"BUILDING COMMUNITIES OF USERS REVISITED"
A Longitudinal Follow-up of how learning style preferences affect performance and retention of non-majority students in Engineering

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Polytechnic University is an urban Science and Engineering school with substantial enrollments of non-majority students. Recent efforts at Polytechnic have focused on increasing enrollments of minority women enrolled in two year college physical science and pre-engineering programs to transfer into four year engineering B.S. programs.

A new "core curriculum" required for all entering freshmen in engineering disciplines, and encouraged for minority transfer students, emphasizes "hands-on" laboratory based learning, engineering and mathematics "up-front" on a need to know basis, cooperative learning, and the development of oral and written communication skills. Preliminary evaluation of the "core" for 144 entering students in fall, 1993, demonstrated that while most students prefer the new approach, women and/or Black and Hispanic students are significantly more enthusiastic about cooperative learning, hands-on learning, and peer tutoring; and less enthusiastic about "traditional" lecture-based teaching and learning. These students also show differences in learning style preferences as assessed by the Myers-Briggs Inventory.

This paper presents longitudinal follow-up data for the above sample of 144 students entering Polytechnic in fall, 1993, and an additional 196 students entering in fall, 1994. Data include course performance and grades in the new core and in more "traditional" engineering and science courses, course evaluations, and learning style preferences as assessed by the Myers-Briggs.

1. INTRODUCTION:

Stereotypes of computing in engineering, science, computer science, and design fields often convey images of social isolation, competition, and an inability or unwillingness to work with other people (2,3). In fact, those who have been fortunate enough to overcome these stereotypes discover that IT has opened a whole new world of professional and nonprofessional communities of users. Students at all levels in education, and especially those students already enrolled in an engineering or design field at the postsecondary level, need to become aware of the realities of the scientific and technical workplace where teamwork, and related leadership and communication skills have become increasingly important (1).

Women and minority students are of special concern in relation to the above. Women engineering students entering the workplace today are more likely to lack a set of experiences that come from working in teams (4). Women and minority engineering undergraduates are also less likely to have acquired computer-based experiences at the precollege level.

Polytechnic University, an Engineering and Science school located in downtown Brooklyn (NYC), offers an excellent opportunity for testing strategies for improving access to computing and hands-on technology at the earliest possible moment in an entering student's postsecondary career. More than 50% of all entering students at Polytechnic are economically disadvantaged graduates of urban inner city high schools; 26% are African-American and Hispanic; 17% are women; and another substantial proportion (over 30%) are international students from third world countries.

Although Polytechnic students have elected to pursue careers in engineering and science, on a questionnaire survey of entering student's previous computer uses and skills, a surprisingly high percentage (21%) stated that they had never used a computer. At the other extreme, 10% were highly sophisticated computer users, while the majority fell somewhere in-between. Unfortunately, some but not all women and minority students were over-represented on the lower end of this distribution.

At Polytechnic, a new hands-on laboratory course (EG 101: An Introduction to Engineering) is required of all entering engineering students in the first semester of their freshmen year. The course, consisting of 11 weekly laboratory projects, is structured so that students collaborate in teams (2-3 students) on each project. All of laboratory projects in the course are computer based: students must use the computer as a writing tool, a tool for data analysis, and a scientific measuring device and simulator. A course outline for EG101-An Introduction to Engineering is attached as **TABLE 1.**

At the beginning of the course, women students are assigned to teams which include at least one other female student. However, as the semester proceeds, all students in each section (18 - 20 students per section) eventually work with all of the other students in that section.

Another important feature of EG101, An Introduction to Engineering, is the use of student peer counselors and tutors (Juniors and Seniors) as the lab instructors for the course. These peer counselor-tutors are carefully selected and trained (They have to complete all of the laboratories and attend lectures on related topics). They have proved to be one of the most popular aspects of the course.

This paper presents results from a research evaluation of the effects of the team approach and learning style preferences in An Introduction to Engineering course for all students entering in fall, 1993 at the Brooklyn campus (n=143) and an additional 196 students entering in fall, 1994. These students are compared with the 1992 entering class who did not participate in the new core curriculum including EG101 (n=247). Questions to be addressed include: (1) Do women and minority students enter at a disadvantage in terms of previous knowledge and skills?; (2) If so, do these students "catch up"and what helps them to do so?; (3) Do they express different attitudes about the course? Are they more likely to prefer the team approach in comparison with others in the course?; (4) Do women and minority students have different learning style preferences and how do their learning style preferences affect course and overall GPA performance?; (5)How has the Introduction to Engineering course and the freshmen core curriculum affected retention rates for different

populations of students?

