The Assessment of Personality and Learning Styles of Engineering Students: Advocating Learner-Centered Approach in Engineering Education System

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The study aimed to explore the diversities among engineering college students of their personality types and learning styles. The assessment was based on MBTI and ILS administered to 318 freshmen students enrolled in different engineering programs in Mapua Institute of Technology. The association between personality types and the students' learning styles were analyzed using structural equation modeling (SEM). The full model provided adequate fit to the data, X^2 =3276.48, p<.01, RMSEA=0.023, GFI = 0.636, AGFI = 0.519. This study also investigated the variations of personality types and learning styles based on the participant's gender. There was no significant differences in the ILS variables of male and female participants; however, significant results were found in some MBTI variables such as; in *extraversion* (t=4.69, p<.05), *introversion* (t=-4.73, p<.05), *thinking* (t=-4.94, p<.05), and *feeling* (t=5.01, p<.05). The main advocacy of this research is to promote the importance of learner-centered approach in engineering education.

Keywords: Personality, learning styles, Learner-centered approach

The diversity among students is one of the essential concerns that educational institutions must address. Unfortunately however, many institutions are only focused on addressing diversities in terms of gender and ethnicity while there are still various aspects of students' differences that warrant consideration in order to ensure effective and successful learning. Assessment as an academic endeavor plays an important role in identifying diversities, and this should not be merely confined in determining cognitive abilities but should also involve non-cognitive traits. Through careful assessment of learners' traits and characteristics, educators can better understand students' needs and consequently devise instructional

interventions that can aid in improving students' academic performance and personal well being.

Among the most important aspects of student diversities which requires thorough assessment is related to individual differences in terms of personality types. Personality can be a significant basis for learning since this influences ones way of viewing self and the world where a person interacts with. A review of relevant studies in the succeeding section provides a clear insight on the importance of determining students' personality traits in relation to academic engagement and performance of academic tasks. Aside from personality, another aspect of diversity which may have significant bearing on students learning performance and therefore likewise warrants careful assessment is related to student's way of acquiring and processing information, such aspect refers to the students' learning styles; obviously, one's learning styles would have significant effect to learning. The term learning style is used in a variety of ways in the teaching and learning process. Based on Felder and Brent (2005, p.58), learning styles are "characteristic cognitive, affective, and psychological behaviors that serve as relatively stable indicators of how learners perceive, and respond to the learning environment". It refers to the uniqueness of each learner; such uniqueness might include mental processing, confidence, attitude, sensory intake processes or some complex combination of these and other differences. A thorough review of relevant studies on learning styles is likewise presented in following sections.

For the past decades, several schools and educational institutions find the *learner-centered approach* as an effective learning paradigm for modern education. The major shift from *teacher-centered* to *learner-centered* education revolutionized the educative process towards a greater emphasis on the characteristics of learners including their intelligences, personality, talents and skills, as well as their personal interests. Recognizing such attributes would be essential in learning activities since they can be used as bases for teaching methodologies and assessment techniques.

Based on Weiner's Attribution Theory (1980, 1992), the learner's motivation in the learning process is a significant factor to consider. Such motivations may be attributed to the intrinsic drive of individuals to achieve something, which includes knowledge and skills. However, aside from the intrinsic factors, there is another factor which contributes a lot in determining the learning motivations of students; it is called the *extrinsic* factor. The extrinsic factors encompass external stimulations which can pull individuals to acquire knowledge and develop skills and ability. The teaching strategies and techniques of educators can be considered a significant element of extrinsic factors. The failure of educators to address the learning needs of students would most likely lead into failure to achieve successful learning; thus, academic professionals should primarily take into consideration the screening of students' learning attitudes and potentialities.

People may learn in different ways. Some can learn things more effectively when presented with visual materials; others through hearing, reflecting and acting, memorizing, analyzing, and other ways of absorbing and

processing information. The principle lies on the fact about *individual differences,* which claims that each individual is a unique person. Such principle also applies in the education setting; students have different personality and they learn in different ways.

Mismatches exist between common learning styles of students and traditional teaching styles of professors. Such mismatch may result into undesirable performance of the students in terms of attendance, scores or grades in tests, class participation, and sometimes may lead to transferring or shifting to another program.

The non learner-centered approach in the educative process as implied in the study of Felder and Silverman (1988) would tend to create mismatches between common learning styles of engineering students and traditional teaching styles of engineering instructors. Such mismatch may have negative consequences on both the students and the instructors; a learner who prefers a certain learning style, for example visual learning, can be effectively motivated by instructors who know how to address the needs of visual learners; otherwise, the learner will be demotivated. The instructor on the other hand, will be confronted by low student performance, unresponsive classes, poor attendance and dropouts, and many other problems which can sometimes make him overly critical of his students. The most serious problem that can be foreseen due to mismatch of learning and teaching styles in engineering education would be realized in the long run after several potentially excellent engineers are discouraged to continue with their studies due to the disparity between their learning expectations and the imposed teaching styles of engineering professors.

