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A Multicultural Comparison of Engineering Students: Implications to Teaching and Learning

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Abstract: Problem statement: Personality considerations have become increasingly important in recent years, but studies involving the personality characteristics of engineers have been scarcely reported. Engineers today are expected to have a broader range of skills than in the recent past because users are now equally concerned with the technical as well as the personal services provided by engineers. **Approach:** A multicultural personality profile of engineering students had been presented in this study. The MBTI was used as an instrument to sort personality types of engineering students at both King Fahd University of Petroleum and Minerals in Saudi Arabia and University of Western Ontario in Canada. **Results:** The study had discussed the differences and similarities in the personality profile of Saudi and Canadian engineering students and its implications for engineering education in the light of the MBTI dimensions. Although there had been some teaching strategies useful to a whole class, the personality differences among engineering students made it necessary for instructors to diversify those teaching strategies. **Conclusion/Recommendations:** Adjusting instruction to accommodate the learning styles of different types of students had increased both achievement and enjoyment of learning. Hence, this study had improved the degree of understanding among teachers and engineering students.

Key words: Engineers' personality, diversity in engineering, multiculturalism in engineering, teaching and learning, Myers-Briggs type indicator, MBTI

INTRODUCTION

We tend to teach, as we ourselves like to be taught and we commonly assume that our students can learn best by employing the same techniques that we used as students. However, people differ significantly in the way in which they learn best; it is believed that these learning styles are related to psychological types.

Educators have been using the Myers-Briggs Type Indicator (MBTI)[1] to develop teaching methods and to understand both individual learning styles and differences in motivation. In this study, MBTI is used not only to classify Canadian and Saudi engineering students into personality types, but also on how to better understand their learning differences, strengths and weaknesses. The match or mismatch between the way that professors teach and the way that students learn may have important ramifications for levels of satisfaction with a given program or major and with retention of both students and teachers.

Briefly, the MBTI casts personalities into four bi-directional scales of preferences, but one direction from each scale is used to define a type. Of course, people can and do use all eight preferences in each of the four pairs, but we all have one preference that works better for us than its counterpart:

Extroversion and Introversion (E and I): Some people are oriented to a breadth-of-knowledge approach with quick action; others are oriented to a depth-of-knowledge approach reflecting on concepts and ideas. Jung calls these orientations extroversion and introversion.

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Table 1: The 16 MBTI types and their distribution among the US adult population

ISTJ	ISFJ	INFJ	INTJ
11.60%	13.80%	1.50%	2.10%
ISTP	ISFP	INFP	INTP
5.40%	8.80%	4.40%	3.30%
ESTP	ESFP	ENFP	ENTP
4.30%	8.50%	8.10%	3.20%
ESTJ	ESFJ	ENFJ	ENTJ
8.70%	12.30%	2.50%	1.80%

Sensing and Intuition (S and N): Some people are attuned to the practical, hands-on, common-sense view of events, while other are more attuned to the complex interactions, theoretical implications, or new possibilities of events. These two styles of information gathering, or perception, are known as sensing and intuition, respectively.

Thinking and Feeling (T and F): Some people typically draw conclusions or make judgments dispassionately and analytically; others weigh the human factors or societal import and make judgments with personal conviction as to their value. These two styles of decision-making are called thinking or feeling, respectively.

Judgment and Perception (J and P): Finally, some people prefer to collect only enough data to make decisions before setting on a direct path to a goal and typically stay on that path. Others are finely attuned to changing situations, alert to new developments that may require a change of strategy, or even a change of goals. These two styles are called the preferences for judgment or perception, respectively.

Hence, there are 16 possible configurations, as shown in Table 1. If the MBTI results show that a person is ISTP, then the terminology is to suggest that the person prefers ISTP.

MATERIALS AND METHODS

The MBTI was used as an instrument to sort personality types of engineering students at both King Fahd University of Petroleum and Minerals in Saudi Arabia and University of Western Ontario in Canada.

Canadian engineering students: The type distribution of 235 Canadian students from all engineering programs in their final graduating year 2004 at the University of Western Ontario is showed in Table 2.

