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Abstract

The goal of this project is to provide useful information to the Worcester Polytechnic Institute community on the benefits using the Myers-Brigg Type Indicator to describe learning styles. Information on MBTI types is useful to professors and students alike; it helps assist everyone involved in the education process to receive a better educational experience. This study of the ES2001 Materials class will provide insights into how a class may better serve every type of student, no matter their learning style, equally well.

Acknowledgements

We would like to thank Professor John Wilkes for teaching us about the MBTI, knowledge we used to carry out this project. He helped us in many different aspects of the project, which included the analysis with the SPSS Program and the knowledge of the practical use of the MBTI to create a simple typology of four learning styles. Without him our project would have never gotten off the ground.

We would also like to thank Professor Chrysanthe Demetry who agreed to let us use her class for this study. She has been more than helpful in the progression of this project.

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1. Introduction

People have different preferences, and knowing ones personality type helps them to recognize indirectly what their strengths and weaknesses are as preferences are often associated with strengths. However, sometimes there are preferences that develop for other reasons and it should be everyone's goal to develop their less preferred cognitive skills to the point of competence. The Myers Briggs Type Indicator (MBTI) is an indicator used to help individuals learn their personality type, and today, it is one of the most commonly used learning style indicators; the self knowledge it offers can be empowering. Knowing one's MBTI results can help a person who is struggling with a part of their life, whether it is in the classroom, relationship, or job. Different learning styles are associated with different preferences in learning, methods of studying, processing information, and coming to decisions. Due to these varying patterns of preference, the MBTI can help with understanding a variety of issues, from group interactions and leadership to school, and can even help one find a career that best fits a specific person with given preference.

Using the MBTI as a foundation, research analyzing a student's performance has been done on many levels of education all around the country. From 1997 leading up to the 2003 school year, incoming freshmen at WPI were asked to complete the MBTI. With the thousands of results that the school accumulated, the administration created a database that it hoped would be analyzed and used to help students with different learning styles perform equally well in the classroom and on projects. There is a large amount of interest in this topic at institutions other then WPI as well. This project will add to the data, knowledge, and conclusions that already exists regarding the MBTI, personality

types, and whether or not these types play a significant and predictable role in a student's ability to learn various kinds of material.

A person's learning type consists of a four letter code, one letter being from each of the four scales measured by the MBTI. The first scale is a measurement of introversion (I) and extraversion (E). An introvert will think about something before acting and prefers one-to-one communication and working individually, while an extravert will act before thinking and prefers working cooperatively. The next scale measures sensing (S) and intuition (N). Sensors attend to present opportunities, use common sense, and like concrete experiences. Intuitors attend to future possibilities, use imagination, and like conceptual understanding. Another scale measures the characteristics of thinking (T) and feeling (F). Thinkers tend to make decisions objectively and accept conflict as a normal part of relationships. Feelers tend to make decisions subjectively and are sensitive to people's needs, valuing harmony in relationships. The last measures are judging (J) and perceiving (P). Judgers plan ahead in detail before acting, and they manage life using standard routines and organization. Perceivers are comfortable acting without planning ahead and avoid commitment that would constrain their options in the future. Often used are acronyms when describing someone's type, an example is someone who is an INTP is introverted, intuitive, thinking, and perceiving. (Reinhold)

Previous IQP groups at WPI have dealt with this database and analyzed the results of students in the same class to compare their performance with others of their type, as well as to contrast their performance with others of different types. These previous projects have reported significant findings on the subject, suggesting that there is a link

between learning types, and the way students perform under like conditions. It has been claimed that on average, students of the same type perform similarly, and students of unlike learning types perform differently. At the level of grades, the distribution of A, B, C, and NR grades can differ dramatically by type. Using these previous findings as a background for our study, we looked at the students who took the ES2001 Materials class in A04, specifically to see if the findings of Nathan Shuler's study of a Linear Algebra course and a Signals Analysis (EE) course would replicate or not.

Along with a student's personality type being a factor in the way they learn, the teaching style to which they are exposed and the way the class is organized can alter a student's performance. If the teacher is knowledgeable on the subject, he/she still has to be able to better reach out to all types of students and present information in a way which will be understood by the entire class. A range of strategies is generally best, and those that are less appealing to the instructor tend to get neglected. For example, extraverts prefer working in groups, so a class with cooperative assignments may put them at an advantage while introverts would rather work alone. In a group environment, introverts may feel timid and not be able to communicate with their peers until feeling more comfortable if they ever communicate at all. An extraverted professor may overdo it on the group work and oral presentations, making it hard for an introvert to display their mastery to the best of their advantage. By knowing their students learning styles, professors may be able to accommodate the range of learners in the class more effectively. Obviously it is impossible to accommodate everyone, but a professor has the ability to structure a class so that one type of student is not setup to fall behind, or to excel by the assignments selected and by their relative weight in the grading. In his well

known research on the MBTI and its effects in the classroom, particularly engineering, Felder tells us that it is important to not completely structure a class around the students learning types, but rather to " 'teach around the cycle,' making sure that every style is addressed to some extent" (Felder, 14).

It is not a simple task to accommodate everyone sufficiently. One reason is that in general, there are not equal proportions of people of each of the types. Traditionally, there are more people who are extraverts than introverts and more sensors than intuitive people; this tends to be the case in the general population and most of the literature on the subject. However, it is not true at WPI; the WPI student body is 55 – 60% introverted, 55 % intuitive, 75 – 80% thinking and about 60% perceiving. Also, different aspects of a class appeal to certain personality types. For example, something resembling a multiple choice intelligence test would put intuitive people at an advantage, "Because the symbols of language have to be translated into meaning. That is done by intuition" (Lawrence, 51). One way that a teacher can reach out to all students is to provide options during class and on assignments so that they can choose the option that best fits their type. This is something that an extraverted teacher may be more apt to do than a teacher who is an introvert (Lawrence, 74). The flexibility of a teacher in his/her style of teaching can help benefit the student's performance.

One thing we wanted to get out of this project was a better personal understanding of the topic of personality types and cognitive learning. In addition, our goal is to aid professors and students of the WPI community by studying the relationship between MBTI types and classroom outcomes, so as to improve the overall classroom experiences for future WPI students. We would also like to figure out an effective structure and

grading policy for a class that may have the effect of balancing a class so that all types have an equal chance of success. This can be achieved by further understanding of the MBTI results, and making suggestions on how a professor may improve his/her presentation of material to better reach out to different types of learners. The way we hope to reach this goal is to form a database containing the MBTI results of the WPI students in the current ES2001 course. Given the existences of two prior studies, documented by Nathan Shuler, a third demonstration would be strong evidence that courses throughout WPI are similar with respect to favoring one or another type of learner – but not always the same one. When these results have been analyzed in search for significant findings which were obtained by comparing the different learning styles on each major course assignment to see which ones favor which types of learners, and whether the course overall is easier for one type than another. However, there are many factors involved in this study that are out of our control. For example, the number of students who fall into each type category differs; since each type is not equally well represented our finds are more reliable for some types than others. We have performed significance tests on the results to show whether or not our findings are significant in an effort to compensate for this problem.

The overall purpose of this analysis is to improve the typical class presentation. However, our host Prof. Demetry is not a typical professor, but rather an innovator who was experimenting with this course often the last few years. She uses technology to allow class members to "vote" anonymously on the answers to questions in class and more to the point, has been experimenting with a project assignment in class which was mandatory in the past, but was optional this year. Her hope was that this study would

provide some feedback on the consequences of that decision, and which of the three parts of the course she considers quite different is the most challenging for each type of learner. In short, she wants actionable feedback, and we were determined to try to provide it as well as replicate the prior findings. In the long run, we hope to help professors and students learn which strategies are best suited for each of the major types of learners, so as to assist them in their teaching and learning. This data set alone can only take one part to this ultimate goal, but we hope to make a key contribution

Finally, using this database we have looked at each personality type individually to see how each student faired in the class that was selected to be analyzed. The results have given clear indications as to why some students performed better than others in certain areas of the material. Thus, we conclude that somehow all teachers should have access to the MBTI distribution of their upcoming classes, not the type for each name, but overall. They should have this information for planning purposes and be able to refer to the outcomes in prior classes by types of learners as well. A new Integrated Student Information System (ISIS) is needed to provide this information which ties class data to learning style, and provide the new class distribution anonymously. We note with concern that WPI stopped collecting data with the class of 2006, and thus we had to spend much time, effort and money, collecting data from the class of 2007 and 2008 for the class under study. At the very least, we hope to help make the case for resuming data collection and make ISIS possible in the future.

2. Background

Before fully understanding the results that of this study, it is best to get an idea of what each indicator measures and a good background on the MBTI needs to be presented first.

2.1 MBTI Information

The MBTI, (Myers Briggs Type Indicator) was created by Isabel Briggs Myers and her mother, Katherine Cook Briggs in 1943. This 1943 version of the MBTI (Form A) was the first and would later be developed into what we use today (Form M). Before her death at the age of 82, Isabel wrote a book to explain the personality types associated with the MBTI. In her book, Gifts Differing: Understanding Personality Types, she breaks down the 16 different personality types and describes each factor that determines ones personality type.

In this explanation of the personality types, the author stresses that every individual is unique and that everyone's mind works in completely different ways. When describing personality differences Briggs writes "All too often, others with whom we come in contact do not reason as we reason, or do not value the things we value, or are not interested in what interests us" (Myers 1). Because of these differences it is important to understand the personality types, most importantly yours, and those of the people around you. Basic differences in people are derived from the way they perceive and how they make judgments. "Together, perception and judgment, which make up a large portion of people's total mental activity, govern much of their behavior" (Myers 1). Perception is how a person sees a particular state of affairs, and judgment is how a person acts toward that situation when making a decision. Therefore, when two people act

differently toward a comparable situation, it is most likely a difference in perception or judgment.

Everyone as a child develops one of two dominant ways of perceiving things. The first way of perceiving is a process of sensing by which a person becomes aware of a situation by using their five senses. The second way of perceiving is by way of intuition, where the person subconsciously perceives an outside situation. This intuition is often seen as a "hunch." As children, we naturally choose one of these ways of perception, and in doing this the other naturally fades away and is not used. It is possible for someone to use both ways, but one will always be dominant. "Children have enough command of their mental processes to be able to use the favorite processes more often and to neglect the processes they enjoy less" (Myers 2). Whichever process they prefer, sensing or intuition, that will be their main perception and the other will fall behind, this is known as the SN preference: S for sensing and N for intuition.

Along the same lines, two ways of judging or reaching conclusions is developed as well. The first way of judging is by thinking, a logical process of weighing the facts. The opposite way of judging is by feeling, an inner emotion or reaction. As with perception, Myers theory states that an individual trusts one way of judging over the other. This is the TF preference: T for thinking and F for feeling.

Another basic difference in people's judgment and perception is their awareness of the outer and inner worlds. Introversion focuses on the inner world of concepts and ideas, and extraversion is involved with the outer world dealing with people and things. As discussed before, people are categorized into one of the two groupings, not to say that a person is strictly an introvert or an extravert in all behavior, but people tend to lean one

way or the other by preference. "Well developed introverts can deal ably with the work around them when necessary, but they do their best work inside their heads" (Myers 7). Conversely extraverts work well in hands on activities but under certain situations can deal with ideas. This is known as the EI preference: (extraversion or introversion). The EI preference is independent of the SN and TF preferences. Extraverts and introverts can have any of the four combinations of perception and judgment.

