

# A Student's Perspective on the Effectiveness of Personality and Learning Tools in Engineering Education

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**Abstract:** In 2008 and 2009, first year engineering students at the University of Adelaide were introduced to several personal learning-development tools as part of their coursework on communication and teamwork. The Myers-Briggs Type Indicator and Kolb's Learning Styles were the main focus, with minor assessment included based on both tools. Myers-Briggs Type Indicator and Kolb's Learning Styles both offer an insight into the inner workings of a team; why some teams are successful and why some teams do not work effectively together. Students were then encouraged to use the knowledge gained through these studies and apply to later teamwork based assessments, both in this course and onto future courses. Through the study of both Myers-Briggs and Kolb, students were given the opportunity to gain a better understanding of themselves in the hope this would further develop the skills being taught in the course. This paper investigates the effectiveness of these two learning techniques in teaching teamwork and communication skills from a student's perspective and the general consensus of other students who participated in the course.

## Introduction

With new technologies continually developing and emerging, together with human knowledge and understanding of the world increasing, it has never been a more exciting time to be an engineer. Engineering firms strive to 'outdo' one another as they compete to become leaders in industry. As a student, considering the capabilities and innovation of professional engineers, it is inspiring to witness what people are capable of creating. However, knowledge and ingenuity can only progress an organisation of engineers 'so far' when they all must work as one to achieve success. Barry Spiker from Rath and Strong Incorporated states that engineers need to be "connected to the overall vision of the company." (n.d. cited in Taninecz et al, 1996). Thus effective teamwork and communication skills have become vital for engineers if they are to be successful in their field of expertise and ensure the success of the company for which they work.

Engineering firms seek engineers with a developed personality and a set of skills, which extend beyond the scope of their field of expertise (see for example Back & Sanders 1998, Darling 2003, Lappalainen 2009). This view is also supported by evidence from the growing number of Engineering positions which advertise for high level teamwork and communication skills as part of the position criteria. For this reason, first year mechanical engineering students at The University of Adelaide are introduced to concepts of academic and professional communication, including teamwork, as part of a combined Design Graphics and Communication course. The aim of doing so is to introduce students to situations in which they must rely upon teamwork and communication skills in order to ensure effective outcomes, as well as to initialise awareness of the importance of these skills as students continue on through their chosen degree and into the work force.

Whilst the development of oral and written communication skills courses within university engineering programs have been documented by a number of researchers and curriculum developers worldwide (see for example Artemeva et al 1999, Einstein 2002, Najar 2001) including The University of Adelaide (Missingham 2006, 2007), developing teamwork learning in a 'generic' first year course posed a unique challenge. During the 2008 and 2009 courses, students were introduced to Myers-Briggs Type Indicator (MBTI) (see for example Myers 1980, Culp & Smith 2001) and Kolb's Learning Styles (KLS)

(see for example Kolb 1979, Kolb & Boyatzis 2001, Stice 1987) and Maslow's Hierarchy of Needs (see for example Maslow 1943, Maslow 1954, Maslow 1969, Lappalainen 2009) to provide some theoretical background to the students' understanding of how and why teams may operate in different ways. Students were also introduced to simple versions of MBTI and KLS evaluation tools. Students from the 2008 course were tasked with completing a simple online MBTI test (Kisa n.d.); chosen because it is both freely available and easily accessible by students. Students who completed the 2009 course were tasked with completing the same online MBTI test as well as a simple online KLS test (University of Birmingham, 2010). Similarly to the MBTI test, the particular form of the KLS test was chosen because it is freely available and can be easily accessed and completed by students. These theories and the results from the tests were used to help students recognise their strengths so that they could attempt to develop their weaker areas throughout the course.

This paper will briefly discuss the importance of teamwork and communication skills in the engineering industry as well as examining one approach used to facilitate engineering students' learning in these areas. The focus of the paper is on the fundamentals of MBTI and KLS as learning tools followed by an analysis of students' comments regarding the effectiveness of raising awareness of teamwork skills through the use of MBTI and KLS. The use of Maslow's Hierarchy of Needs as part of learning in relation to teamwork will not be examined in any depth in this paper.

