Graduation in Engineering Related to Personality Type and Gender

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Abstract

The Myers-Briggs Type Indicator (MBTI) was completed by most students (n=1865) entering the University of Western Ontario (UWO) engineering program during the years 1987-1993 and has provided a stable personality profile of the engineering entry class. The personality type of this entry class of Canadian engineering students shows cross-cultural differences from similar data for American students. The UWO entry class are also significantly I_TJ (introverted, thinking and judging) in comparison with other Canadian first-year students and, additionally, the UWO engineering program graduates an even larger proportion of students with these same I_TJ preferences. On the other hand, E_FP (extraverted, feeling and perceptive) types are under-represented in the entry class yet feature significantly both in the group of students who withdraw after or during first year and also in the group who transfer out of engineering and graduate in other non-engineering disciplines. The engineering profession would certainly benefit from a larger proportion of E_FP types who by nature adapt well to change, enjoy variety and action, are interested in people and are good communicators!

In general those personality type trends which are statistically significant are those for the total group (1865) or for the male students (1601) rather than for the smaller group (264) of female students. However the female engineering students although they are significantly more ENFJ than the male engineering students both in comparing the entry groups and in comparing the engineering graduate groups are nevertheless at least equally successful (68%) as the males (56%) in graduating from the engineering program.

This paper highlights the main connections between personality type and progress of students through the engineering program in terms of retention, choice of engineering discipline and engineering graduation and compares the data for male and female students.

Introduction

Professional engineers both in Canada[1] and the U.S.[2] have identified an increased future demand for engineers who not only have broad-based technical competence but also the adaptability to cope with societal and technological change. In order that the profession can function in an increasingly multiracial and multicultural workplace engineering schools must attract all races and both genders. These future engineers will need an appreciation of society's environmental concerns, a commitment to the solution of environmental problems and the interpersonal skills to work effectively in groups towards their solution. It would therefore be of serious concern if engineering schools were unable to attract, or maybe retain, those students whose personality preferences would dispose them to be good communicators, outgoing, creative and naturally attuned to consider the human aspects of any situation.

A longitudinal study of a seven-year cohort of entry engineering students at the University of Western Ontario (UWO) is investigating the academic performance, the choice of engineering discipline and, eventually, the job satisfaction after graduation as a professional engineer in terms of personality type as recorded by the Myers-Briggs Type Indicator (MBTI). The comparison of the personality types of male and female engineering students shows the female students to be more naturally outgoing and people-oriented, more inclined to value interpersonal and communication skills ; the same talents that will be so necessary for the effectiveness of the engineering profession in the future. Any changes to the engineering schools, therefore, which result in producing more female engineering graduates have the added bonus of also injecting badly needed people skills into the profession.

This paper summarizes in relation to personality type the academic progress for a seven-year cohort of UWO engineering students and presents data on the students choice of discipline, attrition and graduation results for both male and female students.

The Myers-Briggs Type Indicator

Jung's theory of psychological types assumes that much apparently random human behaviour is really quite orderly and consistent and reflects the different ways persons take in information and make decisions. The Myers-Briggs Type Indicator is a self-report instrument based on Jung's theory of psychological types. The instrument returns the respondent's preferences on each of the four dimensions extraversion/introversion, sensing/intuition, thinking/feeling and judging/perceptive. Thus the MBTI describes sixteen possible types such as INTJ, ENFP, etc. which result from the dynamic interplay of these four preferences. All types are good, all types are normal, and none is superior to the others. However, the preferences of one type may match the demands of particular situations better than the preferences of other types.

The eight MBTI preferences are well described in the literature, especially by McCaulley[3], and the following are simply brief descriptions of these preferences. Some people are oriented to a breadth of knowledge approach with quick action; others are oriented towards thoughtful and deep reflection of concepts and ideas. Jung calls these orientations extraversion(E) and introversion(I). Some people are attuned to the practical, hands-on, common-sense view of events whereas others are more attuned to implications, possibilities and meanings of events. These styles of perceiving are known as sensing (S) and intuition (N). Some people typically draw conclusions or make judgements objectively, dispassionately and analytically; others weigh human factors, consider societal implications and make judgements with personal conviction as to their value. These decision-making styles are called thinking (T) and feeling (F) respectively. Lastly, some people gather only enough information to make a decision, then stay on a direct path towards that goal whereas others are more open to changing situations and new developments which might require changing strategies or setting new goals. These preferences are called judgement (J) or perception (P).