The final preference that indicates ones type is the judgment-perception preference. These two attitudes are used by everyone on a daily basis, but not at the same time. A good example of this can be explained by a person reading a controversial article in a newspaper. Some people will read the entire article with an open mind; others will make up their mind halfway through the article and not care to continue. This is the difference between judgment and perception. "This preference makes the difference between the judging people, who order their lives, and the perceptive people, who just live them" (Myers 8).

We have analyzed a few of the different generalities and inclinations that professors have in the way they structure their class as well as the way in which they teach by looking at previous IQP reports on how two other classes were organized and run. Different classes may consist of different contributions of homework, testing, grading policies, or projects. In general, the MBTI literature suggests that introverted teachers are more apt to control the class in a way which makes sense to them, and are less likely to concern themselves with whether or not the students are adapting well. Extraverts are more likely to change their class in order to make the students more comfortable. Sensing professors tend to prefer concrete ideas and factual information,

but intuitive professors may stress dealing with abstract ideas and concepts. Intuitive professors are more likely to give options to students, which for the most part is more accommodating. A professor who is a feeler rather than a thinker is beneficial to the students as well because they tend to praise (or criticize) the students openly and often to motivate them. (Lawrence 74). Thinkers are more likely to wait until the outcomes are evident and fairly and equally distribute rewards and punishments at the end.

In a study done at North Carolina State University, Professor R.M. Felder reported several interesting findings in the field of Chemical Engineering which applied to our study. It is our belief that a similar type of engineering curriculum to that described by Felder is in use here at WPI. He also reports similarities in the way students performed according to their type. Our group made a hypothesis based on research done by Felder, and by the basic well known differences between the types.

Felder concluded that in an introductory engineering course, which ES2001 is, "Intuitors performed significantly better than sensors in courses with a high level of abstract content." We feel that the first half of the ES2001 course is very abstract, with concepts that are not concrete, but require imagination. By contrast, the second half of ES2001 is more visual, allowing the sensors to have an advantage. It is because of this finding that we predicted there would be a shift in grading throughout the class, with the intuitive students beginning well and slowly eroding, while the opposite would occur with the sensors. They would start out relatively weak, but finish strong with solid improvement.

2.2 Dominant/Auxiliary

No matter what the dominant type of an individual, an auxiliary exists that is used slightly less than the sometimes obvious dominant trait. The J-P dimension of the MBTI Personality test was originally created for the sole reason of determining the dominant and auxiliary aspects of certain types. It has been proven to be important for other reasons to, but the dominant idea is important in shaping a person's actions too. A person's dominant determines the way they live, the way they think, and the way they deal with everyday experiences. People act and think differently when dealing with life experiences by using their best skills which are different for people with different dominant traits. This is the attribute that people show externally through their actions in everyday life. However, it is not that simple. The dominant trait is not always the one that is visible. Sometimes, a person's dominant trait is visible and other times, it may be the auxiliary trait that is visible to the outsider. It depends on the 4 letter type of the person. Whether dominant is visible or not depends on the I-E dimension. For someone who is an I, their dominant is not what they show the outside world. The dominant of extraverts will be used in the outside world and the dominant of introverts will be used in the internal world because that is what is preferred by each type. Therefore, the auxiliary trait is what is used in the non-preferred world. In the case of introverts, what is visible is the auxiliary.

Of the four sets of mental preferences, J-P is considered the least among professionals when analyzing results. The I-E, S-N, and T-F dimensions are used most often. Because of this, we decided to look more profusely at this J-P difference to see if we could find anything interesting about the performance of Js and Ps. Prior WPI

researchers were reporting that it was a key variable, but theoretically it should not have been.

2.3 Studies of Courses

One of our major interests was to see whether the data we collected would be consistent with previous studies and the present theory of cognitive styles. Our group looked at past research done on the subject by students at WPI and found that an IQP done by Nathan Shuler in 2003 was very useful in making our plans. Nathan reported the results of studies done of a linear algebra class and a signals analysis class. He simply reported the signals analysis study done by a prior researcher, but he carried out the linear algebra study himself nothing that the similarities were more striking than the differences. Nathan's main goal was to prove that there was a correlation between a student's MBTI type and the way they performed in the classroom. He focused on helping at-risk students by seeing if their initial grades in the class could be turned into a reliable lead indicator or not. He reported that some types of learners are more predictable in their fashion than others, but in all cases reasonable correlations were found. We are interested to see if these findings from his project can be replicated in ours. We will also be able to look into some issues that did not come up in the classes he was studying.

2.3.1 Signals B02

A portion of our study included the MBTI results from the Continuous Time Signal course of B term 2002, reported by Nathan Shuler for his IQP project though Ole Bida did the actual analysis. In his report, Nathan briefly explained the breakdown of the class. He used the MBTI results from 98 students, covering 90% of the entire class, a

very respectable sample. Of these he had to collect data from about 33, as only 67% of the students in the class had filled out the MBTI during freshman orientation for the class of 2005. Collecting this missing MBTI data for the class delayed him in his analysis which made the instructor have to assign a paid assistant to do the analysis over the summer. The class included three tests, several quizzes, weekly homework assignments, and three projects. Of these available grades, Ole used the three tests, the quiz average, and homework average to create tables using SPSS software in hope of finding significance of differences between types.

2.3.2 Linear Algebra B02

Nathan's own study drew-on the Linear Algebra Class of B term 2002. This was a sophomore level math class of 134 students, 101 of which Nathan had MBTI data for, covering 75% of the students, and in this case he had to collect about 25% of the data personally. The grading for this class was based on weekly quizzes of which there were 5, a final exam, and weekly homework. To find any significance in the data, Nathan used the SPSS statistical program and the students overall quiz average, the final exam, homework average, and a special "early measure" which included the first three quizzes as a lead indicator. Nathan's IQP is still available in the WPI library and the results can be seen there.

2.4 Current Course Material

In our current study, we are looking at the ES2001 Materials course and comparing it to the previous course from term B03. The courses have some differences and similarities which can be seen in the following sections.

2.4.1 Materials A04

The group observed the data that was gathered from the students of the ES2001 class from A term of 2004, and found that the structure of the class played a part in their performance. Depending on the type of the student, it was noticed that the class material could be helpful or detrimental to their overall grade. This course is an introductory materials class for students studying in a variety of different majors which include mechanical, electrical and computer, biomedical, and chemical engineering. The material covered was both concrete, which included factual knowledge, preferred by sensors, as well as abstract ideas, principles, and generalizations involved in the subject, which is preferred by intuitors. There are two of the members of this group that have taken this class in the past, in D term 2004, an ES2001 class that is not included in our research.

By the way the class was structured, it seems that Professor Demetry tried to accommodate all students by providing them with whatever she thought might be helpful to them throughout the term. The class was provided with a conference once a week to go over homework assignments, old exams, or for students to ask any questions they had from lectures. Professor Demetry also used the myWPI portal, which is a website with all the course information and materials for the students, which is available 24 hours a day. The students had in-class assignments and were required to discuss them with peers, and were encouraged to work in groups for most aspects of the class, whether it was in class assignments, homework assignments, or the optional project. This may be an advantage for extraverts who are outgoing and prefer working collaboratively but it does not prevent introverts from preparing independently as well. The grading breakdown of the class grading weight looks like this:

Preparation assignments – 10%

In-class problems – 10%

Homework – 15% / *20%*

Exams – 45% / *60%*

Recommended Project (Optional) – 20%

If a student chose not to complete the project, then homework assignments are worth 20% and exams are worth 60%. The project was recommended (instead of being required) because the professor felt that it would not be worth the time a student would need to finish it, if the student was not interested or motivated to do well on it. For an uninterested student, she felt time would be better spent on other parts of the class. In our analysis we based our results on the grading policy used here at WPI, so possible grades are A, B, C, NR. A being 90+, B being 80-90, C being 70-80, and NR being below 70.

The objective of the project was for the students to apply material learned from ES2001 about structure-property-processing relationships. The project was done in groups of 2-4 people and the students chose their own topic to work with. However, some people chose to work on it by themselves. We predicted that these people would turn out to be introverts. Professor Demetry also had three check points for the project during the term to discourage the students from procrastinating. There included the submission of a proposal, a second draft report, and a final project report. The project was graded as follows:

Proposal submitted on time – 5 pts

Quality of draft report – 10 pts

Final project report – Content – 60 pts

Final project report – Communication – 25 pts

An additional 10 bonus points were available for the students who participated in the MBTI study, some of whom had to fill out the MBTI. Others just had to release their results to her from the archive.

2.4.2 Materials B01

The major difference between the Materials class of 2001 and 2004 was the project. As explained previously, in A04 the project was optional for students, with the potential to replace part of their exam average. The project in 2004 was unstructured, leaving almost all of the structure up to the students. In B term of 2001 however the project was structured by Professor Demetry, with specific tasks due at given dates throughout the term. Rather than having the option to do the project and have their exams count for less, the project was required and carried with it a predetermined part of their final grade. Much like the A term class of 2004, students participated in in-class problems and used the Classroom Performance System (CPS) for class participation to account for their attendance. This system utilizes a "clicker" where students respond to questions that are displayed in the front of the classroom. Each student is designated a certain number so there will be no confusion during the term. This is also used to help the professor to see a continuing patter of wrong answers which would be indicative of what areas the students are struggling with during the term. We have MBTI data for this term and the A04 term too.

2.5 VARK as an alternative to the MBTI

There are other learning styles indicators besides the MBTI that produce information on how a student will perform in a classroom situation. The MBTI is known

as the gold standard, a very in depth and thorough analysis of ones learning preferences, but others exist that strive for the same results in a quicker and simpler way. VARK is supposed to be a catalyst for reflection, and it uses a series of thirteen questions that reveal how the individual prefers to receive and give information. The MBTI has 126 questions. A simple thirteen question quiz can not match up to the lengthy MBTI, but the VARK displays its results differently through four types rather than the sixteen we have been discussing for the MBTI.

The acronym VARK stands for Visual, Aural, Read/Write, Kinesthetic, and each person who completes the quiz is classified as being primarily in one of these categories. The questions asked are multiple choice questions, providing four answers, one common response from each type. When the questionnaire is completed, a grader tallies points based on the answers given, and through a points system shows the preferences of that individual. A person who prefers visual presentation will answer accordingly by, for instance choosing to draw a map when giving directions. An aural person would choose to simply explain the directions verbally. An individual who is categorized into read/write would write directions on a piece of paper. Finally a kinesthetic person would physically bring the person to their destination. The category in which one is placed, is not a permanent trait for the individual, it simply appears as a preference, much like the MBTI. A person's preference can be shifted throughout their life, but with both indicators a dominant preference is brought to the surface. These four categories are general, simply showing how the person prefers to give and receive information, while the MBTI shows a personality type of the individual going as far as who they are most compatible with in a relationship. We only have VARK data for the B01 run of the class.

This is helpful for this study because it provides us with another learning style to observe. Our research will include VARK to see if it can be applied to future courses.