## Importance of Teamwork and Communication Skills in the Engineering Industry

'Inter-organisational Teamwork', and intra-organisational teamwork, refer to the collaboration and cooperation between project members, contractors and clients in a manner that allows each participant to feel that they have made a significant contribution towards the end goal (Chan et al 2001 cited in Whitman et al, 2009). The beneficial aspects of teamwork and communication being applied effectively throughout the engineering industry have extensively been examined by numerous researchers. Coates et al, (2004) identify managerial coordination as being an extension of effective communication. That these "...organisational socialisation experiences" in the engineering industry "are critical for (engineers) organisational commitment and long-term performance" is explored by Kowtha (2008). Additionally, Chen and Lin (2004) identify the beneficial aspects of a multifunctional team as being able to offer improved communications, stronger identification and commitment to the assigned tasks and a focus on cross-functional problem solving. The corollary of these benefits is discussed by Culp and Smith (2001) who state that team associated problems may "often (be) blamed on 'poor communication,' an overly broad label for a range of personality differences that can create tensions and misunderstandings." In earlier work, Taninecz (1996) reports that teamwork increases the likelihood of success for new products. Taninecz also claims that corporate revenues for new products released within the five years prior to publication, of his research, increased from 10% – 18% to as much 30% – 50% as a result of effective teamwork. It is evident, then, by today's standards that teamwork and communication skills are vital to the industry and to graduating engineers.

It is through the successful application of organisational teamwork that an engineering firm can capitalise on the resultant benefits. However, for the application of teamwork to be effective in practice, the process is greatly improved if graduate engineers have been prepared with the appropriate teamwork and communication skills.

## Introducing Teamwork skills to Engineering Students

Often engineers have a strong desire to work individually and will avoid working with others when they deem it unnecessary. This situation was clearly demonstrated by a large group of engineers involved in a management-development program in the United States. Thompson (1996) describes how the engineers involved were broken up into small clusters and given a geometric counting task. Thompson explains how the majority of engineers attempt the problem without any endeavours made to collaborate with those sitting in their groups despite the fact that challenge presented would have been greatly simplified if attempted as a group. Taking this example into consideration, it is understandable that engineering students typically have a strong disposition towards anything related to teamwork and communication. The comments below, are representative of the majority of views expressed, by a randomly selected group of mechanical engineering students, prior to being introduced to teamwork and communication skills:

“Teamwork and communication skills aren’t something you can be taught. These skills require developing, not being lectured on.”

- Chris

“I find it aggravating to be forced to work with people who may not necessarily make the same effort as I do. You essentially sacrifice your grades to learn about how to fail as a team.”

- Shaun

“Communication [course] components [are] taught in a very self righteous manner [and don’t] account for different communication techniques and styles.”

- Orddom

Teaching engineering students teamwork and communication skills in a manner that is stimulating to the student and beneficial to the long-term needs of industry is a challenge that is important to address. With these issues in mind, a combined Design and Communication course was taught at the University of Adelaide in both 2008 and 2009 in which student centred learning was encouraged.

Based on notions of constructivist learning, in particular those of Vygotsky (1978) and Bruner (1960), student centered learning is a pedagogical approach in which students are placed at the centre of the learning and teaching experience and which aims to both engage students in taking responsibility for their own learning as well as building a responsive classroom in which students will think critically and creatively. Introducing theories on personality, learning and human needs provides first year engineering students with ‘tools’ to assist them in taking responsibility for development of their own learning in relation to teamwork.