The sixteen possible personality types for any group of MBTI respondents are usually displayed as a 4X4 arrangement known as a type table. These MBTI type distributions for particular student groups may readily be compared with the type tables of other student populations using the Selection Ratio Type Table (SRTT) software[4] ,which uses 2X2 chi square tests to check for

significant differences (at a probability level of at least $p < 0.05$) between the two distributions.

The results shown below, in part a summary of previous work [5,6], are derived from the output of such comparative SRTT chi-square analyses which generate sample differences not only as main effects on the four bi-polar dimensions but also as cross dimension letter pairs such as IJ, FP, ES etc and also for combinations of three and four letters. Each of the SRTT outputs generates forty-four such comparative statistics. The results below do not show all these detailed type difference combinations but highlight the more significant (at a probability level of at least $p < 0.05$) main effect type difference trends obtained from the SRTT analyses.

Results

Cross-cultural American / Canadian type differences and gender

A cross-cultural comparison of the personality types of two groups of American and Canadian students is shown in Table 1. The MBTI types of a group of first-year Canadian general science and humanities students (U. of Ottawa, Casas[7]) is compared with the types of a large group of American traditional college age students (MBTI Atlas[8]) and shows that the Canadian students, both male and female, are significantly more N than the Americans and that the Canadian male students are also more IN_P.

Data from the current study provides another cross-cultural comparison, this time of engineering students. The Canadian UWO engineering students , both male and female, in contrast to American engineering students from an ASEE six-school consortium[3] are significantly more I__P and the male students are also more I_FP.

Table 1 : American / Canadian type differences and gender.

	Population (n)	**Sample (n)**	**Type difference of sample**
Female	U.S. trad. age college (14519)	U of Ottawa anglophone (464)	_NT_
Male	U.S. trad. age college (12637)	U of Ottawa anglophone (381)	IN_P
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Female	ASEE entry engineers (365)	UWO entry engineers (264)	I__P
Male	ASEE entry engineers (1667)	UWO entry engineers (1601)	I_FP

Although more studies are needed to confirm these trends, it is suggested that Canadian students, both male and female, are more I__P than their American counterparts and that Canadian male engineering students are more I_FP than American male engineering students.

These cross-cultural differences on the I and P dimensions support the view that American students are generally more outgoing and realistic, organised and goal-oriented (i.e. more E and J) than their Canadian counterparts. Such differences also emphasise that MBTI research findings should only be generalised cross-culturally with caution.

Engineering students / general students type differences and gender**.**

Table 2 shows the results of type comparisons between engineering students and general first-year students. The American comparison is between the ASEE six-school cohort[3] of engineering students and the large group of traditional age college students and a similar comparison of Canadian students is between the UWO entry engineering students and the University of Ottawa anglophone science/humanities students . Both American and Canadian entering engineering students are seen to be significantly more __TJ than the general first-year entry, and also seem to differ from their respective general student populations on the S/N dimension; the American engineering students being more N than their general student population whereas the Canadian engineering students are more S than their general student group. This apparent difference between the American and Canadian engineering groups on the S/N dimension could be due to differences either between the general student populations or to differences between the engineering student groups. It has already been shown at Table 1 that the general Canadian student group is more N than the general American college students, so this S/N difference is between the general student groups used in the comparisons.

Table 2 : Engineering student type differences and gender.

	Population (n)	**Sample (n)**	**Type difference of sample**
Female	U.S. trad. age college (14519)	ASEE entry engineers (365)	_NTJ
Male	U.S. trad. age college (12637)	ASEE entry engineers (1667)	INTJ
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Female	U. of Ottawa anglophone (464)	UWO entry engineers (264)	ISTJ
Male	U. of Ottawa Anglophone (381)	UWO entry engineers (1601)	_STJ

If the entry engineering students, Canadian and American, are compared directly, as shown in Table 1, there is no difference on the S/N dimension for male or female students but the UWO Canadian male students are significantly more I_FP.

In summary, the engineering students seem to be more I_TJ than the general college students although more research data is needed to confirm the trend towards introversion. This I_TJ emphasis fits the common concept of college engineering programs as requiring mostly individual work centred around objective, logical problems and busy with laboratory and assignment deadlines.