Table 2: Type distribution of Canadian engineering students, (N = 235)

ISTJ	ISFJ	INFJ	INTJ
N = 51	N = 6	N = 4	N = 14
21.70%	2.60%	1.70%	6.00%
ISTP	ISFP	INFP	INTP
N = 19	N = 4	N = 8	N = 11
8.10%	1.70%	3.40%	4.70%
ESTP	ESFP	ENFP	ENTP
N = 11	N = 2	N = 9	N = 30
4.70%	0.90%	3.80%	12.80%
ESTJ	ESFJ	ENFJ	ENTJ
N = 45	N = 4	N = 5	N = 12
19.10%	1.70%	2.10%	5.10%

The sample distribution is similar to other samples found in engineering majors at different universities across the United States[2] and Canada[3].

RESULTS

The results show that ISTJ, ESTJ and ENTP compose over 50% of the sample, thus significantly over-represented; whereas ESFP, ESFJ, ISFP, INFJ and ENFJ are all particularly under-represented in that group. The study found more introverts (I = 50%) than extroverts (E = 50%); slightly more sensing (S = 60%) than intuitive (N = 40%) types; significantly more thinking (T = 82%) than feeling (F = 18%) types; and less perceiving (P = 40%) compared to judgment (J = 60%) types.

Saudi Arabian engineering students: Our subjects comprise a group of engineering students attending the King Fahd University of Petroleum and Minerals. Ninety-six engineering students were invited to participate in the study and were administered the MBTI (Form G) to determine their personality types. The type distribution of these students is shown in Table 3.

This study has shown that ESTJ, INTJ, ENTP and ENTJ compose almost 50% of the sample, therefore, over-represented. On the other hand, ISTP, ESTP, ISFP and ESFJ are all particularly underrepresented in this sample. This research also found almost the same proportion of introverts (I = 49%) than extroverts (E = 51%) types; fairly less sensing (S = 36%) than intuitive (N = 64%); significantly more thinking (T = 66%) than feeling (F = 34%); and slightly more judging (J = 60%) compared to perception (P = 40%) type.

Although there are many similarities in the type distribution of Canadian and Saudi students, it is worth noticing that there are more ISTJ (21.7%) in the

Table 3: Type distribution of Saudi Arabian engineering students, (N = 96)

ISTJ	ISFJ	INFJ	INTJ
N = 7	N = 3	N = 7	N = 15
7.30%	3.10%	7.30%	15.60%
ISTP	ISFP	INFP	INTP
N = 2	N = 1	N = 6	N = 6
2.10%	1.00%	6.30%	6.30%
ESTP	ESFP	ENFP	ENTP
N = 2	N = 7	N = 3	N = 11
2.10%	7.30%	3.10%	11.50%
ESTJ	ESFJ	ENFJ	ENTJ
N = 11	N = 2	N = 4	N = 9
11.50%	2.10%	4.20%	9.40%

Canadian sample and INTJ (15.6%) in the Saudi sample, than any other type respectively. The biggest discrepancies occur in the ISTP, ESFP and INFJ cells: 8.2% as opposed to 2.1, 0.9% against 7.3, 1.7% rather than 7.3%, respectively. The other remaining numbers for the other cells are more in accordance.

It can also be noted that STs comprise almost 44% of the Canadian, against 23% in the Saudi sample. SFs appear 11% among Canadian engineering students and 13% among Saudis. NFs are only 13% in the Canadian side, but 21% in the Saudi side. Finally, 32% are NT in Canada, whereas 43% in Saudi Arabia. But most importantly, it can be clearly seen that both samples contain significantly more NTs and much less SFs than estimated to be in the general population.

It is relevant to point out that NTs (43%) are more common among Saudi engineering students than among the Canadians (32%). On the other hand, STs (44%) can be encountered among Canadians, as opposed to 23% among Saudis. It came as a surprise to find almost the same percentage of STs (23%) and NFs (21%) in the Saudi subjects, which is unusual in engineering schools in North America.