Myer Briggs Personality Type Indicator, Kolbs Learning Styles and Maslows Hierarchy of Needs were chosen as relevant ‘tools’ for multifarious reasons, including pedagogical and pragmatic;

1. First year engineering studies at The University of Adelaide consists of courses which are considered fundamental to engineering, such as physics and mathematics, but which contain little actual engineering. Practical ‘hands-on’ engineering projects are not part of the first year experience. Engineering students in later years of study are frequently expected to work in teams, yet only minimal preparation is provided for this process. Students are sometimes ‘thrown in the deep end’ of teamwork situations, often with substantial assessment tasks attached to the outcomes. Therefore, an authentic, achievable (yet complex) set of tasks could be designed around an industry relevant issue, which at the same time could provide first year students with practical and theoretical teamwork experience.
2. Engineering firms are, not uncommonly, known to use ‘personality’ and other types of psychological testing as part of the employment and placement process. MBTI frequently being one of the tests applied. Thus students are exposed to MBTI and are provided the opportunity to think critically about its application before encountering its use in industry.
3. Students from the 2008 first year class, initiated interest in the theories of Kolb, Maslow and Myers-Briggs. This interest suggested an ‘ideal’ topic for bibliographic research, and the application of this research to oral and written tasks. At the same time the inclusion of these theories for investigation by the students reinforces the responsive nature of student centred learning as well as emphasising the value of students own intellect in the education process.
4. All three of the theories, MBTI, KLS and Maslow’s Hierarchy of Needs, have previously been applied to engineering in a number of research situations due to their validity and reliability as ascertained in the field of applied psychology. Studies on this research are readily available thus allowing for the theories to be integrated into the coursework with relatively ease and confidence in the understanding of the material.
5. The large number of resources freely and easily available allows students to extend their individual and team understanding on teamwork in engineering.
6. KLS is focused on an individuals’ learning preferences while MBTI is focussed on an individuals’ personality and can be extended further to analyse learning preferences. However, as both theories are different in their makeup, they allow for different learning preferences, of students, in developing similar skills while also providing an opportunity to develop skills that only one particular tool may address.

After several lectures and small assignments focusing on the importance of teamwork and communication being part of an engineers’ skill set, students were briefly introduced to MBTI and KLS, as well as Maslows Hierarchy of Needs. A new approach to engaging students in the material, as well

as further promoting student centred learning, was the provision of mini lectures on each of these theories by fellow students

The aim of providing peer lecturers is to introduce students to ways of exploring teamwork and communication skills in a potentially fun and interesting manner. The student lecturers achieved an atmosphere within the lecture in which the student audience was relaxed and attentive and at the same time provided positive role modelling of effective modes of engineering communication.

“[The student] lectures were beneficial as each student had a differing way of presenting their chosen 'learning tool' which, over the course of a few lectures, proved to be sufficiently interesting and exciting to draw the attention of the class. A class, which is presented by a fellow student, is more relaxed, and this atmosphere is helpful to the confidence of the speaker.”

- Anonymous

“[The student lectures] very useful. Full of information, and were well presented.”

- Miles

“[The student lectures] showed us how to give a lecture to our fellow students, which will be useful in case we are in that situation in the near future”

- Peter

Introducing students to MBTI and KLS also presented the opportunity to learn more and about themselves and fellow classmates while also building awareness of their own capabilities as individuals and in teamwork. Ideally, this process of critical reflection also promotes the development of independent learning skills. Additionally students were tasked to investigate the theories out of class and to critically evaluate MBTI and KLS (and Maslows Hierarchy of Needs).

## Myers-Briggs Type Indicator

MBTI is a personality clarification tool, which categorises an individual's personality into four distinct 'preference' poles. Each pole is responsible for an aspect of your personality in which a personality is categorised in accordance with the two opposite extremes of each pole. The poles are as follows:

- Introversion (I)/Extraversion (E)
  - iNtuition (N)/Sensing (S)
  - Thinking (T)/Feeling (F)
  - Judging (J)/Perceiving (P)
- (Myers 1980)