2. METHODOLOGY:

Subjects are all entering freshmen students enrolled at the Brooklyn campus of Polytechnic University in EG101-An Introduction to Engineering in fall, 1993 (n=143) and fall, 1994 (n=196). These students are compared with students entering in fall, 1992 (n=247). In addition to descriptive data (age, sex, ethnicity, high school records and entering SAT scores), measures to be used for data analysis include:

1. A **Previous Computer Uses and Skills Questionnaire** administered to all entering EG101 students during the first week of EG 101. This questionnaire was quite detailed in that it asked not only about overall computer experiences and skills (non-existent to excellent) but about knowledge of specific software packages and programming languages. Students were also asked about computer access (Do you own a PC? (50% did)) and preferred computer uses (Computer games scored the highest!).

2. A **Course Evaluation Questionnaire** administered during the last week of class. This questionnaire asked for student evaluations of all aspects of EG101 including quality of instruction (instructors and laboratory assistants in all sections) and assessments of each individual laboratory project and lecture. It also included questions concerning cooperative learning ("Did you enjoy working in teams?" "Do you believe that working in teams helped your learning and performance in the course?"). All questions were based on a scale of 1 - 10.

3. Student **grades** in EG 101 and in other related freshmen courses including the Introduction to Programming course (PASCAL) which is taken concurrently with EG101, and math, physics, English, and chemistry.

4. Student's **Preferred Learning Styles** as assessed by the Myers-Briggs Type Indicator (Form Q) (5) administered after the final examination for EG101 in December, 1993 and 1994.

3. RESULTS:

Over the first year of the introduction of the course curriculum and the Introduction to Engineering Course, retention rates improved by 50%: In 1992, 30% of the students left at the end of the freshmen year. In 1993, only 15% of the entering freshmen class left Polytechnic at the end of their first year. (Obviously, 1994-1995 retention rates remain to be assessed).

Students varied widely in terms of self-rated previous computer knowledge and skills. African-American and Hispanic women scored highest on self-rated previous computer-related knowledge and skills mean = 6.43): Asian-American women scored lowest on such skills (mean=3.55). In contrast, amongst the men, African-American males scored the lowest on self-rated computer knowledge and skills (mean=4.26) and white males scored the highest (mean = 4.89).

In 1993-1994, women in general were significantly more positive about the overall quality of instruction in the Introduction to Engineering (EG101) course, and about the contribution of the student laboratory assistants to the course. The laboratory assistants were perceived as being well-prepared and helpful by both women and minority students. In fact, in 1993-1994 minority students (African-American and Hispanic students-both male and female) were significantly more positive about the quality of instruction in EG101, and about the benefits of working in teams. In 1994-1995, the above aspects of EG101 continued to be the most popular aspects of the course, but were so well liked by everyone that there were no significant sex or ethnic differences.

There were no significant correlations between overall course grades (GPA), grades in EG101, and preferred learning style. There were also no significant sex or ethnic differences in terms of overall academic performance.

Preferred learning styles as assessed by the Myers-Briggs varied considerably amongst the students in the course (See TABLE 2 and TABLE 3). Learning styles also varied amongst the 1993-94 and 1995 entering classes.

The majority of students in both classes do not fit a traditional engineering "type" although they do tend to be "Thinkers (rationalists)" as opposed to "Feelers"; and Sensors (sense data oriented) as opposed to Intuititive (N). Women students are significantly more "Thinkers" than are men, however.

Women students are also more likely to be Extroverts than Introverts, and somewhat more theoretical (P) than results-oriented (J). This means that they are more likely to resemble research scientists than engineers. But, fewer than 44% of the students fit an engineering or a research scientists' profile on the Myers-Briggs.

4. CONCLUSION:

Formal strategies to enhance opportunities for teamwork, cooperative learning, and hands-on learning may be especially beneficial for "non-traditional" students in engineering and technology, but would appear to be helpful and appreciated by even the majority of students in engineering and science today. By offering students a variety of classroom and learning environments, students with different learning style preferences and skills may have a better opportunity to discover what best fits their own strengths, needs, and weaknesses.

REFERENCES

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TABLE I

EG101 - INTRODUCTION TO ENGINEERING
FALL 1993 SCHEDULE (EXAMPLE)