Educators should be concerned about the impact of diversities in engineering classes; one important aspect of differences among students which may have significant effect on their learning is their personality. Several studies were conducted to prove the effect of personality types to the learning of students, and example of these is the one conducted by Hull (2007) which used personality preferences in MBTI to predict persisters and droupouts among two-year college students. The main goal of the study was to distinguish persisters to degree completion from those who do not persist. Four additional factors were included to understand the multivariate relationships between personality type and the additional variables such as; placement into developmental coursework, gender, academic department, and socio-economic status. Results indicated no significant correlations between college readiness, MBTI type and degree completion, but significant correlations were indicated for students in specific academic departments, for male students, and for non-Pell eligible students. For male students, preference for the personality construct of Perceiving was found not only to correlate with dropping out, but also to make a significant contribution to the prediction of the outcome of dropping out. In the experimental study of R. Felder, G. Felder, and Dietz (1990), the MBTI was administered to a group of 116 students taking the introductory chemical engineering at North Carolina State University (NCSU). The introductory course as well as the four subsequent chemical engineering

courses was taught in a manner that emphasized active and cooperative learning and inductive presentation of course material. Type differences in various academic performance measures and attitudes were noted as the students progressed through the curriculum. The observations were generally consistent with the predictions of type theory, and the experimental instructional approach appeared to improve the performance of MBTI types (extraverts, sensors, and feelers) found in previous studies to be disadvantaged in the engineering curriculum. They concluded that the MBTI is a useful tool for helping engineering instructors and advisors to understand their students and to design instruction that can benefit students of all types.

Researchers in the field of education are becoming interested in areas related to how students acquire information. Particularly, there is a growing interest in determining students' diverse learning styles. Felder and Brent (2005) were interested to distinguish dominant learning styles among undergraduate engineering students who completed ILS. They found out that among the participants (*N*=129) 63% were classified as active learners, 37% were reflective, 67% were sensing, 33% were intuitive, 85% were visual, 15% verbal, 58% were sequential, and 42% were global. Several implications were made and tested in connection to the students' learning styles including the mismatches between students' learning styles and the traditional teaching styles in engineering education. For instance, they found out that 63%of the undergraduate students were sensors, while traditional engineering instruction tends to be intuitors. Another finding was that 82% of the students were visual learners, while most engineering instructions are heavily verbal.

There were also studies conducted to investigate the correlations between personality types and learning styles of students. Allida and Vyhmeister (2003) investigated the relationship of personality types using the Personal Style Inventory (PSI) and the learning styles Perceptual Modality Preference Survey among 500 students from six selected academic majors in tertiary schools in Northern Philippines. They also investigated the differences of personality types and perceptual learning styles on the basis of some demographic factors of the respondents (i.e gender, age, and ethinicity). Among the findings of this study indicate that the dominant personality types of college students, there were more extraverts than introverts, more sensers than intuitors, more thinkers than feelers, and more judgers than perceivers. They also noted that the preferred learning modalities of college students were print and kinesthetic, comprising almost 64% of the total population. The students who preferred aural, interactive, haptic, visual and olfactory modalities comprised only 35% of the total population. Furthermore, there were significant differences in the personality types of college students by gender and ethnicity and there were significant differences in the perceptual learning styles of college students by gender, age, and ethnicity. They also found out that there were significant relationships between personality types and perceptual learning styles of college students. As far as the correlates of academic performance are concerned, it was found that personality types, interactive learning style, and ethnicity were significantly related to academic

performance. The best predictive model of academic performance, given the variables of the study, includes Sensing-Intuition dimension, interactive learning style, gender of college students, and Thinking-Feeling dimension. In the study of Davis (2006), the possible association of personality and learning styles of community development extension educators was investigated using the *Witkin's* GEFT and Hogan and Champagne's PSI, respectively. The scores were tested for correlation and both measures were examined in relation to age, gender, and academic background of the respondents. Among the findings were: more than 56% of the community development extension educators involved in this study favored a field dependent learning style. Females were more field dependent. Subjects with academic backgrounds in the physical sciences were more field independent. Males were more than three times more likely sensing type than females. Twice the number of female subjects preferred gathering information through use of their intuition over males. Males preferred thinking, while females preferred feeling. There was a negligible level of association between learning style and personality type subscales.

The principal assumption in this study lies on the fact that personality is an encompassing mechanism within an individual. Having a certain type of personality can presumably affect one's way of viewing the world including of course one's way of absorbing information. The main objective of this study is to assess the diversity of engineering students in terms of personality and learning styles, and their implications in engineering education. Also, the study is concerned in the theoretical investigation of the hypothesized association between personality types and learning styles.

Method

This study is principally a correlation analysis on the associations between personality types and learning styles of engineering students. This also involves analysis of difference of personality types and learning styles across genders (Male or Female) of the respondents. The participants' gender was also treated as a possible factor for ones learning styles. The study employed SEM to further investigate the association between the main variables of the study.