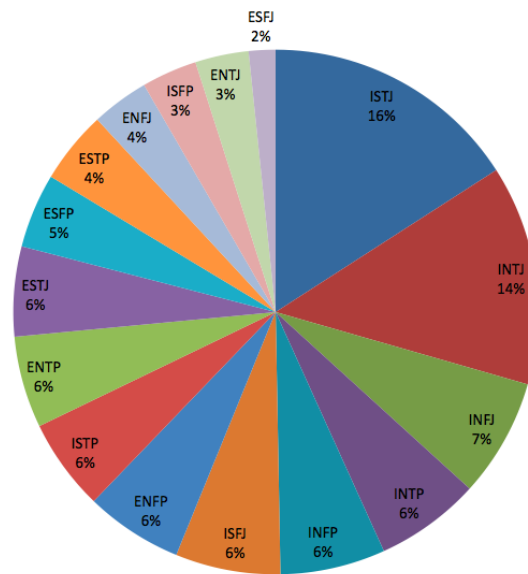
Whitman and Missingham (2009) outline the characteristics of each pole to the theory as follows.

- The I/E preference determines how individuals orientate themselves around others. An individual may prefer to spend their time living in the physical world and interacting with people around them (E) while others may spend more time inside their head, slightly separated from reality (I).
- The N/S preference determines the process by which we prefer to take in information. Individuals may prefer to see the 'big picture' when learning something new (N) while others may prefer to process the smaller details before seeing how all the combined ideas will come together (S).
- The T/F preference determines the criteria that we prefer to base our decisions on. Some people make decisions that usually follow a logical and sometimes impersonal pattern (T) while others may consider how they feel about a situation and how their decision may impact on others (F).
- The J/P preference determines how we coordinate ourselves with the world around us. Some individuals like living spontaneously and leaving their options open (P) while others will prefer to keep themselves organised and prepared ahead of time (J).

In completing the test, an individual is assigned a personality type, which encompasses each of the preference poles represented as a four-lettered anagram. An individual may receive the personality type INTJ, which indicates that the preference poles associated with that personality are Introversion (I), iNtuition (N), Thinking (T) and Judging (J). As there are four preference poles and each pole contains two opposite attributes that combine to make up a personality. A total of sixteen personality types are available from this test, each corresponding to a unique personality.

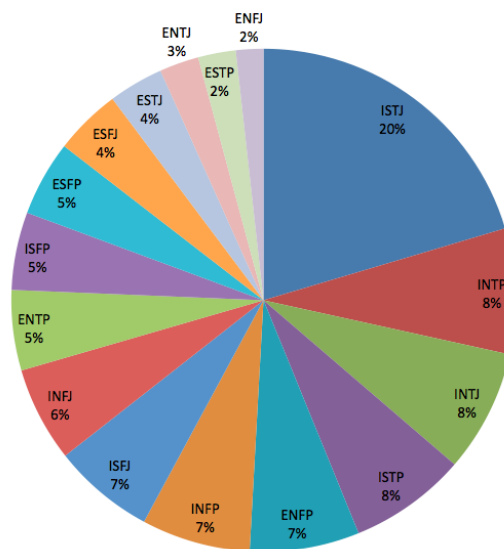
During the 2008 and 2009 combined Design and Communications course, students were tasked with completing a simple online MBTI test in order to encourage the investigation of the MBTI outside of class. Whitman and Missingham (2009) released the results of the 217 engineering students that

completed the test in 2008 as can be seen in Figure 1, and discussed the predominance of ISTJs (16%) and INTJs (14%) in the results noting, through the use of several examples, that these results follow a familiar trend within the industry (Varvel et al, 2004, Culp et al, 2001).



**Figure 1: Percentages of Myers-Briggs Types among 217 First Year Engineering Students, 2008**

Students from the 2009 course were tasked with completing the same online MBTI survey as those that completed the course in 2008. The results of the 231 students that completed the test can be seen in Figure 2. Similar to the 2008 results, the a large percentage of engineering students were comprised of ISTJs (20%), INTPs (8%) and INTJs (8%).