3. Methodology

As our project began, it was apparent that there was a lot of MBTI data to be collected from students who had taken ES2001 in both B term of 2001 and A term of 2004. We wanted to analyze ES2001 because of the interest shown by Professor Demetry, who had taught the class of B01, and at the time was teaching the class of A04. Previously in 2001, Professor Demetry had gathered some MBTI data from the MBTI archive on her students and became fascinated with the results she discovered, running the four MBTI factors in relation to grades. She had VARK data too, but the clearest relationship was the J-P relationship. The combination of Professor Demetry's previous findings, and IQP's that have been written on the subject, we felt that with the help of Professor Wilkes, we had a promising research opportunity if we went into the current data is some detail, as Nathan Shuler had.

We began our project in A term of 2004 by collecting all the MBTI data that we had on the students who took ES2001 in B01 and those who were currently taking the class in A04. After discovering we only had little more than 50% of the two classes, we began to contact students whose data was not available to improve the datasets. Specifically we created a dataset with the results we did have, and then contacted all of the students whose data was missing.

As soon as the missing data students were identified, they were contacted via email with information about our project and a link to the Consulting Psychologists Press MBTI site where they could complete the indicator online. In the letter we gave the students, they received a written description of our project and were offered a reward, five points towards their test grades for the class, for their participation in our study. The

class members who had already taken the test were also offered a reward which they could receive by allowing us to use their existing data in the archive for our study.

Midway through A term, responses to our emails began to come in at a steady pace, resulting in the topic of our first several weekly meetings to be how the data set had improved over the past week. The flow dried up, and with resistance to data collection growing, we decided that out dataset was complete when we received results for 47 of the 65 B01 students, 72% of the class, and 71 of 86 students in the A04 class, equaling 83% of the class. Nathan had gotten 90%, but his study was done when the archive covered the whole class. We had a class catering to the class of 2007 when that class was not part of the archive. About a third of the 2005 and 2006 students were in the archive, meaning that we needed the other 2/3 for our study.

From this point our focus was to analyze the data we had collected, we expected that the result of Professor Demetry changing the course set up would have a positive affect on the outcome of class grades. We suspect that she was not looking to take away the J students advantage, but that she hoped to bring the rest of the class to the level of the J students.

4. Findings

Our data analysis produced the following findings.

4.1 Significance of Class Project

During the course of the term the students had a choice of completing an optional project which would affect how they were graded. The overall percentages of the homework and exams would decrease if the project was completed. The following shows the relationship of who was likely to complete the project and how their final grades ended up.

4.1.1 Project Completion

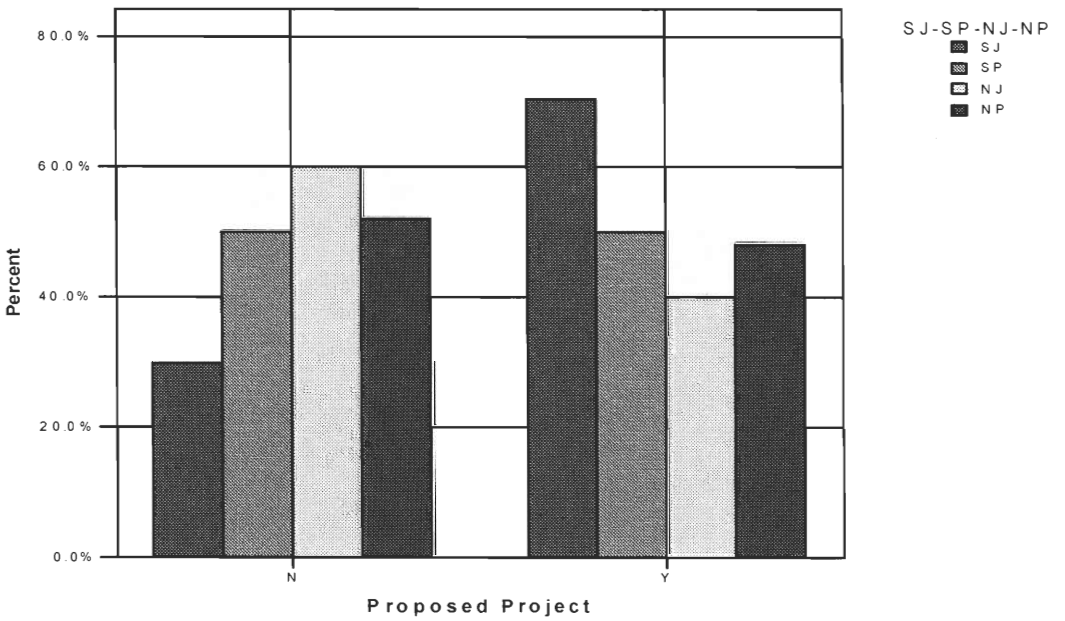

Figure 1: SJ, SP, NJ., NP Proposed Project

This graph above, Figure 1, shows the percent of students from each of the four types who submitted a proposal near the beginning of the term. N meaning they did not propose a project and Y meaning that they did propose the project. The four types we

were looking at were based on the crossing of the S-N and J-P dimensions. We took special interests in these dimensions because these typology had been used before and produced significant findings in studies of other classes at WPI. In the class there was 27 SJ's, 19 of which submitted a proposal. Of the 14 SP's, half submitted a proposal. On the low side, out of the five NJ's that were in the class, only two submitted a project proposal. The NP's had a total of 25 students in the class, out of those, about half submitted a project proposal at the beginning of the term.

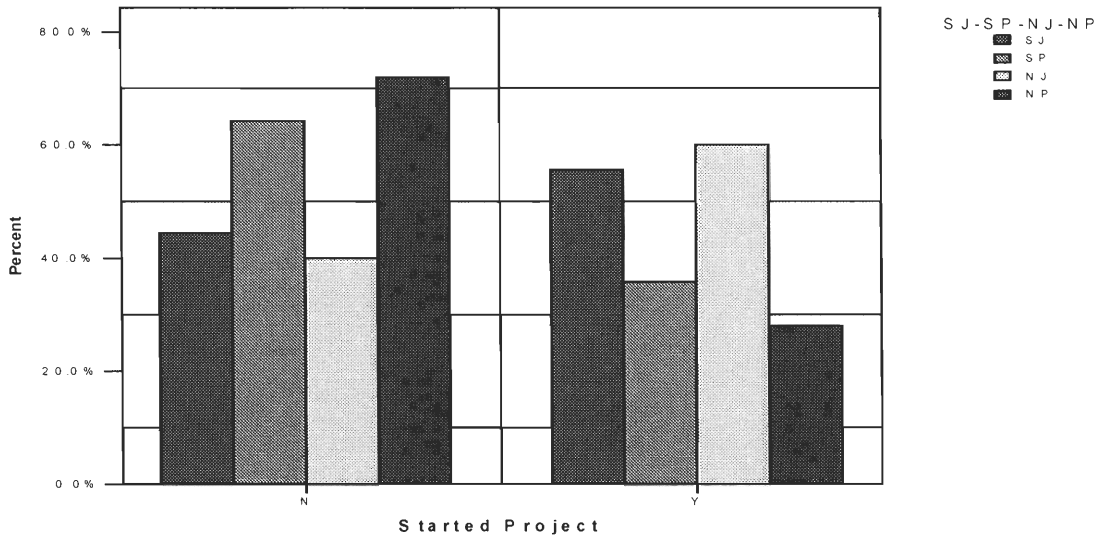

Figure 2: SJ, SP, NJ, NP Started Project

The next graph, Figure 2, shows that the 19 SJ's who submitted a proposal, only 15 actually started the project and met the first deadline. Five of the seven SP's who submitted a proposal began the project. The NJ's actually gained a student in the starting of the project. Apparently one student realized he/she may need the help and began the project without a proposal, making the number of NJ's involved 3. Only 7 of the 12 original NP students started the project after submitting the proposal.

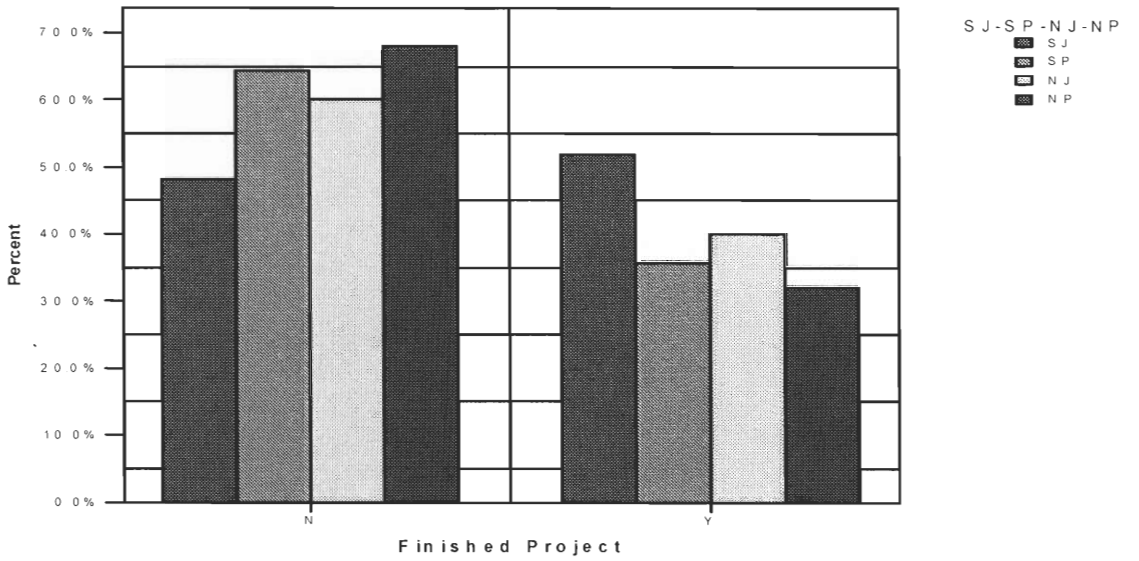

Figure 3: SJ, SP, NJ, NP Finished Project

After starting the project, one more SJ dropped, bringing the total number of SJ students to complete the project down to 14 of 27. Every SP the started the project was able to finish it, leaving the total number of SP's at 5 of 14. This time the NJ's dropped one student; 2 of 5 NJ's completed the project. One NP was added to the number of students who submitted work for the first deadline, bringing the number of NP's who finished the project to 8 of 25. The final results for these four types were that 29 out of the 71 students finished a project, that's 50% of the J's and 33% of the P's.

Another important typology that we wanted to keep track of was E-I and our E-I and JP cross made sense, the four possibilities being:

SJ 14/27 = 55%
SP 5/14 = 38%
NJ 2/5 = 40%
NP 8/25 = 32%

J = 16/32 = 50%
P = 13/39 = 33%

There were striking differences between the groups.

