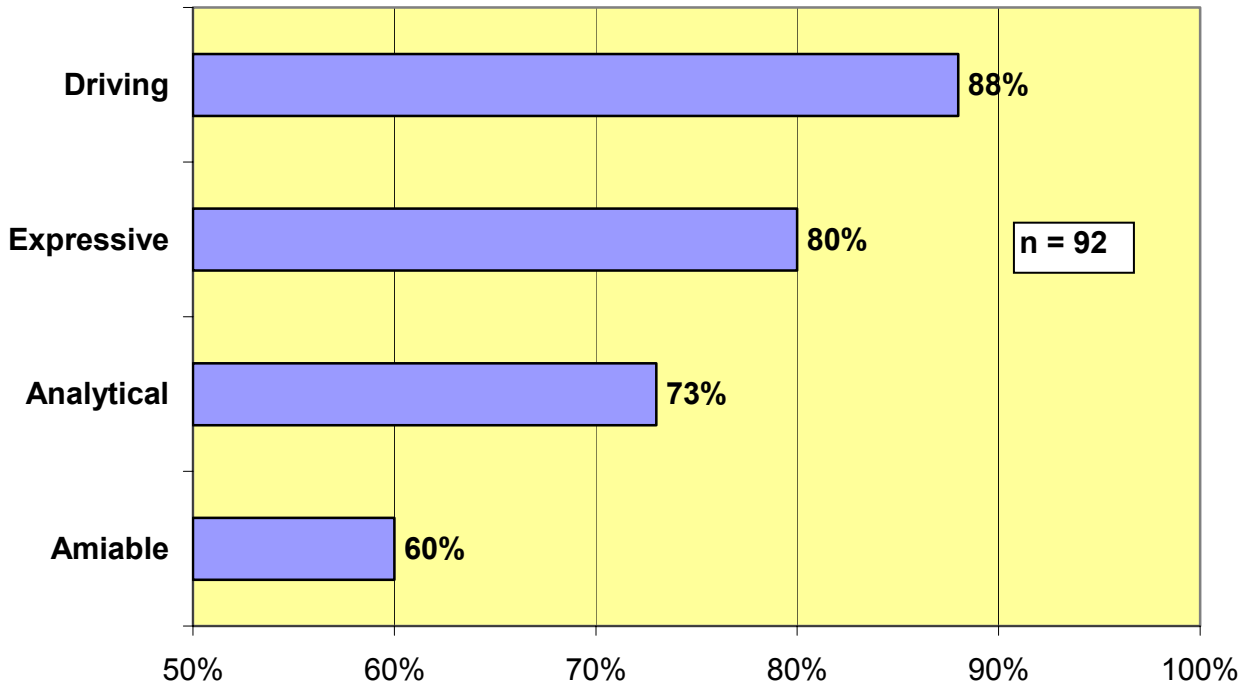
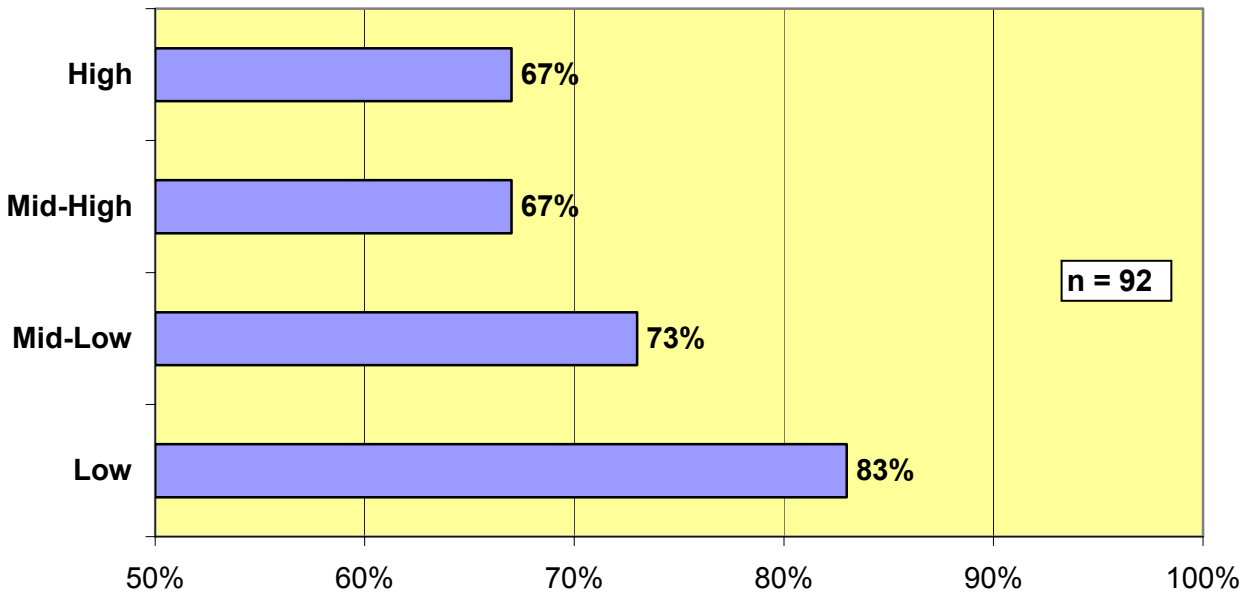Figure 4. Third-semester retention of students by social style.