Participants

The data was obtained from (*N*=318) freshmen engineering students of Mapua Institute of Technology. The participants were taking PSY10 (General Psychology) and are enrolled in different engineering programs (e.g. Mechanical Engineering, Electrical Engineering, Industrial Engineering, and others). Their participation in the study was counted as part of the grading criteria in PSY10 course under the co-curricular activity (5%) of the total course grade.

All the participants completed both the MBTI and ILS in order to determine their personality types and learning styles. A total of 76 female

engineering students (24%) and 242 male engineering students (76%) participated in the study.

Design

The study employed a descriptive design to test the associations between the participants' personality types and learning styles. This study also tested variation using t-Test (Between Groups Design) by setting genders (Male and Female) as categorical predictors, to personality types (E,I,S,N,T,F,J,P) and ILS (ACT,REF,SEN,INT,VIS,VRB,SEQ,GLO). Finally, the study utilized Structural Equation Modeling to further analyze the associations of the main variables of the study.

Instruments

Myers Briggs Type Indicator Form M (MBTI-M). To assess the personality types of the respondents, the *Myers-Briggs Type Indicator (MBTI) 94 items - Form M* was utilized (see appendix A). This instrument was primarily based on Jung's theory of Psychological Type (Introversion vs. Extraversion) and subsequently developed by Isabel Myers and her mother Katharine Briggs. In MBTI, people are classified in terms of their preference for *introversion* (I) (interest flowing mainly to the inner world of concepts and ideas) or *extraversion* (E) (interest flowing mainly to the outer world of actions, objects, and persons); *sensing* (S) (tending to perceive immediate, real, practical facts of experience and life) or *intuition* (N) (tending to perceive possibilities, relationships, and meanings of experiences); *thinking* (T) (tending to make judgments or decisions objectively and impersonally) or *feeling* (F) (tending to make judgments subjectively and personally); *judging* (J) (tending to live in a planned and decisive way) or *perceiving* (P) (tending to live in a spontaneous and flexible way). An individual type can be expressed as one of the 16 possible combinations of these typologies (e.g., ENTP, ISTJ, ENFP, and so on). A preference for one or the other category of a dimension may be mild or strong. MBTI had been validated and tested for reliability several times. Among the tedious test of reliability methods are the internal consistency reliability estimates (split-half reliability and internal consistency coefficients based on coefficient alpha) and the test-retest reliability estimates based on 1996 National samples involving 308 employees and 116 college students. The validity of MBTI was established through the comparison with 4 preference scales such as; 16 PF 5th Ed., Millon Index of Personality Styles, California Psychological Inventory, and NEO-PI. Results of cross-correlations between MBTI and the 4 other scales were all significant (Myers, McCaulley, Quenk, Hammer, 2003)

Felder's Index of Learning Styles (ILS on-line). The on-line learning styles questionnaire is composed of 44 questions and each has (2) forced choices from which the participant can select a choice which best describes his characteristic as a learner. The on-line ILS automatically scores and

interprets the result of the survey. Though the web-based system does not have a database to store the results, the program provides a feature to print the results reflecting the learner's inclinations between contrasting learning styles like; *Active* vs. *Reflective*, *Sensing* vs. *Intuitive*, *Visual* vs. *Verbal*, and *Sequential* vs. *Global*. The printed result also provides description of scales ranging 1 – 3 (fairly or well balanced), 5 – 7 (moderate preference for one dimension of the scale), and 9 – 11 (very strong preference for one dimension of the scale). Several studies were conducted to contribute to the reliability and validity of ILS. Based on Felder and Spurlin's (2005) article on applications, reliability and validity of ILS, Test-retest reliability measurements had been carried out by several researchers with at least 4 weeks interval; the results were also significant. (4 wks, N= 46, A-R= 0.804, S-N=0.787,Vs-Vb=0.870,Sq-G=0.725); further, Cronbach Alpha was also calculated (A-R =0.56, S-N=0.72, Vs-Vb=0.60, Sq-G=0.54) to assess the reliability of the instrument.

Procedure

The MBTI Form M was administered to each PSY10 class handled by psychology professors in Mapua Institute of Technology. Ten (10) sections were assessed comprising of at least 40 students per section. To collect the *Index of Learning Styles* of the participants, the students were instructed to access the website *http://www.engr.ncsu.edu/learningstyles/ilsweb.html* (see appendix B). The online access of Index of Learning Styles questionnaire was assigned by the psychology professors to the participants and they were required to submit the printed ILS results on a specified date. The collected data were then tabulated and plotted in preparation for statistical analyses.

Data Analysis

The mean scores and standard deviations were obtained from each instrument. The Pearson correlation coefficient (r) was used to test the correlation among the variables included in the MBTI and ILS. Using the p value ($p<.05$) of the correlation among certain variables significance and no significance were detected. The respondents' scores in both scales were varied across the genders (Male or Female) using t-Test of independent samples. To further analyze the association between the participants' personality and learning styles, Structural Equation Modeling was performed. Data analyses were performed using the software STATISCA 7.

