The Role of Myers-Briggs Type Indicator in Electrical Engineering Education

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Abstract: In this paper, the properties of Myers-Briggs Type Indicator and its application to electrical engineering education are addressed. In recent years, many engineering schools witnessed a much more diverse cohort of engineering students at both the undergraduate and graduate levels. The different levels of performance of the students were sometimes attributed to factors such as cognitive ability and background preparation. However, a closer examination of the student characteristic indicated a third factor might play a significant factor in academic success. The use of Myers-Briggs Type Indicator (MBTI) provided an extra analytical dimension. From the MBTI test data and course grades, it is concluded that the "learning patterns" play a significant role in student performance and specifically, in relations to issues such as learning environment, dissemination methods, and teamwork. Based on the combined results, a number of recommendations are brought forth for improving curriculum design and student assessment.

Keywords: Myers-Briggs Type Indicator, learning pattern, team work, curriculum design, academic performance

1. Introduction

Engineering differs from most other education fields in that the graduates are expected to be able to transform their classroom experience into the industrial environment which requires critical thinking, design abilities, team-work, management skills; in additional to fundamental scientific/engineering knowledge. The definition of a qualified graduate, from the educational institute's perspective, should reflect the student's ability to thrive in the industry. Standard classroom evaluation is heavily based on individual paper accomplishments: assignments, quizzes, exams, term projects, etc. While these are effective measures, a serious gap remains in assessing the student's ability with respect to the abovementioned industrial criteria. Traditionally, electrical engineering education appeals to a focused group of candidates: those with strong analytic skills. However, with the changes in technological integration, the influx of "non-traditional students" into the EE degree programs poses special challenge to the curriculum design and student assessment processes which are further affected by the following conditions:

- Many EE courses are theoretically oriented with little or no experimental work.
- Assessment is dominantly based on assignments, examinations, and "paper" projects.
- Part-time students constitute a significant portion of the student body.

Over the past decade, many observations and comments about the changing characteristics of EE students, have been made. Specifically, it is generally considered that the students are not as "good" as they used to be. However, It has also been observed that the best students, in terms of indicators such as GPA, are not always the ones to excel in their careers.

The central issues facing academic institutions are then:

- How to assess student performance with respect to broad-spectrum academic/industry benchmark.
- How to provide a learning environment so that the students can realize their full career potential.
- How to improve team-work and communication skills.

Over the years, a widening decorrelation between theoretical and experimental performances is observed with the class grades resulted in a bimodal distribution. Preliminary analysis quickly revealed that this decorrelation trend has less to do with gender, ethnicity, or the average GPA of the class. Rather, the learning patterns of the students play a major role in determining academic success. It is therefore of significant interest to profile the learning patterns in a coherent manner. Among a number of the available learning style inventories (Kolb Learning Styles Inventory, Personal Style Inventory, Grasha-Riechmann Student Learning Style Scales, Auditory- Visual-Tactile/Kinesthetic Learning Proclivity), the MBTI Inventory is one of the most appropriate instruments that the educators can adopt to better prepare future engineers with technical skills, knowledge and professional qualities to meet the market demands. MBTI use the language less abstractive to majority of the student population and its application could be extended beyond education/learning style implication. Corporate consultants often use MBTI for leadership/management training and team building. The authors favor its versatility and consider its long term effects which students can continue to benefit even in their future professional careers. The Theory Y approach accepted by modern Organizational Behavior clearly indicates that employees tend to work hard and increase productivity when appropriately trained and recognized. [1] A brief discussion of the MBTI is given in Section 2 of this paper.

A number of results describing the role of MBTI in engineering education have been reported. For example, the use of MBTI in curriculum analysis and design was discussed in [2]. In [3] experimental confirmation of the relationship between MBTI, various psychometric factors, and categories of cognitive activities was obtained. MBTI was also used as a part of a profile analysis to predict student performance in a first year chemical engineering course [4] . In [5] the use of MBTI for team formation was discussed.
In [6] a group problem-solving model, based on MBTI, was introduced to address student deficiencies in problem solving skills and teamwork. MBTI was used to predict academic success and subsequent career satisfaction for engineering students in [7]. In [8], the authors used MBTI as part of a student portfolio for biological engineering students to initiate student-centered learning.