Comparisons of male students / female students personality types

A direct comparison of the MBTI personality preferences of male and female students is shown at Table 3. The personality types of the female students are consistently more E_FJ in comparison with the personality types of the males. This trend holds true for both American and Canadian students, for both general students and engineering students. This result suggests that the female students tend to be more naturally outgoing, to be more disposed to develop people skills and to have a preference to be more organized and systematic than the male students.

Table 3 : Student personality type and gender.

Male Population (n)	**Female Sample (n)**	**Type difference of female sample**
U.S. trad. age college (12637)	U.S. trad. age college (14519)	ESFJ
U of Ottawa. anglophone (381)	U of Ottawa anglophone (464)	E_FJ
ASEE entry engineers (1667)	ASEE entry engineers (365)	E_FJ
UWO entry engineers (1601)	UWO entry engineers (264)	ENFJ

Engineering graduation, personality type and gender

The current status of the 1865 students in the seven-year UWO cohort indicates that 57 % of the group have already graduated in engineering and a further 7% are still registered in the

engineering program so probably will graduate. Another 16% have graduated or will graduate in other non-engineering UWO programs, bringing the total proportion of eventual graduates from the original entry cohort to 80%. The remaining 20 % of students withdrew from the university in most cases because they were required to do so because of their substandard academic performance.

The graduation data at Table 4 shows that the male engineering graduates are more I_TJ than the entry group and that the male students who graduate within the minimum time of four years, usually the better students, are more ISTJ. The American data from the ASEE six-school consortium showed that retention in the engineering program was associated with I--J. Insofar as the American students were already significantly more __T_ than the Canadian students at entry, it seems that both engineering programs show a predisposition to attract and graduate students, at least male students, with an I_TJ preference. This result is in general agreement with type theory[9] which predicts that general academic aptitude is associated with IN_P and aptitude for analysis courses tends to associate with T. Additionally , application to studies is associated with J.

Table 4 : Engineering graduation, type and gender.

	Population (n)	**Sample (n)**	**Type difference of sample**
Female	UWO entry engineers (264)	UWO engineering graduates (180)	IN__
Male	UWO entry engineers (1601)	UWO engineering graduates (891)	I_TJ
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Female	UWO entry **e**ngineers (264)	UWO four-year graduates (96)	no sig diff
Male	UWO entry engineers (1601)	UWO four-year graduates (469)	ISTJ

The female engineering graduates showed a tendency to be more IN__ than their entry group, but the number of female students is small and less likely to show statistically significant differences. The females in comparison with the males were more ENFJ both when entry groups were compared and also when graduate groups were compared. This female personality preference would have suggested that the females were less suited to perform well in the I_TJ engineering program. This was not the case however as the female graduation rates (68% overall, 36% four-year) were higher than the male graduation rates (56% overall, 29% four-year). This

result highlights that one obvious way to increase those personality types which are currently in a minority amongst the graduating engineers would be to increase the numbers of female students.

The most persistent type letter common to all the graduating groups including female students is J (judging). This serves to underline the fact that engineering programs are busy programs with lots of assignments , laboratory reports and design projects and it is the orderly and systematic J's who thrive in this world of deadlines and schedules.

Attrition, personality type and gender.

The proportion of the total engineering entry students who withdrew from both engineering and the university was 20% and there was a significantly greater proportion of male students than female students in this attrition group. If this attrition group was separated into first-year withdrawals and upper year withdrawals, it was found that the proportions of first-year withdrawals were statistically similar for males and females but that the proportion of upper year withdrawals were significantly more for the male students.

The personality types of students withdrawing from engineering is shown at Table 5.
The proportion of withdrawals amongst female students is significantly lower than for males and the female withdrawal group show no particular type preference, partly due perhaps, to their smaller numbers being too low to indicate statistical trends. The total male withdrawals on the other hand show a significant preference for _SFP and the first-year male withdrawals are ESFP. It would seem that many male students who experience a lack of fit between their E_FP preference and the I_TJ program do so in their first year and do not survive at university for more than one year.

Table 5 : Engineering attrition, type and gender.