Results

All the participants (*N*=318) completed both the MBTI and ILS in order to determine their personality types and learning styles. A total of 76 female engineering students (24%) and 242 male engineering students (76%) participated in the study. A preliminary analysis was conducted to assess differences in the participants' gender (Male or Female) across the measures of MBTI and ILS. Using the *t*-test, it was revealed that the mean scores of the participants in ILS variables have no significant differences with respect to their genders. However, significant results were found in some MBTI variables such as; in *extraversion* (t=4.69, p<.05), *introversion* (t=-4.73, p<.05), *thinking* (t=-4.94, p<.05), and *feeling* (t=5.01, p<.05).

The correlation analysis of the study variables revealed that some variables across MBTI and ILS are significantly correlated (*p<.05). Both the MBTI and ILS are dimensional instruments; as such, pairs of factors are expected to have negative or inverse significant correlations. Thus, the analysis depicts an inverse correlations between the extraversion and introversion factors of MBTI (-.98), sensing and intuition (-.94), thinking and feeling (-.99), judging and perceiving (-.98).In the ILS scale, it was also noted that inverse correlations were observed between opposite dimensions of the students' learning styles such as; active and reflective (-.49), sensing and intuiting (-.54), visual and verbal (-.54), and sequential and global (-.46). Furthermore, the data reveals that cross-correlations between some factors in MBTI and ILS have significant relationships; for instance, the extraversion factor of MBTI is positively correlated with the active learning styles of ILS (.15), the introversion factor of MBTI is positively correlated with the reflective learning style of ILS (.23). It can be noted that the attributes or characteristics embedded in these factors have resemblance as explained by Felder and Spurlin (2005) proven as a result of convergent validity of the two instruments. Interestingly, the intuiting type (coded as N) in MBTI and the intuiting preference (coded as INT) in ILS are also positively correlated (.22); also, the sensing type (coded as S) in MBTI and the sensing preference (coded as SEN) in ILS are positively correlated (.26). These suggest consistency of responses of the participants in the two instruments; this also denotes that MBTI and ILS coincide with certain factors being measured

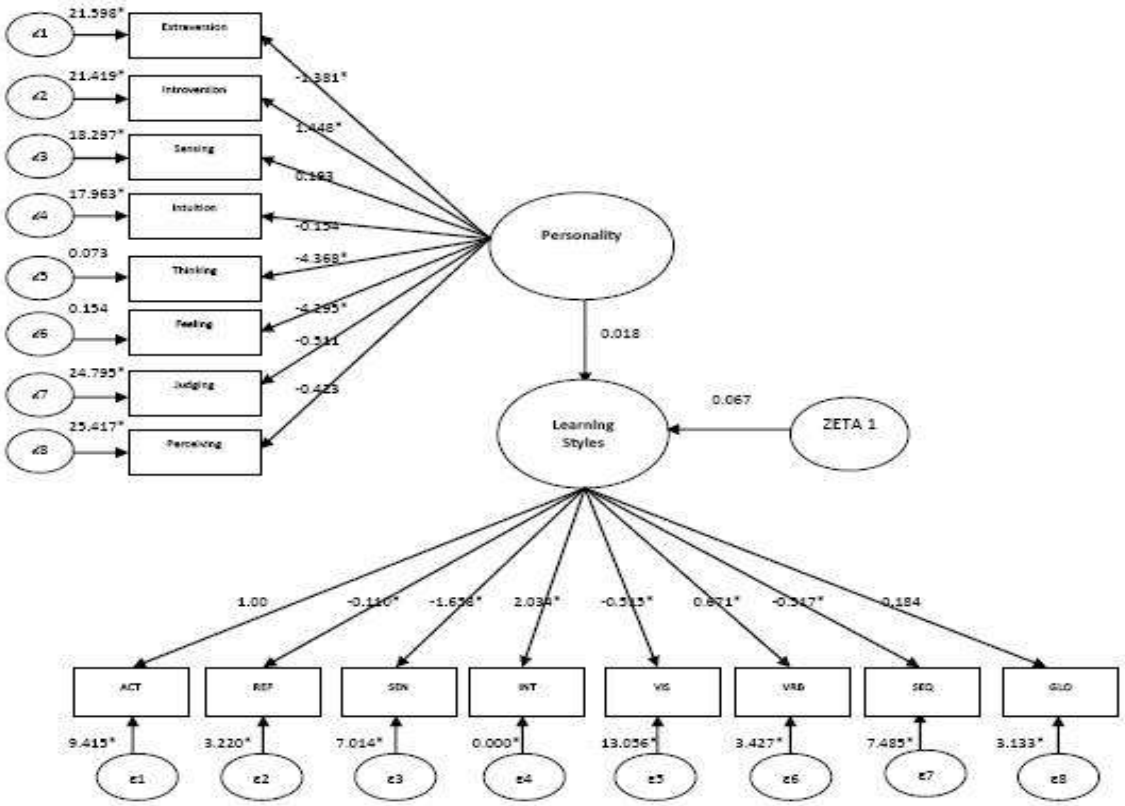

Figure 1. Full model: MBTI Personality Types; Index of Learning Styles. The coefficient of personality on learning style is significant, p <.05