2. Myers-Briggs Type Indicator and its applications
The MBTI Personality Inventory is based on Jung's theory indicating how the interactions among the preferences of perception and judgment (mental functions) and attitudes of orientation toward external world would result in 16 distinctive personality types. The MBTI is most often used by educators to identify students' learning styles, by student development professionals to provide career guidance and to improve student retention, as well as by management consultants to develop leadership and group dynamic/ teamwork training among employees.

The MBTI Personality Inventory identifies two opposite preferences for each of the four scales. 1) the EI scale, where does one prefers to focus one's attention? People who prefer extraversion tend to direct energy in the outer world, communicate more by talking, like action and variety. People who prefer introversion tend to be reflective observational learning type, like lecture format. 2) the SN scale, how does one acquire information? Sensing type tends to have concrete experiential learning and/or abstract sequential learning styles with high factual retention. Intuitive type, on the other hand tends to be abstract conceptual learner, high in academic comfort, reflective judgment and likes self directed learning. 3) the TF scale: how does one make decisions or draw conclusions? Thinking types tend to be both abstract conceptual and sequential learner and have a talent for analyzing a problem or situation. Feeling types tend to be concrete experiential learner and/or abstract random learner. 4) the JP scale, how does one orient toward the external world? Those who prefer judging tend to be abstract conceptual learner, like structure and motivation in learning, high in fact retention and academic comfort. Those who prefer perceiving are more likely to show concrete experiential learning style, active experiential learning and collaborative learning.
According to [9], the SPs and the SJs each comprise roughly 38 percent of the population in the United States, while the NTs and the NFs comprise 12 percent of the population respectively. In this study sample, there are 6 NTs, 1 NF, 15 SJs and 5 SPs. SJ types (55% of this study) are often labeled as "good student" in academic setting because they valued hard work and demonstrated dependability. They do better in theory class when they can follow outlines and if the teacher pointed out how the theory apply to the real world before class. The research indicates that as long as what they are studying are facts or procedures, they are comfortable. For the SJs to speculate, invent, or improve, they often fail to deliver satisfactory performance despite their studious dependability. SP types (19% of this study, despite its 38% representation in general population) are least

represented in higher education and tend to have lowest correlation between academic ability and GPA. NT types (22% of this study) are largely represented in science and engineering fields. A successful engineering professional in the twenty-first century requires a commitment for life long learning, quality of teamwork spirit and ability for project management. MBTI Inventory results provide individuals with avenues for self-awareness and possibilities for human growth and professional development. To respond to the popular request for accountability in higher education and partnerships with business community the graduate engineering programs are encouraged to design curriculum that would address these concerns. The MBTI Inventory would be one of the instruments that the educators can adopt to better prepare future engineers with both technical skills, knowledge and professional qualities to meet the market demands. Recent research [10] identified three factors which affect the quality and quantity of students' learning. They are 1) native ability, 2) background, 3) match between their learning style & teaching style. The educators have no control over the first two factors; however, MBTI types give the teacher a framework from which one could design techniques that will fit the students. It is never the authors' intent to suggest restructuring the classroom to meet the needs of each learning style. The focus of this application is to include broad enough range of activities and approaches so that no one type of students feels completely left out [11]. Applying the MBTI typology in electrical engineering classes will not only address the concerns of fundamental "mismatch" between the preferred styles of faculty and those of students but also enable educators to accomplish the following benefits:

- Develop curriculum to support and challenge each type.
- Facilitate the learning process of team project by recognizing individual strengths and introducing the elements of complementary working styles among opposite types.
- Adopt a holistic approach in assessment that would warrant appropriate and fair evaluation of student performance.

As for engineering students, they would gain better insights regarding their learning style and obtain optimum learning outcomes. In addition to recognize their individual strengths, they are given the opportunities to develop competencies in the areas that are perceived as their weaknesses. With this knowledge, the authors hope to instill self-confidence among engineering students and to challenge students intentionally learning the skills that are in less functioning areas.

3. Recommendations:

(I) Restructure curriculum to support and challenge each type

The Educators would consider the data collected from MBTI to develop curricula and classroom environment that are conducive to active and cooperative learning. Sensing type learners appreciate clearly stated instructional objectives, which contain verb such as *list, state, explain, optimize, calculate, derive, design, formulate, determine,* and *justify* instead of the commonly used words such as *know, learn* and *understand* when writing course objectives. Most college students would like to know what they will learn and how they will achieve these objectives. Create projects allow them to work from their preferred styles and also to develop skills in the opposite types. According to [9] [10] [12], students learn more when teaching style matches their own; however they learn even more if they are aware of how they learn and how to use their strengths and develop their weak areas.