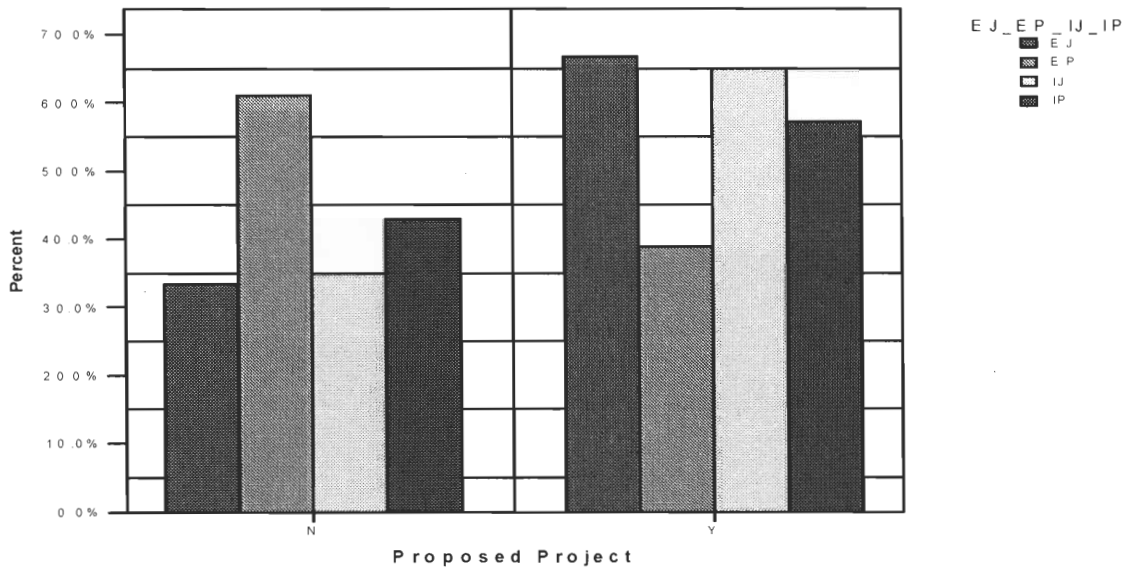

Figure 4: EJ, EP, IJ, IP Proposed Project

There were 12 EJ students in this class, 8 of them proposed a project at the beginning of the term. Of 18 EP's in the class, only 7 of them submitted a proposal. 13 of 20 IJ's originally planned on doing a project, and 12 of 21 IP's.

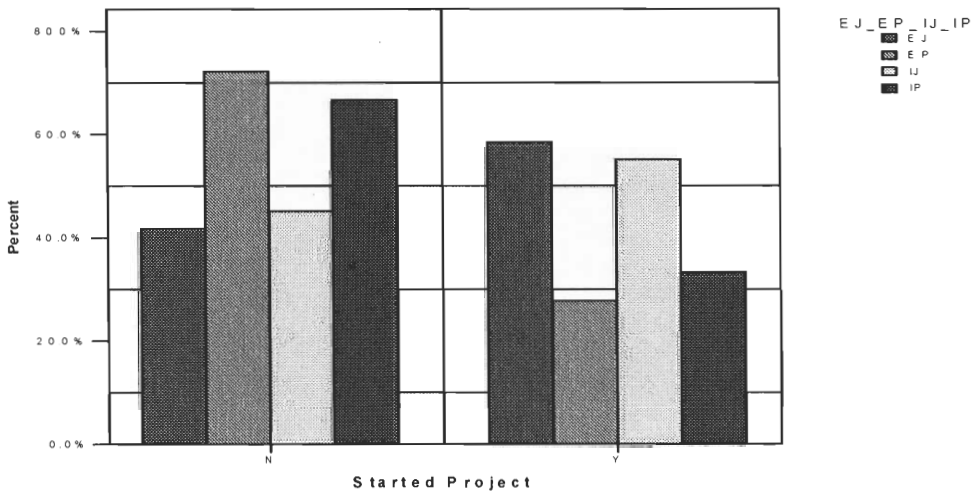

Figure 5: EJ EP IJ IP Started Project

Out of these four types, all of them dropped students from the time of the proposal to the first due date of the project. Only one EJ dropped the project, bringing them to 7

students of 12 who began the project. Two EP's decided not to go through with the project, making their number 5 of 18. One IJ dropped after the proposal making it 11 of 20 who would start the project. Finally, the IP's would start the project with 7 of 21 possible students.

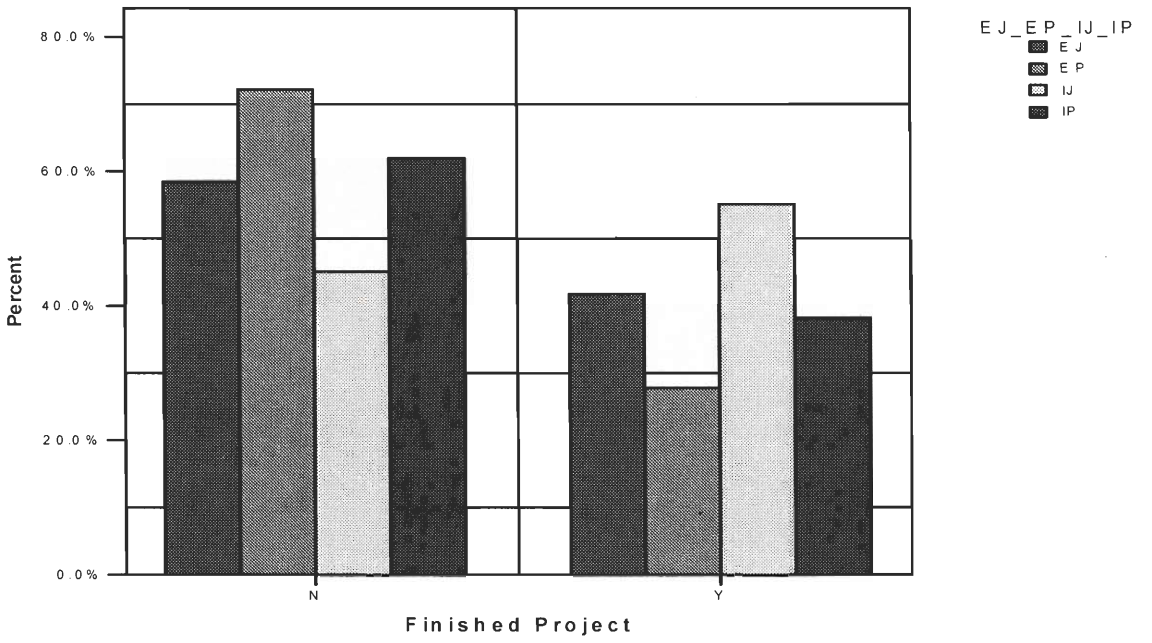

Figure 6: EJ, EP, IJ, IP Finished Project

Throughout the course of the project, two more EJ's dropped; bringing the total number of EJ's that finished the project to 5 of 12. The EP's ended the term with 5 of 18 who completed the project. Eleven of the possible 20 IJ's were able to complete the project. Finally 8 of the 21 total IP's finished the project.

EJ 5/12 = 40%
EP 5/18 = 30%
IJ 11/20 = 55%
IP 8/21 = 38%

For the most part, any student with the P dimension that started a project finished it. For any student with the J dimension, they did just the opposite. They started the

project and then realized that they might not need it or did not have the time for it and the stopped working on it. The P's probably stuck with the project because it was unstructured and they could set up their own structure.

4.1.2 Project Grade

From these cross tabulations formed in SPSS, it is obvious to see how the project helped some students quite a bit. The first table shows the grades of students without factoring in their project grade.

		SJ-SP-NJ-NP				
		SJ	**SP**	**NJ**	**NP**	
	A	5	1	3	1	10
	B	10	6	2	15	33
	C	8	6	0	5	19
	NR	4	1	0	4	9
Total		27	14	5	25	71

Figure 7: SJ, SP, NJ, NP Letter Grades with Project Not Included

By viewing the Chi-Square tests performed in SPSS, we can see the significance of these findings. The Chi-Square test gives a probability that the difference between two groups is due to chance. A significance factor of 0.1 means that out of 100 times, the probability that the relationship between two given groups is due to chance, it will come true 90 times.

	Value	**df**	**Asymp. Sig. (2-sided)**
Pearson Chi-Square	16.222(a)	9	.062
Likelihood Ratio	15.434	9	.080
Linear-by-Linear Association	.004	1	.947
N of Valid Cases	71		

a 11 cells (68.8%) have expected count less than 5. The minimum expected count is .63.

Figure 8: Chi-Square Test of the Significance of the Final Grade without the Project

The Chi-Square test shows that this finding is indeed significant, meaning that it is not just a coincidence that the SJ, SP, NJ, NP dimensions match with grades. By tradition, any finding that has significance around a .05 is a reliable finding; through the Chi-Square test here we found a significance of .062 when the project grade is taken out of the students' final average. It is so close to the traditional significance level that we will recognize this as a reliable finding.

When the project is considered, SJ picks up one extra A and one extra B. SP gains an A and NP gains a B from what would have otherwise been a C or an NR.

		SJ-SP-NJ-NP				Total
		SJ	**SP**	**NJ**	**NP**	
Letter Grade	**A**	6	2	3	1	12
	B	11	6	2	16	35
	C	7	5	0	5	17
	NR	3	1	0	3	7
Total		27	14	5	25	71

Figure 9: Final Grade with Project

Chi-Square Tests: Project Letter Grade SJ-SP-NJ-NP

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	13.140 (a)	9	.156
Likelihood Ratio	13.540	9	.140
Linear-by-Linear Association	.070	1	.791
N of Valid Cases	71		

a 11 cells (68.8%) have expected count less than 5. The minimum expected count is .49.

Figure 10: Chi-Square Test of Final Grade with Project

We noticed that when the project is factored into these students' grades, the pattern is blurred and the significance is .156. In some circles, this finding is not reliable with 15 chances out of 100 that there is really no relationship instead of 6 out of 100.

The Results are similar for the EJ, EP, IJ, and IP:

		EJ-EP-IJ-IP				
		EJ	**EP**	**IJ**	**IP**	
	A	1	1	7	1	10
	B	4	7	8	14	33
	C	4	6	4	5	19
	NR	3	4	1	1	9
Total		12	18	20	21	71

Figure 11: EJ, EP, IJ, IP Final Grade without Project

Chi-Square Tests: No Project Letter Grade EJ-EP-IJ-IP

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	17.004 (a)	9	.049
Likelihood Ratio	15.849	9	.070
Linear-by-Linear Association	4.583	1	.032
N of Valid Cases	71		

a 10 cells (62.5%) have expected count less than 5. The minimum expected count is 1.52.

Figure 12: EJ EP IJ IP Chi-Square Test of Final Grade without Project

Once again, when the project grade is removed from the final average of these students, a significant finding of 0.49 appears to indicate that there really is a difference between the IJ's and the other types. Without the project, the grades become more predictable. This could be because the project allows certain types to set up structure for themselves, which they like, and other types to have to set up structure for themselves,

which they do not like. This is more of a pure reading for this class because it takes out any advantage that one dimension would have over another.

		EJ_EP_IJ_IP				
		EJ	**EP**	**IJ**	**IP**	
	A	1	1	8	2	12
	B	5	8	8	14	35
	C	4	6	3	4	17
	NR	2	3	1	1	7
Total		12	18	20	21	71

Figure 13: EJ, EP, IJ, IP Final Grade with Project

	Value	**df**	**Asymp. Sig. (2-sided)**
Pearson Chi-Square	15.171 (a)	9	.086
Likelihood Ratio	14.038	9	.121
Linear-by-Linear Association	3.948	1	.047
N of Valid Cases	71		

a 11 cells (68.8%) have expected count less than 5. The minimum expected count is 1.18.

Figure 14: EJ, EP, IJ, IP Chi-Square of Final Grade with Project

When the project grade is factored into the final average for the EJ, EP, IJ, and IP types, the significance figure indicates 9 chances in 100 rather than 5 that the claims of difference could be wrong.