Structural Equation Modeling (SEM) was employed to test the study hypothesis in which one's personality affect his ways of viewing himself and the world including his ways of absorbing information (learning styles). According to Lattin, Carrol, and Green (2003) SEM permits a more general pattern of dependence relationship among variables, this also allows us to account for measurement errors in observed variables and examine the dependence relationships among the underlying constructs. Particularly, the Generalized Least Squared (GLS) – Maximum Likelihood (ML) method as implemented through Statsoft (STATISTICA 7) –SEPATH computer software was used to estimate all models. Path coefficients reported represent standard values. Personality (MBTI) was set as the exogenous variable. Personality as latent variable has the 8 personality types as its manifest variables. Learning Styles (ILS) was set as the endogenous (latent) variables having its manifest variables the 8 learning preferences. The full model provided adequate fit to the data, X^2 =3276.48, p<.01, RMSEA=.023, GFI = .93, AGFI = 0.91.

As the pattern of association among the main variables of the study differ, the data shows that some of the model paths are significant except for some paths which are constrained to low parameter values that indicates no significance (p<.05). Thus, separate analyses were conducted to determine the

effects of each dimension of personality as revealed in MBTI to the different factors of ILS. The subsequent analyses present the breakdown (path analysis) of each of the 8 temperaments under MBTI to the 8 learning styles of ILS. The breakdown intended to explore the effects of each dimension of personality as predictors to the engineering students' learning styles. For this purpose, the dimensions were termed as "temperament", connoting types or tendencies.

The Path Analysis provided adequate fit to the data, $X^2 = 36280.157$ $p<.01$, RMSEA=.0295, GFI = .944. The model also shows the significant effects of temperaments as predictors to learning styles or preferences of engineering students.

The data shows that *extraversion* significantly affects active learning style (2.596, $p<.05$) and reflective learning style (-.0861, $p<.05$). In the same way, *introversion* significantly affects active learning style (0.446, $p<.05$) and reflective learning style (-.0.376, $p<.05$). *Sensing* significantly affects the sensing learning styles (1.640, $p<.05$), visual learning style (-2.164, $p<.05$), and verbal learning style (1.213, $p<0.5$). *Intuition* significantly affects intuiting learning style (0.819, $p<.05$), visual learning style (-1.838, $p<.05$), verbal learning style (1.156, $p<.05$), sequential learning style (0.956, $p<.05$), and global learning style (0.477, $p<.05$). *Judging* significantly affects sequential learning style (1.001, $p<.05$) and global learning style (-1.407, $p<.05$). *Perceiving* significantly affects sensing learning style (2.105, $p<.05$) and intuiting learning style (1.000, $p<.05$), *thinking* and *feeling* did not yield any significant result when tested as predictors to the 8 learning styles.

Discussion

In this section, results and findings are discussed in to three parts. The first part is devoted on the descriptive interpretations as well as the implications of the association between personality (temperaments) and learning styles of engineering students; insights are also provided for educators on how a particular type of learner can maximize learning in classroom environment. The second part is focused on the discussions about the effect of certain temperaments as measured by MBTI to the students learning styles. In this portion, temperaments were treated as predictors to the learning preferences of students; discussions revolve around the results of path analyses conducted using SEM. Lastly, the third part discusses the recommendations particularly on how to address the diversities of engineering students.

Personality is indeed a complex system and pattern of traits and characteristics of individuals; it is reflected in our responses to the world and it tends to be consistent over time. Jung explained personality using a typological model; one can be introvert while others are extravert; one can be perceiving while others are judging; and so on. Learners as individuals respond differently to the environment as a result of their variations in personality.

It was found in this study that certain personality types of learners are significantly related to (positively and negatively) their learning preferences; for instance, extraverted persons are most likely active learners; introverted persons are most likely reflective learners. Also, the data reveals that the participants (engineering students) significantly incline in certain dimensions of personality and that of learning styles over the other. For example, majority of the participants are extraverted-MBTI (62%) and active learner-ILS (77%); this means that most of the engineering students prefer to learn things by doing and by working in a group; lecturing methodology would not be an effective teaching strategy for them (Felder and Soloman, n.d). In addition, this implies that engineering will benefit more in group activities, hands-on or performance-based learning process and other classroom activities which allow students to self-expression. Another finding in relation to the participants' inclination to certain dimensions of personality and learning styles is on the sensing dimension, majority of them are classified in MBTI as sensing (67%) as well as in ILS (78%); this signifies that most of the engineering students tend to like learning facts, solving problems, and hands-on works. Sensing types of learners resent subject matters that have no apparent connection to the real world; from the word sensing itself, learners of this type can maximize knowledge acquisition trough practical, mechanical and well established methods. Further, according to Felder and Soloman (n.d), sensors tend to be patient with details and good at memorizing facts and doing hands-on (laboratory) work; they also resent being tested on material that has not been explicitly covered in class.