Figure 5. Third-semester retention of FYEP students by versatility.

extends to other areas of engineering performance (cultural awareness, ability to be effective under rapidly changing conditions, etc.) with broader implications for the profession. Our results also imply the importance of making engineering students more aware of the value of communications versatility in the practice of engineering and the need to help raise the level of versatility and collaboration among students.

Future research on communication style among first-year engineering students is underway. Greater numbers of profiles are needed to statistically determine real differences, if any, in retention by style and the impact of gender and ethnicity on the retention of students with various social styles. Also, additional research is needed to determine the impact of social style training on student effectiveness. Qualitative research will be conducted to gather feedback on students' experiences of social style instruction and to determine whether students with different styles differentially experience engineering design curricula. Finally, additional longitudinal investigation of students will be conducted to determine social style patterns as students move through the engineering program.

References

1. Wu, J.C. & Chang, P.F. *Effectiveness of Problem-Solving and Teamwork Skills for Cultivating Technological Creativity Within a Team-Based Design Course*. in *ASEE Conference Proceedings*. 2004. Salt Lake City, UT.
2. Grose, T.K., *Trouble on the Horizon*. ASEE Prism, 2006: p. 26-31.
3. Jouaneh, M.K. *A Study Of Learning Styles and Team Performance*. in *ASEE Conference Proceedings*. 2005. Portland, OR.
4. Ivey, S., et al. *Learning Styles and Freshman Attrition: What are the Links?* in *ASEE Conference Proceedings*. 2005. Portland, OR.
5. Jablokow, K & Parker, P.J. *Cognitive Style and Learning Preferences in Engineering Undergraduates*. in *ASEE Conference Proceedings*. 2002. Montreal, Canada.
6. Thompson, R.S. *Relative Validity of Peer and Self-Evaluations in Self-Directed Interdependent Work Teams*. in *FIE Conference Proceedings*. 2001. Reno, NV.
7. Merrill, D.W. & Reid, R.H. *Personal Styles & Effective Performance*. 1999, New York: CRC Press.
8. Sheppard, K., Dominick, P.& Aronson, Z. *Preparing Engineering Students for the New Business Paradigm of International Teamwork and Global Orientation*. International Journal of Engineering Education, 2004: p. 475-483.
9. Chan, M.Y. & Lau, M.Y. *How Does 'Group Project' Facilitate Students' Skills in Learning?* in *ASEE Conference Proceedings*. 2005. Portland, OR.
10. Feland, J.M. *Building Teammates: Bringing Better Team Skills to Design Courses*. in *ASEE Conference Proceedings*. 2002. Montreal, Canada.
11. Carlson, L.E., & Sullivan, J.F., *Exploiting Design to Inspire Interest in Engineering Across the K-16 Engineering Curriculum*. International Journal of Engineering Education, 2004: p. 372-378.
12. Doré, S. *Use of Personality Type as a Means of Team Building*. in *ASEE Conference Proceedings*. 2002. Montreal, Canada.
13. Mulqueen, C.M., *Social Style Profile - Enhanced, Technical Report: Development, Reliability and Validity*, TRACOM Corportation: Highlands Ranch, CO.