Many teachers believe that being fair means treating all types of students equally. If this translates into using the same approach with every student or treating students identically, then problems are likely to arise for students who may feel left out because of teachers' choice of classroom activities biased by their own teaching style.

Effective learning: College is for learning, but not everyone's learning style is the same. According to the MBTI theory each of the sixteen types has a different style that works best for them. If a student is having difficulty learning new material it may be because the student is trying to learn in a way that is not consistent with his/her natural style. In an ideal learning environment, teaching should appeal to a range of leaning styles such that each student, at least for some of the time, is able to learn in their own preferred style[4].

Therefore, the idea of accommodating all learning preferences in a classroom can be daunting. It is natural to lean towards our own learning preferences when teaching. However, instructors should strive to meet the learning needs of all students. We can anticipate the learning styles of a group of students by using cues such as pre-session conversations or information from type reports to build an impression of the personality types in the group. When using this information, however, we should avoid stereotyping and respect diversity.

Instructors should plan a balance of activities. For example allow time for reflection before starting a group exercise, share outlines and overviews as well as facts and details, provide some flexibility within a structured way and not be too strict with the deadlines. Ice-breaks, designed to develop rapport, must serve a practical and logical purpose. We should project a friendly, competent approach, by sharing our working and teaching experience; some students want to see our credentials, yet others may find it pretentious to state them all up front.

One way to plan our lectures to accommodate all learners is to consider the learning preferences associated with the eight dominant MBTI functions. Dunning[5] recommends the checklist described in Table 4 to determine if we are incorporating training strategies that appeal to all personality types in the classroom.

Myers *et al*.[1] also give a summary of findings that relate psychological types to teaching and learning styles, as expanded in the next two sub-sections.

Further characterization of learner's types:

Sensing-Thinking (ST): The ST learner is realistic, practical and matter-of-fact. This type of learner is efficient and results-oriented. They prefer action to words and involvement to theory. They have a high energy level for doing things that are pragmatic, logical and useful.

Intuitive-Thinking (NT): The NT learner is theoretical, intellectual and knowledge-oriented. These learners prefer to be challenged intellectually and to think things through themselves. The NT is curious about ideas, has a tolerance for theory, a taste for complex problems and a concern for long term consequences.

Table 4: Learning preferences checklist[5]

Responders (ESTP and ESFP):
1. Include activities in which participants can move around
2. Provide links to practical applications
3. Engage the senses with color, texture, scent, or sounds
Explores (ENTP and ENFP):
1. Provide opportunities to generate or explore ideas
2. Introduce ideas with an overview or conceptual framework
3. Link material to other frameworks and applications
Expeditors (ESTJ and ENTJ):
1. Demonstrate competence of trainers and credibility of information
2. Provide a logical rationale for activities
3. Provide opportunities to question or debate information or ideas
Contributors (ESFJ and ENFJ):
1. Include activities to build group rapport
2. Provide opportunities to collaborate and cooperate
3. Deliver in a pleasant physical environment
Assimilators (ISTJ and ISFJ):
1. Use well-organized structure and follow a clear agenda
2. Provide useful and practical information
3. Include facts, details and links to experience of others
Visionaries (INTJ and INFJ):
1. Provide additional resources for interested participants
2. Use precise language to discuss complex concepts and ideas
3. Integrate information from a variety of sources
Analyzers (ISTP and INTP):
1. Use efficient design and implementation
2. Provide information in a logical manner
3. Include challenges or problem solving
Enhancers (ISFP and INFP):
1. Explore the personal meaning and significance of learning
2. Provide support and encouragement for participants
3. Consider the unique situation and needs of each participant

Sensing-Feeling (SF): The SF learner can be sociable, friendly and interpersonally oriented. These learners are very sensitive to people's feeling, their own and others. They prefer to learn about things that directly affect people's lives rather than impersonal facts or theories.

Intuitive-Feeling (NF): The NF learners are curious, insightful, imaginative and creative. The NF are the ones who dare to dream, are committed to values, are open to alternatives and constantly searcher for new and unusual ways to express themselves.