It should be noted that some of the factors of personality and learning styles (as measured in MBTI and ILS) are not always complementary; they did not even yield a significant correlation in the data analysis. Thus, a separate analysis should be warranted.

Analyzing the participants' learning style preferences, it was revealed in this study that majority of them are visual learners (84%); according to Felder and Soloman (n.d), visual learners remember best what they see; they learn more through images, diagrams, films, and demonstrations. Furthermore, descriptive data analysis reveals that majority of the engineering students prefer sequential learning (68%); learners of this type tend to gain understanding in logical fashion. They prefer to follow logical stepwise paths in finding solutions to any problem presented. From the word sequential, students who have this learning style may not favor skipping or jumping from topics to topics, they favor to stick with the logical sequence of learning or acquiring knowledge and skills (Felder and Soloman, n.d).

In MBTI, it was revealed that majority of the participants are judging (J) type comprising of around 64% of the total samples. In Myer's observation of behavioral pattern, some people habitually use judgment in interacting with the outer, extraverted world. People who have judging attitude are concerned with making decisions, seeking closure, planning operations, or organizing activities. For Thinking-Judging types (TJ), the decision and plans are more likely to be based on logical analysis; while for Feeling- Judging

types (FJ) decisions and plans are usually based on weighing or assessing values (Myers, McCaulley, Quenk, and Hammer, 2003).

The gender was used in this study as a potential source of variance of the students' learning styles. This was based on the common assumption that males and females learn differently. The use of gender as a factor for regression and or variance in relation to learning styles can be seen in previous studies (Hull, 2007; Allida and Vyhmeister, 2003; Davis, 2004). Contrariwise, in this study gender did not impose significant effect on the students' learning styles. Variations of the participants' learning styles were not significant, while only the *extraversion-introversion* and *thinking-feeling* dimensions of MBTI significantly differ in terms of gender.

In the analysis of effects of personality types to learning styles using path analysis, all models provided adequate fit to the data. This implies that the number of samples used in the study suffice the necessary requirement in order to test for the effects of predictors (personality/temperament) to the criterion variables (learning styles). Several models were tested to determine how the temperaments affect the learning styles of engineering students. The data shows that *extraversion and introversion traits* can predict active and reflective learning styles or preferences; this indicates that the person's social attitude and ways of interacting with other people significantly dictates ones learning preference as to whether one will be more interested and effective in individual work or group task. The *sensing and intuition traits* can predict the sensing, visual, and verbal learning styles of students. Based on MBTI Manual (2003) sensors are types of persons who rely heavily on facts, this means that a person who are high in sensing temperament can be predicted as a sensing type of learner who remembers and understands information best if he can see how it connects to the real world; a visual type of learner who remembers best what he sees like pictures, diagrams, flow charts, time lines, films, and demonstrations, and contrarily resents verbal learning which is purely based on written and spoken explanations. Opposite to sensing temperament, people who are high in *intuition temperament* prefer intuitive type of learning which is inclined on discovering possibilities and relationships, and also on abstraction and theorizing; they are most likely verbal learners who are more interested in listening to explanations and are more active in group discussions. Moreover, people who are high in intuition are most likely global learners who tend to learn in large jumps, absorbing material almost randomly without seeing connections, and then suddenly "getting it." (Felder & Soloman, n.d). The *judging trait* can predict sequential and global learning styles. This means that people who are high in judging temperament are most likely sequential learners who tend to gain understanding in linear steps, with each step following logically from the previous one; they are less likely global learners who try to learn things by getting first the big picture before learning specific things. The *perceiving trait* can predict sensing and intuiting learning styles. Perceiving temperament has something to do with ones adaptability, persons who are high in this temperament can be intuiting learners who adapt in the world by learning though conceptualization, innovation and formulations. In

the same way, people with perceiving temperament can be sensing who express adaptability by inclining on factual information and following methodical steps. The *thinking* and *feeling traits* did not yield any significant result when tested as predictors to the 8 learning styles. The thinking temperament is related to logic and analysis while the feeling temperament is related to warmth and sympathy. In MBTI, these temperaments are typically differentiated by genders. One of the possible reasons which may have affected the results of this study concerning thinking and feeling temperaments is the imbalance in terms of number of participants across genders. It can be noted that the female participants in this study is only comprised of 24% of the total no. of samples and they are reported with higher mean scores in feeling temperament than the male participants. Thus, further study with a balanced number of male and female participants is suggested.