4.2 A Term Lead Indicators

The lead indicator is an early performance measure that is highly corrected with the overall performance measures. In this case, the lead indicator may be a homework assignment, an exam, or a certain topic of the class. A lead indicator is something an instructor should look for so the instructor can help students who fall behind. If there is one specific MBTI type that falls behind at the same place in a certain class, then the

instructor should spend extra time on that part to make sure everyone understands that topic. We looked at the Materials course in thirds. The first third was about structures and was rather abstract. The students would learn to determine what material an object was by looking at it atomically. The second third of the course was more concrete and dealt with mechanical ideas. The final third was a mixture of both and the students worked with phase diagrams. Again, as mentioned before, the abstract world appeals to the intuitives (NJ and NP) and the concrete principles are preferred by sensors (SJ and SP). Students may have excelled in the first or second part, but not as well on the third part. Also, grades on the third exam may have been lower due to the fact that the students were working on the project at that time. Students of different types react to different parts of the class and different learning styles in different ways. We will examine which types have what advantages or disadvantages from each shift throughout the class.

The lead indicator in this case may be the final exam that included a mixture of the two principles. The final exam however can not be used as an indicator because it occurs too late in the class for any changes to be made. The students who performed well at the beginning of the class could have possibly had trouble with the second exam and vice versa. We do not believe either of the first two exams could be a lead indicator because the material differed. However, the first exam may be a lead indicator for the intuitors and the second exam for the sensors. In this case there is an assumption that what they do well will be indicative. The reverse may also be true, that what they are expected to find difficult will be the predictor for how the course on a whole will go. The results will inform us if either of these theories is correct.

Appendix A shows the Pearson Correlation of each of the homework assignments along with the exam average, final average, and project grade. The Pearson correlation is a parametric correlation used to find an association between two or more variables. Here we are looking for a homework assignment that may be a lead indicator for the final average. A correlation of 0.0 shows no correlation at all and a perfect correlation would be 1.0. Obviously the highest correlation is that of the exam average, but that is not an important finding because a student's exam average is a large percentage of the final grade so it is not surprising to see that the correlation is higher than anything else. Further, that information is available too late to be of use as a "lead" indicator. Only the performance data available in the first half of the course is of interest as a possible lead indicator. Homework assignment #2 and #4 are the closest to a lead indicator in this case with a correlation of .611 and .635 respectively. By squaring these two numbers we see that homework assignment #2 can explain 37.3% variation and assignment #4 can explain 40.3%. This may not seem like a lot, but homework is only worth 15% of the total final grade and there are 8 homework assignments. Therefore the correlation of these two particular assignments is fairly significant.

Appendix B displays Spearman's Rho correlation, which is a nonparametric correlation; this tells us whether the indicator rank orders the students the same way as the final grade. Again, homework #2 and #4 pass the test, but this time homework #5 also had a fairly high correlation of .620 which can explain 38.4% of the rank order variation. That is interesting but too late in the class to be useful other than as a way of seeing whether intervention that a professor made based on quiz 2 data are having an impact. At that point there would only be two weeks left in the course. We also analyzed

a correlation for each exam individually to see if there was one that may have been a better predictor than the others. Each one of the exams was better predictors than the homework assignments because the exams have more weight than the homework. The correlation of the three exams were similar to each other, thus Exam 1 is also a potential lead indicator.

4.3 A Term Homework

The following charts show the significant findings of how the students differing on variables of the MBTI performed on the homework assignments and exam from each third of the course.

Report

E-I		First Third Homework Average	Second Third Homework Average	Third Third Homework Average
E	Mean	19.3889	17.0000	19.7833
	N	30	30	30
	Std. Deviation	2.89944	3.48065	3.47822
	Median	19.6667	17.6667	20.5000
I	Mean	19.7154	18.9350	20.2927
	N	41	41	41
	Std. Deviation	4.39037	4.09690	4.82568
	Median	21.0000	20.0000	22.0000
Total	Mean	19.5775	18.1174	20.0775
	N	71	71	71
	Std. Deviation	3.81099	3.94168	4.28756
	Median	20.3333	18.6667	21.0000

Figure 15: E-I Dimension and Homework Results

Our analysis of these grades showed a varied significance. The significance from the homework results for the E-I dimension was from the second third, the I's outperformed the E's; the significance was .040. We talked about the structure of the class earlier and much of the class involved working together with other students inside

and outside the classroom. The fact that the introverts did better contradicts the common theory between extraverts and introverts, which is that extraverts prefer working in groups and being able to discuss questions they have, with either other students or the professor.

Report

S-N		First Third Homework Average	Second Third Homework Average	Third Third Homework Average
S	Mean	20.2195	18.6341	19.8659
	N	41	41	41
	Std. Deviation	2.98106	3.37294	4.26325
	Median	20.6667	19.0000	21.0000
N	Mean	18.7000	17.4111	20.3667
	N	30	30	30
	Std. Deviation	4.62821	4.57352	4.37653
	Median	19.8333	18.3333	21.2500
Total	Mean	19.5775	18.1174	20.0775
	N	71	71	71
	Std. Deviation	3.81099	3.94168	4.28756
	Median	20.3333	18.6667	21.0000

Figure 16: S-N Dimension and Homework Results

The S students outperformed the N students in the first homework assignment, but there is no neat pattern other than maybe that the N's start out behind and close the gap in the course as a whole. This came as a surprise to us because the theory behind this dimension seemed to merge with the structure of the class. It was thought that the S-N dimension would identify those who would excel in the class section by section. We predicted the intuitors would do well in the first third of the course, the part that included abstract ideas, but instead they start our behind, and do best in the third part of the course. They move up in relative terms, but it is not clear why they would have a slow start, since that first part of the course should have been the part that was most natural for them.

Report

J-P		First Third Homework Average	Second Third Homework Average	Third Third Homework Average
J	Mean	20.0833	18.7396	19.9688
	N	32	32	32
	Std. Deviation	3.23511	3.33197	4.26716
	Median	20.8333	19.1667	21.0000
P	Mean	19.1624	17.6068	20.1667
	N	39	39	39
	Std. Deviation	4.22183	4.35546	4.35789
	Median	20.3333	18.3333	21.0000
Total	Mean	19.5775	18.1174	20.0775
	N	71	71	71
	Std. Deviation	3.81099	3.94168	4.28756
	Median	20.3333	18.6667	21.0000

Figure 17: J-P Dimension and Homework Results

The J-P dimension did not produce any significant differences in the homework grades. This is not something we expected to happen because we were expecting to find a J advantage. However in this case again the P's, like the N's close the gap by the third part of the course.

Report

T-F		First Third Homework Average	Second Third Homework Average	Third Third Homework Average
T	Mean	19.2403	17.6744	19.2791
	N	43	43	43
	Std. Deviation	4.47410	4.32141	5.06423
	Median	20.0000	18.0000	20.5000
F	Mean	20.0952	18.7976	21.3036
	N	28	28	28
	Std. Deviation	2.46098	3.23095	2.27848
	Median	20.6667	19.0000	22.0000
Total	Mean	19.5775	18.1174	20.0775
	N	71	71	71
	Std. Deviation	3.81099	3.94168	4.28756
	Median	20.3333	18.6667	21.0000

Figure 18: T-F Dimension and Homework Results

The last dimension, T-F, showed that the feeling students excelled especially in the third part of the course. This does not help too much because the last part of the course did not deal with anything too revealing. Feelers prefer teachers who value a relationship with their students and Professor Demetry makes it clear that is true in this class. They also like working together with friends rather than individually. This may be the cause of the feelers' performance in the last section of the course.

4.4 A Term Exam Results

Report

E-I		Exam 1	Exam 2	Exam 3
E	Mean	70.43	77.77	76.07
	N	30	30	30
	Std. Deviation	14.635	11.634	13.427
I	Mean	77.29	82.76	85.07
	N	41	41	41
	Std. Deviation	11.093	8.671	11.710
Total	Mean	74.39	80.65	81.27
	N	71	71	71
	Std. Deviation	13.065	10.257	13.157

Figure 19: E-I Dimesion and Exam Results

The exam grades of the extraverts and introverts are where we found the most glaring differences in performance, a full letter grade on average for exam 3. There was a significant finding for each of the three exams; the first was statistically significant at the .028 level, the second at .042, and the third at .004. Figure 19 above shows that the introverts were a better fit for this course as they received a better grade on all three exams than the extraverts. The one finding we expected to find from this study previous to looking at the results was that the extraverts would enjoy this class because of the emphasis on group work. However the goal of the group work is to master the concepts

and techniques. The exam evidence suggests that the I students did this better than the E students, and the exams are individual performance measures. Since group results may depend on other students in the course the group homeworks and assignments seem to have marked a more important development. Maybe the extraverts had a hard time getting along with other students which decreased their ability to work together. They may depend on the material of the course or even the personality of the professor.

One reason the introverts did better may be due to the fact that Professor Demetry is an introvert. There is a possibility that she communicated better with the introverts through her teaching style. This is interesting because she specifically tried to avoid doing this by emphasizing group work and giving feedback in class with her voting technology. On the other hand, schoolwork in general involves reading and reflects on reading and concepts. These are preferred activities for an I.

Even more evident is that the significance is high in this finding. Later we will talk about how we crossed EJ, EP, IJ, and IP students and those results show a big difference between E's and I's as well.

Report

S-N		Exam 1	Exam 2	Exam 3
S	Mean	73.02	79.95	79.02
	N	41	41	41
	Std. Deviation	12.891	11.135	13.144
N	Mean	76.27	81.60	84.33
	N	30	30	30
	Std. Deviation	13.287	9.016	12.756
Total	Mean	74.39	80.65	81.27
	N	71	71	71
	Std. Deviation	13.065	10.257	13.157

Figure 20: S-N Dimesion and Exam Results

Again, to our surprise, the grades for exam one and exam two of the S and N were not significantly different. However the third exam was the culmination of the intuitors who improved on each exam compared to the last. The material that was covered in that last portion of the course may have been a good fit for them, or maybe they were getting it better and better as the course progressed. The sensing students hit there plateau on Exam 2- covering the material we thought they would like best. If there was an S-N finding we expected it to be either the intuitors outperforming the sensors on the abstract first third or vice versa when studying the concrete second exam, but we see a 3 point edge, 1.5 edge, and a 5 point edge on the three exams respectively.

Report

J-P		Exam 1	Exam 2	Exam 3
J	Mean	74.16	82.75	80.16
	N	32	32	32
	Std. Deviation	14.301	10.274	14.319
P	Mean	74.59	78.92	82.18
	N	39	39	39
	Std. Deviation	12.145	10.046	12.236
Total	Mean	74.39	80.65	81.27
	N	71	71	71
	Std. Deviation	13.065	10.257	13.157

Figure 21: J-P Dimesion and Exam Results

There is no clean pattern to the J-P exam results.

Report

T-F		Exam 1	Exam 2	Exam 3
T	Mean	75.16	81.91	82.40
	N	43	43	43
	Std. Deviation	13.077	10.908	12.542
F	Mean	73.21	78.71	79.54
	N	28	28	28
	Std. Deviation	13.198	9.014	14.107
Total	Mean	74.39	80.65	81.27
	N	71	71	71
	Std. Deviation	13.065	10.257	13.157

Figure 22: T-F Dimesion and Exam Results

The results of the thinkers and feelers, as well as the judgers and perceivers did not produce statistically significant results. Since our research and data analysis shows no significant findings in this area, this is actually a good thing, for the instructor. This just lets the instructor know that there is no need to change or worry about this part of the course, it is working out fine, in terms of balance between the J and P students who had different experiences in the prior run of the course. The continuously better test scores, while small, are worth looking into but not a matter of senior concern, as least compared to the E-I difference.