Further characterization of teachers' types:

Sensing-Thinking (ST): The ST teachers are primarily outcomes-oriented (skills learned and projects completed). They maintain highly structured, well-organized classroom environments. Work is purposeful, emphasizing the acquisition of skills and information. Plans are clear and concise. Discipline is firm but fair. Teachers serve as the primary information source and give detailed directions for student learning.

Intuitive-Thinking (NT): The NT teachers are intellectually oriented. The teacher places primary importance on students' intellectual development. The teacher provides the time and the intellectual challenges to encourage students to develop skills in critical thinking, problem solving, logic, research techniques and independent study. Curriculum planning is developed around concepts frequently centring around a series of questions or themes. Evaluation is often based on open-ended questions, debates, or position essays.

Sensing-Feeling (SF): The SF teachers are empathetic and people-oriented. Emphasis is placed on the students' feelings of positive self-worth. The teacher shares personal dealings and experiences with students and attempts to become personally involved in students' learning through games and activities that involve the students actively and physically. Plans are changed frequently to meet the mood of the class.

Intuitive-Feeling (NF): The NF teachers are innovatively oriented. The teacher encourages students to explore their creative abilities. Insights and innovative ideas highly valued. Discussions resolve around generating possibilities and new relationships. The classroom environment is often full of creative clutter. The teacher encourages students to develop their own unique styles. Curriculum focuses on creative thinking, curiosity, insight and artistic self-expression are welcomed.

DISCUSSION

Learning style is a term that refers to an individual's characteristic and consistent approach to perceiving, organizing and processing information while learning.

Kalsbeek[6] stated that "learning can be understood as a person's preferred approach to information processing, idea formation and decision making; the attitude and interests that influence what is intended to in a learning situation; and a disposition to seek learning environments compatible with these personal profiles". Thus adjusting instruction to accommodate the learning styles of different types of students can increase both achievement and the enjoyment of learning.

Cooper and Miller[7] reported that the level of learning style/teaching style congruency is related to academic performance and to student evaluations of the course and instructor. Additionally, the existence of the discrepancy between students' preferences of learning in a concrete manner (S style) and faculty's penchant to teach in abstractions (N style) appears to contribute to student dissatisfaction as indicated by the course and instructor evaluations.

Blume[8] suggests that college students can improve their study habits by knowing their MBTI type and show different learning styles are associated with each preference; advice is also provided for the student whose learning style conflicts with the instructor's teaching style. Similar accounts of the relation between MBTI type and learning propensities in a software engineering course is described in Capretz[9].

Zaki and Overton[10] observed student's impressions of a series of open-ended group problem solving exercises; they recommend that instructors should select the group members, not the students, because good students like to work with each other and weak students will end up working together.

It is this well-researched view of type theory that we would like to apply to our goal of providing effective lectures to engineering students. To do so, we consider several approaches to learning and how type is related to each approach. We feel this is the best way to improve teaching effectiveness, because it explains how students are forced to learn in environments that do not suit their learning styles either.

CONCLUSION

The idea that people have different learning styles is enticing for educators. First, it highlights the importance of learning processes, as well as teaching techniques. Second, it is an egalitarian concept because it focuses on people's strengths and weaknesses, that is, learners become different rather than bad, poor, average, good and excellent. Because of this, it would be naive to expect that teachers could easily design and deliver a course to fit the learning style needs of all their students.

Assuming that a broader cross-section of personality types can be attracted to engineering, the next challenge is to retain them. Fortunately, teaching techniques have evolved over recent years and engineering classes have become more generally appealing as a result. However, there still may be a tendency to teach in a style that suits the personality of the teacher. For example, an introvert student prefer to learn by listening, reading and working alone; in contrast an extravert professor prefers to teach by encouraging interaction and discussion.

Engineering professors today need to consider different approaches to teaching and learning, thereby making their courses interesting to the full range of personality types. An introvert teacher who delivers a lecture only in the style that he or she would prefer for learning may lose the interest of the extraverts in the class.