	Population (n)	**Sample (n)**	**Type difference of sample**
Female	UWO entry engineers (264)	Total withdrawals (30)	n.s.d.
		First-year withdrawals (17)	n.s.d.
		Year 2+ withdrawals (13)	n.s.d.
Male	UWO entry engineers (1601)	Total withdrawals (344)	_SFP
		First-year withdrawals (149)	ESFP
		Year 2+ withdrawals (195)	n.s.d.

Type and choice of engineering discipline at UWO

After the common first year program the engineering students select one of the five disciplines; chemical, civil, electrical, materials or mechanical.

Any significant connections between choice of discipline and personality type is shown in Table 6. There is a significantly larger proportion of female students choosing chemical engineering and a significantly smaller proportion of females selecting electrical engineering. As the predominant type of the students choosing electrical is INTJ, so it is not inconsistent with personality type that the female students, who have already been shown to be more ENFJ than the males, might be under-represented in the electrical engineering discipline.

The students selecting chemical or materials engineering were not significantly different by type from the entry group. The students selecting civil were significantly more S, which probably demonstrates their preference for the real, practical, hands-on aspects of civil engineering.

Table 6 : Choice of engineering discipline and type.

	Predominant type of sample	
Discipline	**Male students base entry** (1601)	**Female students base entry** (264)
Chemical	n.s.d.	n.s.d.
Civil	_ST_	_SF_
Electrical	INTJ	n.s.d.
Materials	n.s.d.	IN_P
Mechanical	_NT_	__T_
Other programs	ENFP	ENFJ

Male students who transferred from engineering and subsequently graduated in other programs at UWO were significantly ENFP compared with the engineering entry class. This group of male students successfully graduating in other programs has the exact opposite type to the type of the four-year, male, engineering graduates (ISTJ), which emphasises that personality type is not indicating the academic ability to graduate so much as the fit between student's interests and the demands of different university programs.

The female students who graduated in other non-engineering programs were more ENFJ than the female engineering entry, who, we have already shown, were more ENFJ than the male engineering entry. Nevertheless, the proportion of female engineering students who graduate in

other programs (10%) is only the same as the proportion of male students (11%) even though the female personality type is more similar to the type of the graduates in non-engineering programs.

Implications for changes to the engineering programs

The engineering profession needs all personality types especially those people who are good communicators, outgoing, creative and naturally attuned to consider the human aspects of any problem. Most engineering courses are presented in a way that better suits students with a preference for introversion, intuition, thinking and judging. Consequently, students with an I_TJ preference dominate the engineering graduate group, while male students with an ESFP preference are over-represented among withdrawals and male students with an ENFP preference are over-represented in the group which transfers and graduates in other disciplines. Therefore program additions which accommodate the preferred learning styles of E_FP's should result in increased retention in engineering. An added bonus would be that any changes made to accommodate E_F_ learning preferences would appeal especially to female students who are significantly more E_F_ than the male students.

Specific suggestions[10] for modification of the program would be to incorporate more active group work (E and F); more spontaneous discussion, informal problem-solving and creative discovery tasks (P); discussion of aesthetics, ethics and social factors, work with mentors and groups (F); and more specific, practical, hands-on realistic tasks (S). Insofar as student withdrawals from the engineering disciplines are highly P, the single most important change to increase student retention would be to help students to organise their time, systematically allocating it to different subjects and to the prompt completion of assignments and laboratory reports.

Conclusions

This study shows that the MBTI provides an insightful perspective on the personality preferences of different groups of engineering students and their progress through the engineering program. More studies are needed to confirm the following results:

1. Canadian engineering students, both male and female, are more I__P than American engineering students.

2. Canadian entry male engineering students are more _STJ than the general first-year students and the female engineering students are more ISTJ.

3. Male engineering graduates are more I_TJ than the entry group and the four-year graduates are more ISTJ. The female engineering graduates are more IN__ than the entry group.

4. Although female engineering students are more ENFJ than the males, both when entry groups are compared and also when engineering graduate groups are compared, they are at least equally successful in the engineering program.

5. Male students withdrawing from the university are significantly more _SFP than the engineering entry group.

6. In comparison with the engineering entry class there is a tendency for both male and female students selecting Civil Engineering to be more _S__ , for male students selecting Electrical Engineering to be more INTJ and for those students, both male and female, graduating in other non-engineering programs to be more ENF_.

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