**Figure 2: Percentages of Myers-Briggs Types among 231 First Year Engineering Students, 2009**

Of the two theories, discussed herewith in detail, it is postulated that MBTI is the more powerful and useful of the two. Amongst both the 2008 and 2009 students, there is a clear predominance of ISTJs as well as the other introverted personality types. Whitman and Missingham (2009) also hypothesised that ‘the results will become more defined toward the ISTJ and INTJ personality types [as the particular student cohort progresses through the degree program] due to the nature of engineering being more suited to these preferences, and the possibility of student retention in engineering studies also reflecting these preference types.’ These personality types are also generally individuals who prefer a very theoretical and independent approach to learning. Once these tendencies amongst

engineers have been recognised and understood, educational facilities and engineering firms can work towards maintaining working environments that suit the majority while making accommodations for those of a differing personality. At the same time however, it is important to emphasise that whilst MBTI is a theory that may be useful it is not definitive. An understanding of MBTI may allow an individual to work towards improving weaker areas in their learning and to assist an ability to accommodate people of different personality types and work approaches. Varvel et al, (2004) state that “the value of the (MBTI) test is derived by learning more about oneself and others and gaining a better understanding of the behaviour of someone who has a different personality type.”

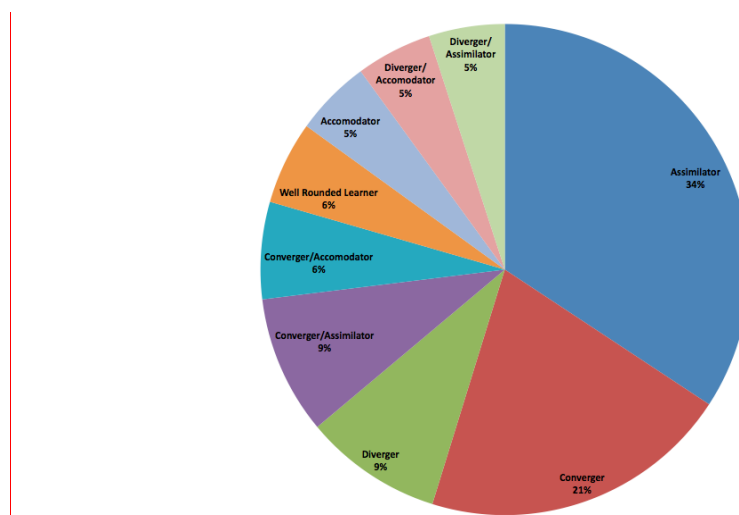
## Kolb's Learning Styles

David Kolb's Learning Styles theory (Kolb & Boyatzis, 2001) and accompanying inventory (Kolb, 1979) determines an individual's learning style from a selection of four preferred methods of accomplishing learning objectives. The four learning styles are:

- Divergers (D)
- Assimilators (As)
- Convergents (C)
- Accommodators (Ac)

The Diverger learning style is known for letting the imagination of an individual run wild in order to create an image of the big picture at hand. Divergers prefer to learn through conversation and brain storming sessions. The Assimilator learning style is in lecture based learning environments where knowledge is passed on from teacher to student in an organised and logical manner. The Converger learning style likes to learn through a trial and error process. In learning and understanding a concept, Convergents like to change the circumstances of a situation in order to examine what consequences will result. The Accommodator is a very 'hands-on' learning style in which the learner prefers to be by oneself and engage in learning by dismantling a concept directly.

During the 2009 combined Design and Communications course, students were asked to complete a simple online KLS test, together with the MBTI test. Whilst students from the 2008 course were introduced to KLS, it was not required that they complete the test. The results of the 219 students that completed the test during 2009 can be seen in Figure 3. As evident from these results, over a quarter of the students (34%) that took part in the 2009 course were Assimilators whilst over half of the students (55%) were either Assimilators or Convergents.



**Figure 3: Percentages of Kolb's Learning Styles among 219 First Year Engineering Students, 2009**

Similarly to the MBTI results, engineers typically have a preferred method of learning. The Assimilator and Converger learning styles are typically more common amongst engineers (Hargrove et al. 2008). This can be explained based on the knowledge that engineers tend to be more logical and unemotional which is a common trait to the Assimilator and Converger learning styles. Acknowledging

this trend among engineers can allow education facilities and engineering firms to direct their activities under conditions that are best suited to the majority and making exceptions where needed for the minority. It was expected that the Accomodator learning style would be more predominant as engineers typically like building things or 'learning with their hands.' These results, however, suggest that a significant number of the 2009 first engineering students surveyed prefer a more theoretical approach to learning. However, it is important to acknowledge that KLS is a theory or framework for understanding different learning styles rather than a definitive tool. While it is useful to recognise what methods best suit a 'typical engineering' approach, it is postulated that student learning may be targeted to the 'Well Rounded Learner' category in KLS as this learning style reflects an integrated level of learning that may potentially produce better prepared engineers.