4.5 Prep assessments

The A-Term 2004 class had class prep work that had to be done. The prep work involved reading and completing an online quiz that would need to be taken before class to get credit for it. The reading would be short but it would prepare the student for class the next day. The quiz comprised of five multiple choice problems and it was administered online.

There was in-class work as well. The in-class work was a few multiple choice questions. These questions were administered with a 'clicker' that was a remote control that the student could use to 'click' in and submit answers. They were only graded as part of class participation, but were indicative of material that was being predicted in class.

The table shows the breakdown of JPs and their in class participation and the prep average. It is also divided into genders, male and female. It shows totals for the whole class, which is the most important. Looking at the totals, the Js outperformed everyone

by about four points in the prep work. Looking at the in-class participation, the Js were the most likely to go to class. However, there were only five of them.

Report

Gender1	J-P		ICP AVE	PREP AVE
Male	J	Mean	95.1231	86.2525
		N	24	24
		Std. Deviation	7.14374	12.36006
	P	Mean	85.7423	77.6279
		N	34	34
		Std. Deviation	19.03239	17.87791
	Total	Mean	89.6240	81.1967
		N	58	58
		Std. Deviation	15.87532	16.28027
Female	J	Mean	91.7614	85.8631
		N	8	8
		Std. Deviation	8.21130	9.94654
	P	Mean	94.3182	92.3016
		N	5	5
		Std. Deviation	10.84022	6.24039
	Total	Mean	92.7448	88.3394
		N	13	13
		Std. Deviation	8.95421	9.01783
Total	J	Mean	94.2827	86.1551
		N	32	32
		Std. Deviation	7.43476	11.64970
	P	Mean	86.8418	79.5091
		N	39	39
		Std. Deviation	18.31326	17.50322
	Total	Mean	90.1954	82.5045
		N	71	71
		Std. Deviation	14.84733	15.41119

Figure 23: J-P ICP and Prep Assessment

Figure 23 above is the JP breakdown. It provides the same data but only for the JP dimension, one of the dimensions we gave a special look at. As the table shows, the male J's scored considerably higher on both in-class participation and the prep work than the male P's. The female P's performed much better and were the high scorers for the prep work, while male and female J's did about the same prep work. They also outscored the J dimension, but not by too much. In general the totals show that the Js scored better all around than the Ps.

4.6 B01 Testing

The 2001 B-Term class was the first class that Professor Demetry requested MBTI data for. She was attracted to the MBTI bye the J-P finding in the data. The finding showed that the Js outperformed the Ps by quite a large margin. The J-P dimension is not studied by most psychologists and deemed less important by the professionals. For the most part, it has only been used to show dominance as described in the background, but we think the need for structure and closure associated with the J performance has large implication for class work in general, preparation for class and project work in particular.

The J-P dimension was run against the final letter grade in SPSS. Figure 24 shows just how much the Js outperformed the Ps. The grading is broken into A, B and Low. The low category is a C or below; this was the easiest way to do this because the cut off for a C or an NR changed from term to term.

Crosstab

			A	B	Low	Total
J P as number	J	Count	7	3	3	13
		% within J P as number	53.8%	23.1%	23.1%	100.0%
		% within Collapsed Grades	77.8%	17.6%	16.7%	29.5%
		% of Total	15.9%	6.8%	6.8%	29.5%
	P	Count	2	14	15	31
		% within J P as number	6.5%	45.2%	48.4%	100.0%
		% within Collapsed Grades	22.2%	82.4%	83.3%	70.5%
		% of Total	4.5%	31.8%	34.1%	70.5%
Total		Count	9	17	18	44
		% within J P as number	20.5%	38.6%	40.9%	100.0%
		% within Collapsed Grades	100.0%	100.0%	100.0%	100.0%
		% of Total	20.5%	38.6%	40.9%	100.0%

Figure 24: J-P Dimension in B Term

This table shows the distribution of the Js and Ps between A, B, and Low. It also includes percentages for within the total J-P dimension count. As the table shows, there are more than twice as many Ps as there are Js in the class and also there are also twice as many Ps that got a score of Low than Js. It is vice versa for the A category. The sample size difference does not create a problem when it is evaluated with a Chi-Square test; it is actually the finding with the highest level of significance of this whole study.

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	12.649[a]	2	.002
Likelihood Ratio	11.814	2	.003
Linear-by-Linear Association	8.275	1	.004
N of Valid Cases	44		

Figure 25:Chi-Square Test of J-P Dimension in B Term

This was the only dimension that showed significance. For example, the Chi-Square test for S-N dimension looks like this:

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	3.245[a]	3	.355
Likelihood Ratio	3.305	3	.347
N of Valid Cases	47		

Figure 26: Chi-Square Test of S-N Dimension in B Term

This Figure's significance does not even come close to the one of the J-P test. This shows that there is no relationship.

Going along with the J-P dimension findings, there was also a J-P dimension finding with the final grade average and the project grade average. Once again, this was only a finding in the 2001 B-Term ES2001 class. In this class, the project was not an option and was very structured. It also was part of the final grade and did not replace a test grade if it was done. In the other two classes, 2004 D-Term and 2004 A-Term, the project was optional and if done, the test portion of the grade would be dropped from

60% to 45%. The homework grade would also change. The homework grade would drop 5% from 20% to 15% if the project was completed. This project replacement is also described in section 3.3.

The table below shows the average grades for the J-P dimensions and their break downs. There is a noticeable difference between the averages for all three; the final average, the project grade, and the exam grade. This table also shows the number of Js or Ps in the class and the median grade for each. For this analysis, we concerned ourselves only with the mean scores for the final average and project grade.

Report

J P as number		final average	project grade	exam average
J	Mean	86.343	86.29	82.714
	N	14	14	14
	Std. Deviation	7.8513	4.827	11.1112
	Median	89.450	86.50	87.200
P	Mean	79.361	83.33	76.406
	N	33	33	33
	Std. Deviation	7.8129	4.005	9.1230
	Median	80.300	85.00	77.300
Total	Mean	81.440	84.21	78.285
	N	47	47	47
	Std. Deviation	8.3847	4.428	10.0645
	Median	81.500	85.00	78.700

Figure 27: J-P Final, Project, and Exam in B Term

Figure 28 shows the significance test for the final average, project grade, and the exam average. The final average is the clearest difference but all are significant at the 0.05 level.

ANOVA Table

			Sum of Squares	df	Mean Square	F	Sig.
final average * J P as number	Between Groups	(Combined)	479.220	1	479.220	7.828	.008
	Within Groups		2754.693	45	61.215		
	Total		3233.913	46			
project grade * J P as number	Between Groups	(Combined)	85.682	1	85.682	4.724	.035
	Within Groups		816.190	45	18.138		
	Total		901.872	46			
exam average * J P as number	Between Groups	(Combined)	391.164	1	391.164	4.124	.048
	Within Groups		4268.336	45	94.852		
	Total		4659.500	46			

Figure 28: ANOVA Table of JP Findings in B Term

Since the J-P dimension finding was dominant only during 2001 B-Term, it is not consistent throughout all the ES2001 classes. In the current offering the E-I difference was more striking.

This is the only term that there was a J-P dimension found for all three major grades, project average, exam average and total average. This could have been because the project was mandatory and very structured. This is also the only finding that came out of the B-Term 2001 class in terms of significances between dimensions.

Figure 29 below shows the grades distribution for the SJ, SP, NJ, and NP dimensions. Once again, the Low grade is comprised of Cs and NRs. The NP dimensions had a lot of Bs and Low grades. The other three dimensions are pretty well distributed though.

SJ/SP/NJ/NP * Collapsed Grades Crosstabulation

			Collapsed Grades			Total
			A	B	Low	
SJ/SP/NJ/NP	SJ	Count	4	0	2	6
		% within SJ/SP/NJ/NP	66.7%	.0%	33.3%	100.0%
		% within Collapsed Grades	44.4%	.0%	11.1%	13.6%
		% of Total	9.1%	.0%	4.5%	13.6%
	SP	Count	2	4	6	12
		% within SJ/SP/NJ/NP	16.7%	33.3%	50.0%	100.0%
		% within Collapsed Grades	22.2%	23.5%	33.3%	27.3%
		% of Total	4.5%	9.1%	13.6%	27.3%
	NJ	Count	3	3	1	7
		% within SJ/SP/NJ/NP	42.9%	42.9%	14.3%	100.0%
		% within Collapsed Grades	33.3%	17.6%	5.6%	15.9%
		% of Total	6.8%	6.8%	2.3%	15.9%
	NP	Count	0	10	9	19
		% within SJ/SP/NJ/NP	.0%	52.6%	47.4%	100.0%
		% within Collapsed Grades	.0%	58.8%	50.0%	43.2%
		% of Total	.0%	22.7%	20.5%	43.2%
Total		Count	9	17	18	44
		% within SJ/SP/NJ/NP	20.5%	38.6%	40.9%	100.0%
		% within Collapsed Grades	100.0%	100.0%	100.0%	100.0%
		% of Total	20.5%	38.6%	40.9%	100.0%

Figure 29: SJ, SP, NJ, NP Grade Distribution of B Term

The Chi-Square test in Figure 30 below shows just how clearly different the experience of the different types of learners was in the run of the course.

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	17.087[a]	6	.009
Likelihood Ratio	20.818	6	.002
Linear-by-Linear Association	3.154	1	.076
N of Valid Cases	44		

Figure 30: SJ, SP, NJ, NP Final Grade Chi-Square Test

The other three dimensions did not produce any significant finding. They were rather scattered.

4.7 B Term Lead Indicators

Unfortunately, we did not have the homework grades of the students in the materials class of B term 2001. We only had access to the exam grades so we did an analysis on the correlation between each exam grade and the final average to see if the first one would suffice as a lead indicator. Appendix C and Appendix D display our results. Both correlations show that exam three was the best correlation, but that does not help us in seeking a lead indicator. Exam 1 is not a correlated with the overall results as exam 3, but it is as good a predictor in the run of the course as it was on the other one, so it would suffice. However, the homework average is a better predictor so perhaps the first few homework again includes one that would be a fine predictor especially if averaged with the first exam.

Pearson's correlation reveals exam three to explain 60.2% variation and spearman's rho shows exam three to explain 68.7% variation. This is not consistent with the results from A term of this year.

In the A term data each of the exams were very similar, but homework #2 and #4 were lead indicators. These assignments were in the second third of the class which do not associate with the third exam. Therefore, the lead indicators from A term of 2004 are not consistent with the lead indicators from B term of 2001.

4.8 VARK

VARK, an acronym for Visual, Aural, Reading/Writing and Kinesthetic, was created in 1987 by Neil Flemming. It is a 13 item questionnaire that tests for learning preferences. It allows the user to learn about their preferences in absorbing and producing information. VARK is not a learning style like the MBTI. The VARK is a learning preference. A learner's preference can be changed in VARK lore.