Learner-centeredness in education involves the assessment of relevant abilities, traits and characteristics. Through assessment, educators can provide the most appropriate instructional intervention based on the specific needs of students. Personality and learning styles as explored in previous studies have significant impact on students' academic performance; thus, these constructs should be part of institutional testing and evaluation of students aside from the usual assessment of cognitive abilities (i.e., aptitude, intelligence, achievement).

In consonance with the findings of previous researches, the data in this study significantly expresses that engineering students as individuals are unique or diverse. This diversity warrants a consideration on the part of engineering instructors as to the methods and techniques that they may use in teaching engineering students. In relation to this, certain recommendations are offered to address the learning needs of engineering students. [1] The institution should provide a systematic mechanism in order to avoid the possible negative effects of mismatches between students' learning styles and instructors' teaching styles. Ignoring the potential negative impact of mismatches may lead into several drawbacks like attrition rate in terms of enrollment and student-retention percentage; this may also cause possible problems in teacher-student relationships; thus, a proposed learner assessment system is presented (see Appendix C). [2] For further researches, the investigations on the possible correlation of engineering ILS with other variables like the results of their entrance examination as well as their GWA before entering college may be considered as significant follow through studies. Through this, the Institute will be able to determine all the possible contributing factors which can be used as predictors of students' learning styles and preferences. [3] Concerning faculty development, engineering schools should provide seminar-workshops to train faculty members on various teaching methodologies that will effectively cater the learning needs and expectations of engineering students.

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Appendix A
MBTI Types and Learning Strategies

ISTJ Linear learner with a strong desire for order. Prefers hands-on, direct experience, audio-visuals, lectures with well-defined goals. Enjoys working alone. Prefers practical tasks.	ISFJ Linear learner with strong need for order. Likes listening to lectures, audio-visuals, and practical assignments. Enjoys working alone.	INFJ Global or linear. Wants to study theory first, then applications. Enjoys working alone. Prefers open-ended instruction. Likes harmony in class.	INTJ Global or linear. Wants to study theory first, then applications. Enjoys working alone. Prefers open-ended instruction. Good at pen-and-paper tests.
ISTP Linear learner. Needs help getting organized. Likes hands-on, direct experience, lectures and audio-visuals. Enjoys working alone.	ISFP Linear learner. Needs help getting organized. Likes hands-on, direct experience, audio-visuals, and practical assignments. Needs well-defined goals and harmony in class. Enjoys working alone.	INFP Global learner. Needs sensitive instructor. Likes reading, listening, and autonomy. Wants to study theory first, then applications. Likes harmony. Prefers open-ended instruction. Enjoys working alone.	INTP Global learner. Needs sensitive instructor. Likes reading, listening, and autonomy. Wants to study theory first, then applications. Good at pen-and-paper tests. Prefers open-ended instruction and enjoys working alone.
ESTP Linear learner. Needs help getting organized. Likes to know "why" before doing an assignment. Likes group projects, class discussions, teamwork, hands-on, direct experience, and audio-visuals.	ESFP Linear learner. Needs help getting organized. Likes hands-on, direct experience, audio-visuals, practical assignments, and class reports. Needs to know "why" before doing an assignment. Likes orderly, well-defined goals.	ENFP Global learner. Needs sensitive instructor. Likes seminars and reading (if interesting). Likes harmony in class, group projects, team assignments, class reports and autonomy.	ENTP Global learner. Needs sensitive instructor. Likes autonomy, seminars, reading and listening. Wants to study theory first, then applications. Good at pen-and-paper tests. Prefers open-ended instruction.
ESTJ Linear learner with strong need for structure. Likes to know "why" before doing an assignment. Likes hands-on, direct experience, group projects, class reports, team projects, practical tests and audio-visuals.	ESFJ Linear learner with strong need for structure. Needs well-defined goals and to know "why." Values harmony in group work, team projects and class reports. Likes audio-visuals and practical assignments.	ENFJ Global or linear. Likes seminars, reading (if interesting). Likes harmony in class, listening, and pen-and-paper tests. Prefers open-ended instruction.	ENTJ Global or linear. Likes seminars, reading (if interesting), group projects, listening, class reports, team assignments, and pen-and-paper tests. Prefer open-ended instruction.

Appendix B
Learning Styles Results (ILS)