## **Student Perceptions Regarding the Effectiveness of Myers-Briggs Type Indicator and Kolb's Learning Styles**

In addition to the quantitative data exhibited through the application of the MBTI and KLS instruments, described above, approximately 40 students in total from both the 2008 and 2009 first year cohort enrolled in the School of Mechanical Engineering provided qualitative feedback on the inclusion of these tools in their course work. Students who responded were self selecting; the invitation to participate having been extended to the entire cohort. This relatively small number of respondents is predominantly due to the difficulty in encouraging students to provide feedback once the course has concluded. However, as many students responded positively to the activities included during the course along with first hand accounts observed by the authors, it was apparent that the inclusion of MBTI and KLS helped students to grasp the concepts of teamwork and communication skills in a more entertaining and concrete manner than conventional teaching may provide. The merits and concerns raised by students who provided feedback in regards to the course are represented in the following selection of quotes.

Most students participating in the qualitative survey agreed that it is vitally important for engineers to possess teamwork and communication skills:

"The global industry not only requires teamwork and good communication skills, but the daily circumstances in life requires it as well."

- Nicholas

"It is important to develop these skills at an early age as they will be helpful in your career. As you get older, it would be harder to change your habits and adopt these skills over ones you are already accustomed to."

- Anonymous

"Teamwork is a vital part of engineering as interdisciplinary teams of engineers are needed. Engineers (and people in general) need to understand how to effectively communicate with a large variety of different people who will invariably be in their teams, all of whom will have different backgrounds/upbringings, ethnicity, religion etc. Being able to understand these different people, communicate with them and work with them on a professional level is a very important skill. Hence learning about teamwork and communication skills is an integral part of our university education."

- Anonymous

"[Teamwork and communication skills are] important as many engineering students choose engineering due to a belief that they can avoid teamwork and communication."

- Michael

"Too many students in this course are lacking effective communication skills. I noticed in small groups, it took at least three meetings for most students to feel comfortable. In group presentations many students were obviously daunted by the task at hand."

- Joshua

"Having worked in industry, poor communication between engineers and production staff is where most conflict occurs."

- Luke

“Teamwork is an integral part of engineering and communication is a fundamental part of any successful team. For engineers to be useful they need to be able to work with others in a group efficiently and be able to communicate their ideas not only within the group, but also to the community at large.”

- Sam

“Most the people going through engineering courses have an apparent inability to write properly. Also, in industry, communication is the only thing that will bring engineering projects to fruition.”

- Anonymous

“[Teamwork and communication skills] facilitates better project outcomes and also better relationships between team members and businesses and clientele.”

- Anonymous

“Engineers have to work in teams through uni and constantly in the working environment. Right now I am working in a team of six people at my work experience placement, and am putting the skills we learnt about into practice every day.”

- Elise

A small number of students that presented feedback did not find MBTI or KLS interesting, completely failed to understand the tools being examined or recognise the reasons for including these theories in the course for a variety of different reasons:

“I found [learning about MBTI and KLS] boring and pointless.”

- John

“I already understand how I function and being classified in certain categories is not possible, as everyone is different.”

- Lachie

“We had no opportunity to apply what we had learned about ourselves.”

- Anonymous

“During our studies of [MBTI and KLS], I decided that the tests were quite ineffective at analysing a single group. In accord with this, I found the tests relatively useless in increasing my teamwork ability or my communication skills. Essentially I believe they did not provide me with any skills, which I did not already possess.”

- Sam

“The ideas [described by MBTI and KLS] are all common sense and can naturally be accounted for by an informed and empathic individual.”