(II) Activities for the students to develop other learning styles

Raising Sensing (S) Learning Style

- Describe essential details and pertinent facts
- Analyze and break down activities into its component parts

Raising Intuitive (N) Learning Style

- Explore new possibilities to solve the problems
- Observe the signs of coming change

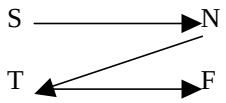
Raising Feeling (F) Learning Style

- Explain how a theory works and pay attention to the audience's response

Raising Thinking (T) Learning Style

- Organize and analyze the predetermined problems or issues in a systematic format

Students are encouraged to write journals or keep learning logs which often heightens the self-awareness and bring forth the desire for personal/professional growth [13]. In addition, the instructor could introduce the concept of "zig-zag" process and using "zig-zag" analysis to help students monitor their own thinking/ problem solving process.



"When faced with a problem, we start with sensing to identify the facts, the given realities of the situation. …… The meaning of the data, their relationships to prior experience are given by intuition. …… Intuition also asks: What are new ways to look at the problems and new possibilities in these data for finding a solution? The arrow moves from N to T when we engage thinking judgement to analyze and decide the logical consequences of acting upon each of the possibilities. And finally the possibilities are also weighted by feeling judgement (F) to assess how deeply we care about the effects of each option; we test the human consequences, the harmony with basic personal values, or the values of others we care about and trust." [14]

(III) Design group projects by teaming a combination of opposite types

- Facilitate the learning process of team project by recognizing individual strengths and introducing the elements of complementary working styles among opposite types.
- Utilize exercises, modeling and coaching techniques which students could demonstrate their strengths while witnessing the other learning skills of their partners.
- Record their observation on the MBTI dynamics in learning logs which also include their questions and study objectives.

Current students, compared to their more traditional predecessors, prefer a high degree of personalism. Student-Teacher Electronic Mail Messages [15] contribute to meeting their needs of frequent and individualized feedback. Using learning log for group projects provide structure in quasi self-designed learning. They adapt well to group activities and collaborative learning. [16]

(IV) Formulate a system to assess both theoretical understanding and practical application

- Adopt a holistic approach that warrants appropriate and fair evaluation of student performance.
- Develop student assessment portfolio by including *Student Goal Ranking, Self- Diagnostic Learning Logs, Minute Paper, Muddiest Point, Analytic Memo.* [15] [17]

The above-mentioned skill building CAT techniques will not only enhance students' awareness of the skills that are in their preferred learn styles but also provide opportunities to reinforce the development of the skills that are in the opposite types. When designing engineering course with the above-mentioned focuses, students would gain better insights regarding their learning style and obtain optimum learning outcomes. In addition to recognize their individual strengths, they are given the opportunities to develop competencies in the areas that are perceived as their weaknesses. With this knowledge, the authors hope to instill self-confidence among engineering students and to challenge them intentionally learning the skills that are in less functioning areas. Last but not least, using MBTI Inventory can be one of the strategies to address issues on academic persistence and student retention. Any effort in acknowledging individual differences and in improving supports for various learning types will definitely enhance academic comfort among at risk students and hence increase college retention.

4. Conclusions

This paper describes the data and analysis of performance assessment for a master level electrical engineering course titled: "Real-time Control Systems". In the seven years history of this course, it was frequently noted that

the theory and experiment grades did not correlate well. In order to help analyze this discrepancy, the Myers-Briggs Type Indicator inventory was administered to the class of 1997 and 1998. The results provided an extra analytic dimension and led to the conclusion that psychological types play an important role in student "performance" in (1) a highly structured classroom environment and (2) a free-structure experimental project. Traditional graduate assessment criteria heavily biased towards the classroom environment so that students with excellent hands-on and creative skills are not evaluated adequately. Given that a master degree is becoming a necessary requirement for practicing engineers, a broad based assessment mechanism that include analytic ability, creativity, hands-on ability, and communication skills should be devised and implemented.

5. References

[1] Greenberg, Jerald, (1996) , MANAGING BEHAVIOR IN ORGANIZATIONS, Upper Saddle River, NJ, Prentice Hall.