Section X

LECTURE (Auditorium)	LABORATORY (RM 116)	RECITATION (107)
Time: 12PM-1PM	Time: 9AM-12PM	Time: 9AM-10AM
Mon Sep 13 [Prof. Kelly] 0. Course Introduction	Thurs Sep 16 [Prof. Kelly] 0. Laboratory Introduction WP/ Labview	Tues Sep 21 0. Excel
Mon Sep 20 [Prof. Kelly] 1. Presentation of Engineering Data	Thurs Sep 23 [Prof. Pagdadis] 1. Take A Device Apart & Describe It Work in pairs; Written report by team	Tues Sep 28 1. Oral Reports on Lab 1
Mon Sep 27 [Prof. Hunt] 2. Putting a Robot to Work	Thurs Sep 30 [Prof. Hunt] 2. The Programmable Robot Part I Work in pairs; Independent written reports	Tues Oct 5 2. Oral Reports on Lab 2
Mon Oct 4 [Prof. Hunt] 3.The Robot Revisited	Thurs Oct 7 [Prof. Hunt] 3. The Programmable Robot Part II; Work in pairs; Independent written reports	Tues Oct 12 3. Oral Reports on Lab 3 Quiz 1 on Lectures 1-3
Mon Oct 11 [Prof.D'Antonio] 4. How Things Break	Thurs Oct 14 [Prof. Pagdadis] 4. Design Failure: Cause & Effect Work in pairs; Independent written reports	Tues Oct 19 4. Oral Reports on Lab 4
Mon Oct 18 [Prof.McShane] 5. Standards & Design	Thurs Oct 21 [Prof. Scarl] 5. Boom Construction Competition Work in pairs; Written report by team	Tues Oct 26 5. Oral Reports on Lab 5 Submit Excel Assignment
Mon Oct 25 [Prof. Kelly] 6. Measuring Distances	Thurs Oct 28 [Prof. McShane] 6. Distance Measurement Work In pairs; Written report by team	Tues Nov 2 6. Oral Reports on Lab 6 Quiz 2 on Lectures 4-6
Mon Nov 1 [Prof. Scarl] 7. Vibration, Waves & Spectra	Thurs Nov 4 [Prof. Wong] 7. Vibrations, Waves & Spectra Work in threes; Independent written reports	Tues Nov 9 7. Oral Reports on Lab 7
Mon Nov 8 [Prof. Voltz] 8. Digital Electronics	Thurs Nov 11 [Mr. Rodriguez] 8. Digital Design Work in threes; Written report by team	Tues Nov 16 8. Oral Reports on Lab 8
Mon Nov 15 [Prof. Otugen] 9. Laser Technology	Thurs Nov 18 [Prof. Cassara] 9. Fiber Optics Communications Work in threes; Independent written reports	Tues Nov 23 9. Oral Reports on Lab 9 Quiz 3 on Lectures 7-9
Mon Nov 29 [Prof. Kumar] 10. Heat: Problems & Challenges	Thurs Dec 2 [Prof. Scarl] 10. Thermal Insulation Competition Work in pairs; Written report by team	Tues Dec 7 10. Oral Reports on Lab 10
Mon Dec 6 [Prof. Kelly] 11. Overall Perspectives	Thurs Dec 9 11. Make-up Lab Submit Labview Assignment	
Mon Dec 13 12. Guest Speaker		

August 13, 1993

TABLE 2

* MYERS-BRIGGS * 1993-94

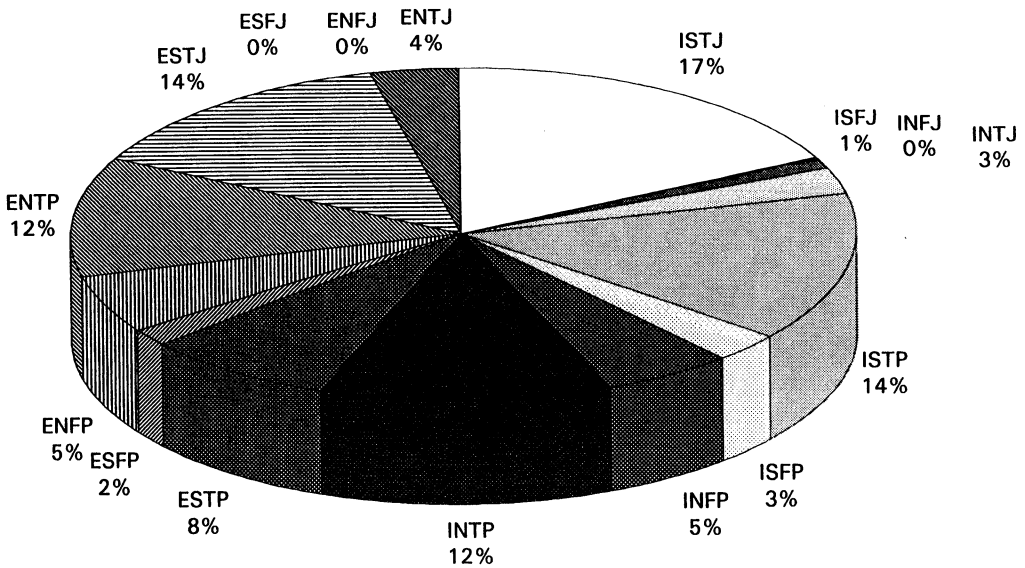

TABLE 3

*MYERS-BRIGGS * 1994-95