Educators should bear in mind that everyone has a learning style that narrows their capacity as a learner. This does not mean, however, there two classes of learners, the privileged class (learner who can overcome their limitations) and the less privileged class (learners who are not capable of using different learning styles). It is only a matter of preference, being more comfortable or not with a style. This challenges the notion that learning potential is reducible to a single dimension such as intelligence. Each learning style has its strengths and weaknesses and therefore a person locked exclusively into one style is never going to be an ideal learner.

Let us explore the student's performance in different scenarios concerning teaching modes and student learning styles in engineering courses. Firstly, it is believed that the psychological theory behind MBTI can predict that the sensing types, in their learning, rely on experience rather than theory and have a preference for moving from the known in a step-by-step manner. Intuitive types, on the other hand, rely more on inspiration and insight, which often lead to an ability to understand abstract, symbolic and theoretical relationships.

Extroverted teachers tend to be more activity-oriented, while introverted teachers usually like to allow more time for reflection. Extroverted teachers are generally more comfortable with noise classrooms than their introverted counterparts, who like to maintain an atmosphere in which they (and their students) can "hear themselves to think". The majority of university faculty members fall further along the scale toward the introvert side than do the majority of university students, who are extroverts. Thus, there seems to be a growing communication gap between these two groups. An ideal learning environment should provide homework assignments to cater for the introverts as well as group exercises during lectures to make the extroverts active.

As the sensing student enjoys details, examples, experiences and well-learned routines but get anxious about new complexities. The intuitive students prefer ideas, concepts and theory and trust their inspiration to connect to increasing complexity. In engineering courses the sensing student might work many problems and become fluent in the problem details but fail to grasp the underlying concept. On the other hand, the intuitive student is more likely to grasp the concept but not bother to work sufficient application problems in order to obtain fluency. Faculty should deliberate attempt to relate the course material to other fields and to the big picture so that it appeals to intuitive types, but also it helps the sensing learners to develop their skills of synthesis.

If these issues are ignored, the unfortunate results may be lower grades and disenchantment with higher education among many engineering students. Specifically, there has been a clear increase in "sensing" types attending engineering programs and such students are more likely to be dissatisfied with the intuitive teaching environment. Because of that, serious attention should be paid to this fact given the political reality that high cost of college education puts increased pressure on student retention, which is combined with an increasingly competitive higher education "market". With introversion, intuition, thinking and perceiving being the characteristics most commonly found in academics, students with other combinations of characteristics may become more disinterested in courses because of the teaching style used and learning styles expected.

Effective teaching is also significantly enhanced by the emotional strength of the teacher who is capable of captivating the feeling students. If instructors are careful to avoid rectifying their approach by saying: "this is how I teach because it is related to who I am", their students can only benefit. The ideal teacher, then, is one who can diagnose learning styles and select, from an armory of skill and techniques, the appropriate strategy for enhancing learning.

Greater effort may be required to attract and retain students with characteristics not usually seen as relevant to engineering. The field would undoubtedly benefit from having more feeling types who can be persuasive and motivational when working in teams and who will empathize with users and clients. Interaction with customers is an increasingly important aspect of engineering and one area where engineers are seen to be deficient

In closing, we remind engineering teachers that all types choose engineering, as it can be shown from Table 2 (Canadian engineering students) and Table 3 (Saudi Arabian engineering students). The data in those tables suggest that a very broad range of personality characteristics is chose engineering. Different characteristics may be more appropriate for different branches of engineering. In addition, the data in conjunction with early studies and current job market conditions indicate that certain types may be less appropriate than in the past, in particular with the diminishing demand for traditional engineers and the increasing demand for people who can communicate well at all levels of an organization, the engineering world will require a much lower proportion of introverts than in the past and there may be a greater need for the skills of under-represented personality types.

Finally, some types are more likely to adapt and stay within the field while others leave. Even so, engineering is losing some atypical students who tried our wares and then sought more fitting studies; it means that we are losing some students of the types which can be important in transforming engineering into a more user-oriented field and in finding new directions for engineering programs in the future. If we can find ways to value the diversity among students, help them to go through the barrier of type and reach niches in the engineering field where they will fit and feel valued, we should thrive to provide alternatives to retain them and enrich the engineering profession.

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