NC STATE UNIVERSITY

Learning Styles Results

Results for: MR. X

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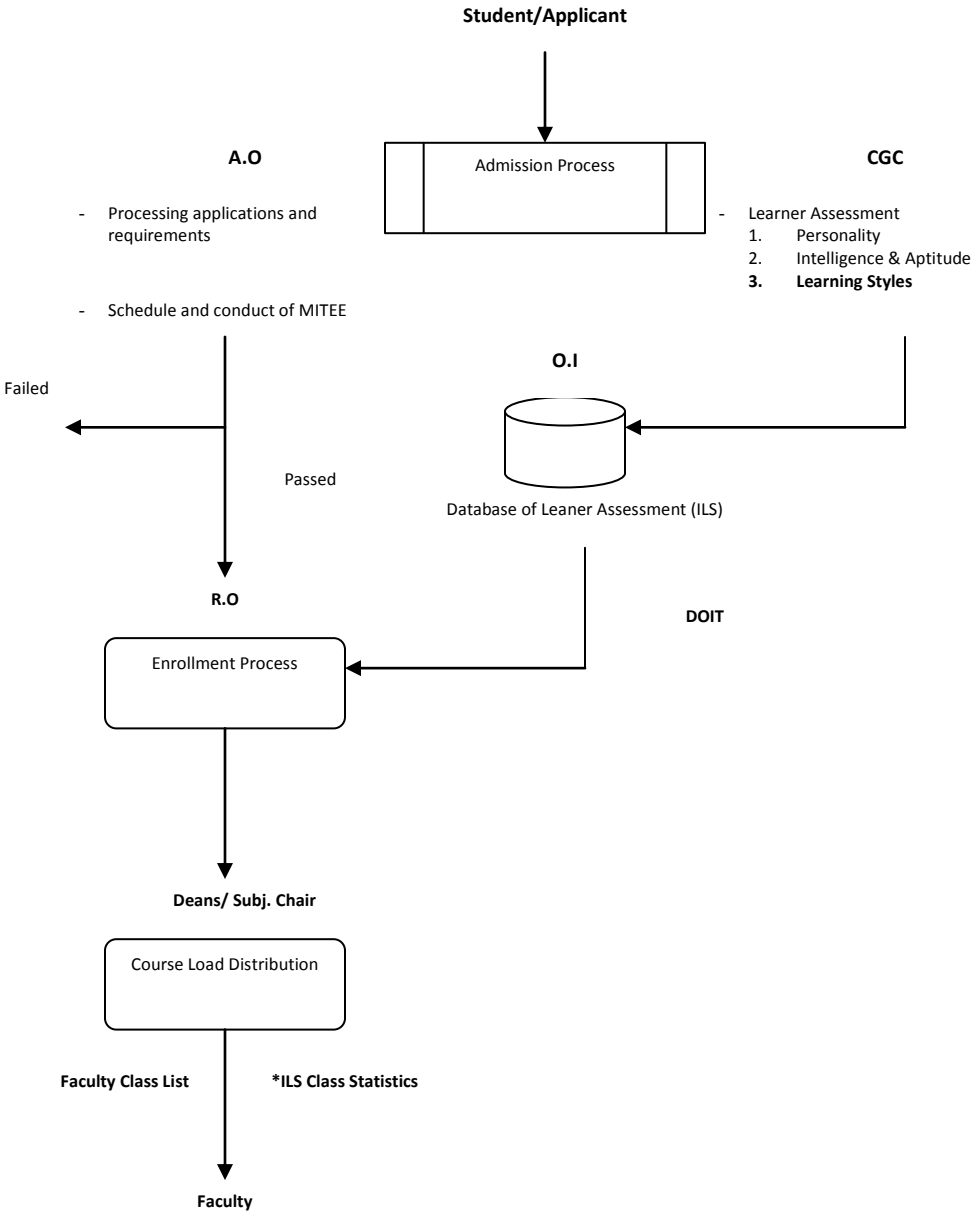
ACT                  X                 REF
  11 9  7  5  3  1  1  3  5  7  9  11
                  <-- -->
SEN          X                     INT
  11 9  7  5  3  1  1  3  5  7  9  11
                  <-- -->
VIS       X                        VRB
  11 9  7  5  3  1  1  3  5  7  9  11
                  <-- -->
SEQ                  X             GLO
  11 9  7  5  3  1  1  3  5  7  9  11
                  <-- -->
```

If your score on a scale is 1-3, you are fairly well balanced on the two dimensions of that scale.
If your score on a scale is 5-7, you have a moderate preference for one dimension of the scale and will learn more easily in a teaching environment which favors that dimension.
If your score on a scale is 9-11, you have a very strong preference for one dimension of the scale. You may have real difficulty learning in an environment which does not support that preference.
We suggest you print this page, so that when you look at the explanations of the different scales you will have a record of your individual preferences.
For explanations of the scales and the implications of your preferences, click on Learning Style Descriptions.
For more information about learning styles or to take the test again, click on Learning Style Page.

Appendix C
A Proposed Learner Assessment System



Prof. Jonathan Macayan is currently the head of the Department of Psychology in Mapua Institute of Technology (2007-Present). He advocated and pioneered the interspersion of technology to the curriculum of AB and BS Psychology in MIT; hence coined the term "PSYTECH" curriculum. At present he is pursuing his PhD in Educational Psychology specializing in Quantitative Methods at De La Salle University. Aside from being an educator, he is a so active in the professional practice as consultant in forensic or psycho-legal cases, organizational and human resource development, environmental impact assessment-social acceptability aspects (EIA), work environment measurement (WEM)-human factors and currently a research consultant for the Philippine Association of Technology Education (PATE) research discipleship program.