[2] Staiger, Eugene H., "CURRICULUM REDESIGN: PSYCHOLOGICAL FACTORS WORTH," Frontiers in Education Conference Oct 15-17 1989 1989, pp 140-144.

[3] Carpenter, Raymond A.; Bishu, Ram R.; Riley, Michael W., "USER CHARACTERISTICS. ARE PERSONALITY TYPES AND PSYCHOMETRIC FACTORS GOOD PREDICTORS?" Proceedings of the Human Factors Society 34th Annual Meeting - Orlando '90 Oct 8-12 1990, pp 351-355.

[4] Felder, Richard M.; Forrest, Krista D.; Baker-Ward, Lynne; Dietz, E. Jacquelin; Mohr, Phyllis H., "LONGITUDINAL STUDY OF ENGINEERING STUDENT PERFORMANCE AND RETENTION: I. SUCCESS AND FAILURE IN THE INTRODUCTORY COURSE," Journal of Engineering Education v 82 n 1 Jan 1993 pp. 15-21.

[5] Parsons, J. Roger; Klukken, P. Gary, "INTRODUCTORY DESIGN AND INNOVATION COURSE AT THE UNIVERSITY OF TENNESSEE," Proceedings of the 1995 25th Annual Conference on Frontiers in Education. Part 1 (of 2) Nov 1-4 1995 v1 1995 Atlanta, GA, , USA, pp. 442-444 .

[6] Daigle, R.J.; Doran, Michael V.; Pardue, J. Harold, "INTEGRATING COLLABORATIVE PROBLEM SOLVING THROUGHOUT THE CURRICULUM," Proceedings of the 1996 27th SIGCSE Technical Symposium on Computer Science Education Feb 15-18 1996 1996 Philadelphia, PA, USA, pp. 237-241.

[7] Rosati, Peter, "STUDENTS' PSYCHOLOGICAL TYPE AND SUCCESS IN DIFFERENT ENGINEERING PROGRAMS," Proceedings of the 1997 27th Annual Conference on Frontiers in Education. Part 2 (of 3) Nov 5-8 1997 v2 1997 Pittsburgh, PA, USA, pp. 781-784.

[8] Christy, Ann D.; Lima, Marybeth, "USE OF STUDENT PORTFOLIOS IN ENGINEERING INSTRUCTION," Journal of Engineering Education v 87 n 2 Apr 1998 ASEE Washington DC, USA, pp. 143-148.

[9] Keirsey, D.; Bates, M. (1984), PLEASE UNDERSTAND ME: CHARACTER & TEMPERAMENT TYPES, Del Mar, CA: Prometheus Nemesis Book Company.

[10] Felder, R. & Brent R (2000), "EFFECTIVE TEACHING: A WORKSHOP AT NEW JERSEY INSTITUTE OF TECHNOLOGY, NJ

[11] Jenson, G.H. , (1987) "LEARNING STYLES" In Provost, J.& Anchors, S., Ed., APPLICATION OF THE MYERS-BRIGGS TYPE INDICATOR IN HIGHER ED., CA: Counseling Psychology Press

[12] Provost, J (1992), STRATEGIES FOR SUCCESS: USING TYPE TO EXCEL IN HIGH SCHOOL & COLLEGE, FL: Center for Applications of psychological Type

[13] Gardner, J.N.& Jewler, A.J., Ed., (1999), YOUR COLLEGE EXPERIENCED: STRATEGIES FOR SUCCESS, Missouri: Wadsworth Pub Co

[14] Lawrence,G (1993), PEOPLE TYPES & TIGER STRIPES, FL: Center for Applications of Psychological Type Inc.

[15] Cross, K.P. & Angelo, T.A. (1988) CLASSROOM ASSESSMENT TECHNIQUES: A HANDBOOK FOR FACULTY, Ann Arbor, Michigan: National Center for Research to Improve Postsecondary Teaching & Learning

[16] Schroeder, C, "NEW STUDENTS- NEW LEARNING STYLES", Change, AAHE Sept/Oct, 1993, Washington DC, USA

[17] Angelo, T.A. & Cross, K.P. (1993) CLASSROOM ASSESSMENT TECHINQUES: A HANDBOOK FOR COLLEGE TEACHERS, 2ND edition, San Francisco, CA: Jossey-Bass Publishers