The V is for visual. These people learn by seeing graphs, charts; graphical representations in general. The A stands for Aural. These learners are able to benefit from discussions with others about the material. These people will enjoy a lecture style learning environment the best. The R is for Reading/Writing. This group learns best when they read the information that they are trying to absorb. The K stands for Kinesthetic. The learners from this group do best when they have the opportunity to try things out themselves; the hands on approach. This is the most interesting style, and common. It incorporates a little bit from the other three. The K preference allows the learner to use all their senses, sight, touch, taste, smell, and hearing. A teacher might be presenting the material in the V, A, or R preference, but the students are actually using their K preference to take in the material. The K is probably much like the "sensing" in MBTI terminology and the rest are preferred mode of sensing.

The VARK has only 13 questions. The questions are right to the point and all of them are geared towards a specific learning preference in terms of taking in information. The author believed that too many questions tend to allow the subject taking the test to lose attention and become tired therefore creating biased results. The test is set up so each answer has one of the letters assigned to it and the user is able to answer each question multiple times. Each time a user answers a question with a V answer, the users gets a point on their V score, same with the rest of the letters. When a user answers a question multiple times, then they get a point for both answers. The maximum score a user can get is 42, answering all the questions totally, while the minimum is 13, answering all the questions with only one response and having it be the same letter each time..

That is how the scoring works. Each uses will get a number score for each letter. The highest score out of all the letters is that person's learning preference. If there are two or more high scores, then that person is multimodal. This can be looked upon as a good thing and a bad thing. It is a good thing because the student would be set for several different ways to absorb information. They would be more flexible when it comes to learning. It is a bad thing because the student has several preferences for obtaining information; they need to satisfy all of them. If a student was an AR and the teacher was teaching the material in a style that an A would pick up on, the AR would understand it, but not totally because their R preference was not satisfied. The student who is just an A would get it right away. The majority of the population, 50 to 75 percent of people, is multimodal.

One of the interesting things about VARK is that the student is able to change their learning preference over time. One is able to adapt to their environment to get the best out of it. The VARK scores also change by age. When people are young they are more likely to have an A or V rather than the other two. As they get older, Vision takes over and Kinesthetic catches up and is close behind. As the child approaches adult hood the Vision stays the dominant and K falls back again.

The goal here was to see if the VARK data enhanced or confirmed the pattern that comes out of the MBTI data. The VARK data came from the ES 2001 B-Term class. As far as analysis goes, the VARK data was run against the MBTI data in SPSS. The following tables are for the frequency of each learning preference.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	.00	42	64.6	76.4	76.4
	1.00	13	20.0	23.6	100.0
	Total	55	84.6	100.0	
Missing	System	10	15.4		
Total		65	100.0		

Figure 31: Visual

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	.00	46	70.8	83.6	83.6
	1.00	9	13.8	16.4	100.0
	Total	55	84.6	100.0	
Missing	System	10	15.4		
Total		65	100.0		

Figure 32: Aural

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	.00	40	61.5	72.7	72.7
	1.00	15	23.1	27.3	100.0
	Total	55	84.6	100.0	
Missing	System	10	15.4		
Total		65	100.0		

Figure 33: Read/Write

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	.00	22	33.8	40.0	40.0
	1.00	33	50.8	60.0	100.0
	Total	55	84.6	100.0	
Missing	System	10	15.4		
Total		65	100.0		

Figure 34: Kines

The tables show the number of students that fell into each learning preference. The number of students is listed under frequency in the columns and in the 1.00 row. The way the data was set up in SPSS it registered the preferred VARK score with a "1.00". Following the row across, it shows the percent of the class that also has that same score. There were a couple of students who where multimodal. For the most part, outside of two, all the multimodal students had a K score along with something else. Since this was the case and the K score incorporates the other three. This allows for some students to show up in more than one group.

The next task was to see if that VARK data and the MBTI data worked together or against each other. In these next series of tables it shows the distribution of letter

grades within each VARK preference. They will also show if there are any significant findings.

		letter grade				
		A	B	C	NR	Total
Visual	.00	10	13	13	6	42
	1.00	4	4	5	0	13
Total		14	17	18	6	55

Figure 35: VARK Visual Letter Grade Count

These are the letter grades for the Visual preference (above). The distribution is in the rows starting with the "1.00". It shows the grade distribution for the Visual. From the data, it looks like the distribution is pretty even. The differences are not significant.

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	2.217(a)	3	.529
Likelihood Ratio	3.582	3	.310
N of Valid Cases	55		

Figure 36: Visual Chi-Square Test

The Pearson Chi-Square test is what we used to test for significances. The value of 0.529 is way too high. A value of under 0.05 is preferred to indicate significance.

		letter grade				
		A	B	C	NR	Total
Aural	.00	13	16	12	5	46
	1.00	1	1	6	1	9
Total		14	17	18	6	55

Figure 37: VARK Aural Letter Grade Count

This shows the grades from the Aural preference (above). The Chi-Square test (below) shows that the significances is 0.10, rounded down. This means that with this level of difference 9 out of 10 times the grade distribution will indicate a difference, but

time will not. One has a 1 chance in 10 of being wrong if this is taken as evidence of a real difference. We typical operate at a 1 chance in 20 level so this will be conservatively called, no difference.

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	6.022(a)	3	.111
Likelihood Ratio	5.889	3	.117
N of Valid Cases	55		

Figure 38: Aural Chi-Square Test

This is not ideal distribution (0.05 and under) but it is the best one found using the VARK data. The next two tables below are the R preference and K preference distribution of final grades. They are followed by their respective Chi-Square tests.

		letter grade				Total
		A	B	C	NR	
ReadWrite	.00	11	11	13	5	40
	1.00	3	6	5	1	15
Total		14	17	18	6	55

Figure 39: VARK Read/Write Letter Grade Count

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	1.135(a)	3	.769
Likelihood Ratio	1.155	3	.764
N of Valid Cases	55		

Figure 40: Read/Write Chi-Square Test

These are the tables for the R preference. As you can see the difference in not significant. Below is the grade distribution and Chi-Square test for the K preference. Once again, the Chi-Square tests show no difference.

		letter grade				
		A	B	C	NR	Total
Kines	.00	4	7	9	2	22
	1.00	10	10	9	4	33
Total		14	17	18	6	55

Figure 41: VARK Kines Letter Grade Count

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	1.633(a)	3	.652
Likelihood Ratio	1.653	3	.647
N of Valid Cases	55		

Figure 42: Kines Chi-Square Test

Since all of the Chi-Square tests failed, then it shows that the VARK will not identify student who have different experiences and performance levels in the class.

When VARK is run against the MBTI dimensions it does not prove to correlate with them either, not even sensing and kinesthetic.

VARK is more aimed at how a student prefers to receive and process that information that they are being taught. Instead of using it as a predictive indicator, it should be used as a way to help understand individual students that are struggling understand their own study habits. There is no bias in this course against any type of learners. They should be able to set up a way to study that would work best for their learning preference and allow them to absorb the most out of the class as possible. The information that the student and teacher receives from the questionnaire can be used to help any student who has been struggling in the class develop better study habits. This can be applied to either the class as whole, specific groups of students or even one-on-one. This information can also help the teacher present class material if the teacher knows all the students learning preference. This will only work on both accounts if the teacher and student thoroughly understand what their VARK score means.

4.9 Gender Effects

In looking at the personality and learning types of the students here at WPI, we are trying to find signs that a student may perform a certain way because of the way they receive and interpret information. But what if a person's personality type is not the only thing that can give clues as to how the student will fair in a certain class? What if their gender is just as strong an indicator as the type of learner that they have become? Through our research and overall observation of student performance in ES 2001, our group noticed trends among students that can not be explained by their learning type, but possibly by their gender. Our advisor, Professor John Wilkes presented multiple theories on why males and females may perform differently in a classroom based on his past research. The first theory deals with a specific type, ESTJ. Traditionally ESTJ is a tough minded group of individuals. Being a tough minded person tends to lead to difference experience of self images for males and females. For instance, a pragmatic, logical female, when she's deciding what field to pursue for a career, in college, she would most likely go onto a field such as chemistry or biology where she would be challenged through the factual sciences when the options were physics, chemistry, economics, sociology, history, math, or English literature. A male with the same tough minded personality would more likely fit into a management, accounting or an engineering field where the workload may be rigorous. They were not seen as potential scientists. The opposite personality to these tough minded people is one who is creative and speculative, not pragmatic. For men, this type of personality best fits in with physics (theory) or sociology, where they are able to experiment with their own ideas, while the same type of woman is more likely to be encouraged to English Literature, and is not considered science material.

Here at WPI, the women are greatly outnumbered by their male counterparts, which some believe may cause them to feel threatened or it may push them to work harder in order to prove that they belong. For whatever reason, the females of WPI have been shown to have a better work ethic, in our case outperforming the males in things such as homework assignments or pre-test preparations, but more generally getting higher grades and studies of them by cognitive type show smaller performance differences by type. MBTI distribution is also different for males and females. Women are more likely to be E, S, F, and J.

Some of our hypothesis dealing with the sampled classes can be proven using the MBTI results we collected; others are evident simply through gender. Considering the image of engineering at WPI, perhaps the most self disciplined women are the ones to come to this school in the first place, regardless of MBTI preference.

4.9.1 Gender B

Our gender discussion begins with B Term of 2001. The sample size for this class was 47 students, 72% of the total class. The scarcity of NP women and equivalence of SJ men and women would be typical of WPI more generally. The NJ distribution is probably unusual for this class. The sampled students in the class were divided by 31 males, and 16 females, each divided by their type below:

		Gender		
		Male	Female	Total
SJ/SP/NJ/NP	SJ	4	3	7
	SP	9	4	13
	NJ	3	4	7
	NP	15	5	20
Total		31	16	47

Figure 43: B Term Students Gender and Types

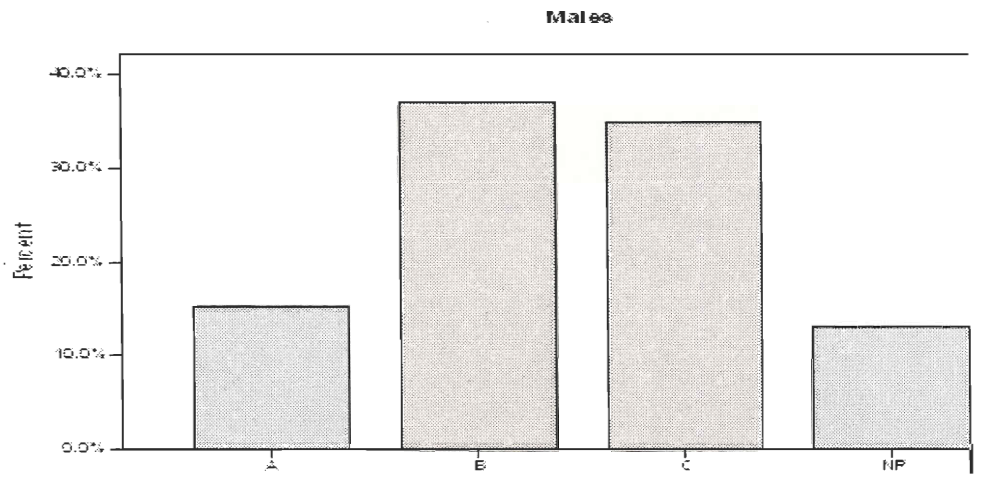

Figure 44: Male Grades B Term

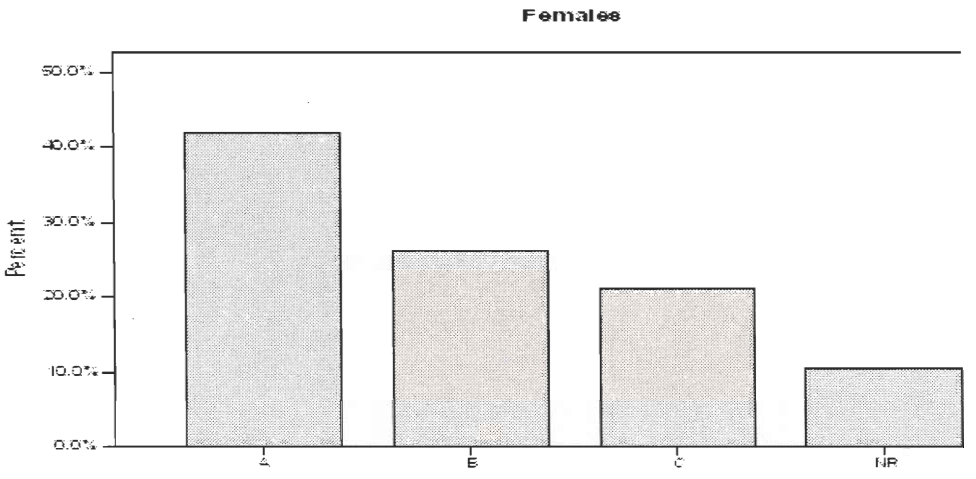

Figure 45: Female Grades B Term

In looking at the final grades in the B 01 materials class, it is evident that a disproportional number of the female students received an A in the class, while the males