- Anonymous

Additionally, some students were initially confused as to why MBTI and KLS would be included in an engineering subject and how these theories could be associated with teamwork and communication:

“Psychological profiling serves little purpose for me as it is in constant dynamic flux, and [is] widely subject to mood. Observation of individuals often gives me better insight into [someone's] state of mind and work ethic.”

- Nathan

“[MBTI and KLS] only highlighted issues of which I was already aware.”

- Jaye

However, the inclusion of mini lectures on MBTI and KLS presented by fellow students 'opened students up' to the ideas and reasoning for including these theories in the course. Students further 'warmed' to the use of these 'tools' after completing associated tasks:

"[MBTI and KLS were] a very interesting and engaging method of analysing personalities and thinking styles, especially when combined with group dynamics lessons, as was presented in [Design Graphics and Communications.]"

- Anonymous

"I especially liked learning about MBTI as it has the potential to tell you so much about your personality if you use it right."

- Amelia

"I really enjoyed getting a better insight into how I and others learn and act, and into each others personalities."

- Elise

Once the student's had been presented with opportunities to think about how MBTI and KLS applies to themselves and to fellow students, they were able to comment on how investigation of these theories allowed them to examine their strengths and weaknesses in scenarios where teamwork and communication skills were put to the test:

"It was good to use skills used in English and to work on something that wasn't heavily Math based!"

- Anonymous

"[MBTI and KLS] helped me understand my self and help give me an overall picture of my weakness, which will help me to become a better engineer."

- Orddom

"[MBTI and KLS showed me] That everyone's different in a group and they can have various way of thinking about problems and solutions."

- Sam

"[MBTI and KLS] both highlight the different ways in which people's minds work, and how the same things can be perceived so differently by different people."

- Anonymous

"I think knowing about different personalities and learning styles helps us to be more conscientious of others in group situations, and because of this, opposing personalities may be more likely to work better together, rather than clashing."

- Kaylina

"[MBTI and KLS] helped furthering my knowledge about the people I met in groups."

- Peter

"[MBTI and KLS] created heightened awareness of different personality types encouraging tolerance while also highlighting personal tendencies."

- James

"MBTI provided insight into the aspects of my personality that could grate on people's nerves, thereby giving me an indicator of what I should work on in a team environment to prevent conflict."

- Anonymous

"[MBTI and KLS] made me realise that there is such a wide variety of people that all work and react in different ways and it is important to recognise these differences to learn how to work effectively in a team."

- Amelia

"[MBTI and KLS] provided insight for ourselves. We could then look objectively at the category we were placed into and determine if it was a true reflection of ourselves. It helped to identify strengths and weaknesses, so that we can grow as a person or at least understand where misunderstandings may occur with different types of people."

- Elise

## Conclusion

This paper examines one approach to the learning and teaching of teamwork and communication skills in a first year Design Graphics and Communication course at an Australian university. The use of personality and learning theories as 'tools' was introduced to assist students develop skills and understanding in relation to teamwork practice.

It is evident that this approach did not suit every student. A small number of students failed to grasp the concepts introduced or the reason for their inclusion in the course while others were unable to understand the connection between a theoretical grounding in psychological and learning tools and their application to teamwork.

However, comments provided together with anecdotal evidence and author observation indicate that the majority of student respondents found that investigating MBTI and KLS theories was a productive and useful approach. As observed, in results from the MBTI and KLS tests conducted, a majority of students in the 2008 and 2009 first year engineering Design Graphics and Communication courses were categorised with personality types and learning styles naturally suited for learning through the teaching of complicated methodologies and theories.

Despite teamwork and communication skills being topics that most engineering students do not feel passionate about learning, the inclusion of MBTI and KLS promoted interest amongst many students and was also successful in promoting the process of student centred learning. It is envisaged that this increased awareness of the importance of teamwork and communication skills in engineering, and an understanding of tools to assist in team building will encourage the development of strong professional skills which students can apply in both the academic and, later, the engineering industry setting.

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