disproportionately received B's. The difference in numbers of males and females receiving A's and C's is overwhelming, but we believe that our results are independent of the small number of female students in the class, and reflect a campus wide trend among males and females, for the females to get higher grades per capita than the males.

		Gender		
		Male	Female	Total
letter grade	A	7	8	15
	B	17	5	22
	C	16	4	20
	NR	6	2	8
Total		46	19	65

Figure 46: Male and Female Grades

Through SPSS we were able to test the significance of a gender finding in the B term class. Rather than only using students for whom we have MBTI data, as is many of the previous significance tests, we were able to use the entire class due to only heeding a gender designation to make the comparison. Despite the small number of women in the class, the Chi Square test indicates that a significant difference was almost found. The trend was not quite strong enough to be reliable. We would be wrong if we took this as evidence of a gender difference. Our significance factor for a gender finding in B 01 is .136 meaning that the result is basically the same fourteen times out of one hundred in this case.

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	5.555	3	.135
Likelihood Ratio	5.223	3	.156
N of Valid Cases	65		

Figure 47: B Term Gender Chi-Square Test

By collapsing out data into three grades instead of the previous four, we improved the significance to get twelve chances in one hundred of error in declaring a reliable gender difference.

		Gender		
		Male	Female	Total
Collapsed Grades	A	7	8	11
	B	17	5	21
	Low	22	6	28
Total		46	19	65

Figure 48: Male and Female Grades with Low = NR and C

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	4.156	2	.125
Likelihood Ratio	3.922	2	.141
N of Valid Cases	60		

Figure 49: Male and Female Significance of B Term Grades including Low

By simply combining the C's and NR's into one category, the significance level increases slightly. This is due to the fact that there are 22 males in the Low category, and only 6 females. The females are equally divided throughout the performance scale, six in each category, with the majority of males falling into the Low category with 22.

The final breakdown of B 01 grades is displayed below, showing the three exams, their average, and total homework average. The females received higher grades in every assignment except for Exam 2, but the males and females came very close to performing exactly the same on both the first and second exam. The females had the edge on the third one. For the overall homework average, the females held a tremendous advantage, outperforming the males by a letter grade of nine points. As stated before, it appears that

at WPI in general, the females hold the edge on things such as homework due to their better work ethic. In this particular class the females held the lead in exams as well, but dominated the males in homework grades, leading to a C+ vs. B- average overall, and thus, striking differences in the grade distribution by sex.

Gender		Exam 1 Grade	Exam 2 Grade	Exam 3 Grade	homework average	exam average	final average
Male	Mean	78.78	79.98	72.67	78.502	76.952	78.861
	N	46	46	46	46	46	46
	Std. Deviation	10.598	11.552	17.264	17.1632	10.2561	9.3285
Female	Mean	79.37	79.95	78.26	87.900	79.321	83.026
	N	19	19	19	19	19	19
	Std. Deviation	11.417	11.816	15.881	10.2967	11.0680	9.1526
Total	Mean	78.95	79.97	74.31	81.249	77.645	80.078
	N	65	65	65	65	65	65
	Std. Deviation	10.756	11.537	16.943	15.9843	10.4686	9.4017

Figure 50: Female and Male Exam and Homework Grades - B Term

These findings neither prove nor disprove the gender hypothesis, but provide an alternative explanation to the performance of students at WPI. With our results we have shown that there is room for a valid gender discussion.

4.9.2 Gender A

Our gender study continues with A term of 2004. This class was larger than the previous B 01 class, producing a larger sample size as well. The gender ratio in A 04 was even greater than in previous classes, nearly a 4.5:1 ratio in favor of the males. The interaction of type is now very striking with the females disproportionately sensing, and not at all likely to be NP.

SJ-SP-NJ-NP * Gender1 Crosstabulation

Count

		Gender1		
		Male	Female	Total
SJ-SP-NJ-NP	SJ	20	7	27
	SP	10	4	14
	NJ	4	1	5
	NP	24	1	25
Total		58	13	71

Figure 51: A Term Male and Female Types

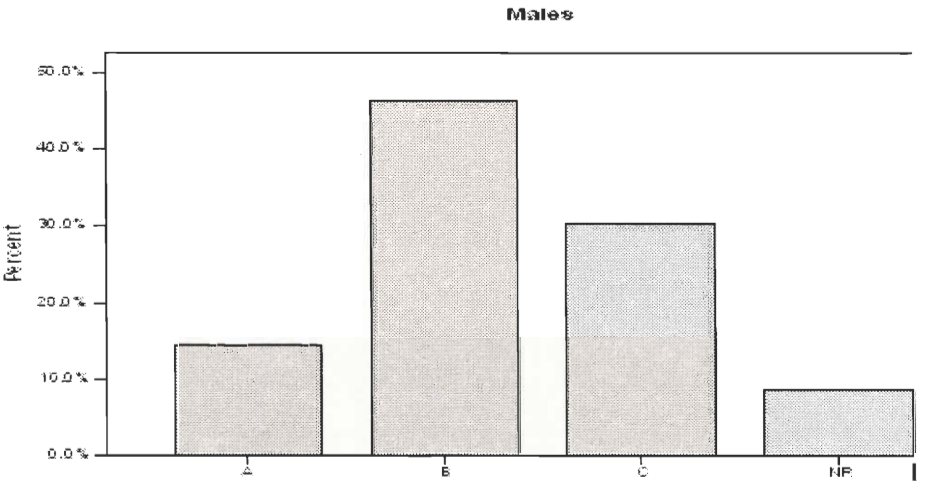

Figure 52: A Term Male Final Grade Distribution

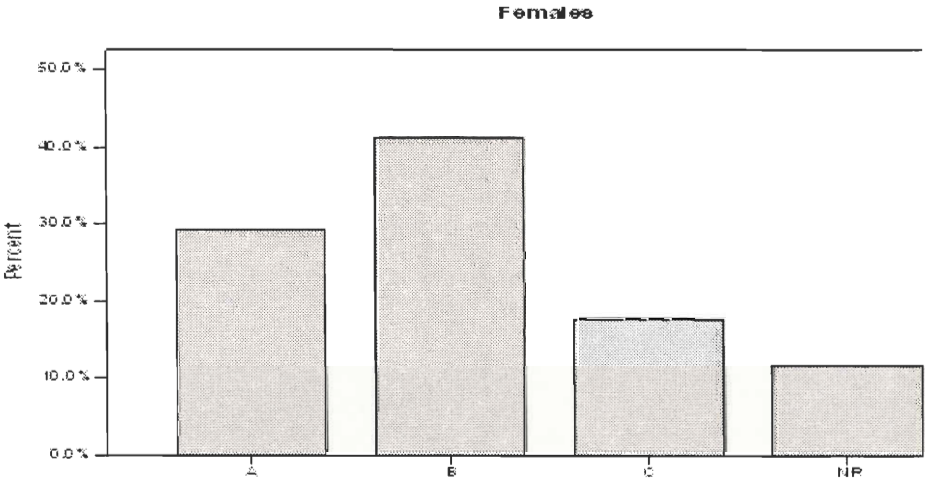

Figure 53: A Term Female Grade Distribution

We see slightly different results in A04 than in B01as far as grading. Here you can see that the majority of males received B's and C's, which is consistent with B 01,

but the females here also averaged a B, although a high B. In the B term study the females averaged an A. The females still outperformed the males, not as overwhelmingly as in the previous study, but they still have twice as many A's, the same proportion of B's, about half as many C's, and the proportion of NR's is similar.

		Gender1		
		Male	Female	Total
Letter Grade	A	10	5	15
	B	32	7	39
	C	21	3	24
	NR	6	2	8
Total		69	17	86

Figure 54: A Term Male and Female Final Grades

Using SPSS again as we had before to find any significance in our findings, we were less successful with the A 04 class. The Chi-Square test shows only a .430 significance factor. Our previous study produced a .135 significance. This is most likely due to the fact that the difference in grades is not as obvious.

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	2.759(a)	3	.430
Likelihood Ratio	2.626	3	.453
N of Valid Cases	86		

Figure 55: A Term Gender/Final Grade Chi-Square Test

Again we collapsed the grades into three categories rather than four hoping to see a better significance.

		Gender1		
		Male	Female	Total
3 outcome grades	A	10	5	15
	B	32	7	39
	low	27	5	32
Total		69	17	86

Figure 56: A Term Gender Final Grades including Low

The results are slightly more significant but still remain well below the acceptable significance of .15 and lower.

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	2.168(a)	2	.338
Likelihood Ratio	1.971	2	.373
N of Valid Cases	86		

Figure 57: A Term Gender Final Grades with Low Chi-Square Test

The final report for A term of 2004 shows that the females prevailed again over the males for final class average. Again it was the females' homework average that pushed them up over the males. Although in A 04 the females test average was not as good as the males, unlike in B 01. If not for the females' work ethic and sense of urgency toward homework, the results would have been different. This difference in test average is the reason for a non-significant finding in A 04.

Gender1		Homework Average	Exam 1	Exam 2	Exam 3	Exam Average	Final Average
Male	Mean	77.5389	75.51	80.78	80.58	78.96	80.2233
	N	69	69	69	69	69	69
	Std. Deviation	14.37487	13.013	10.205	13.367	10.474	8.97544
Female	Mean	82.5641	73.06	79.47	82.24	78.25	81.7728
	N	17	17	17	17	17	17
	Std. Deviation	11.40954	15.315	10.296	13.122	11.600	8.90536
Total	Mean	78.5322	75.02	80.52	80.91	78.82	80.5296
	N	86	86	86	86	86	86
	Std. Deviation	13.92356	13.438	10.176	13.259	10.639	8.93085

Figure 58: A Term Gender Grade Distribution

4.10 E I Relationship

There was a finding in the E-I type in both A-Term 2004 and B-Term 2001. It showed that the Is outperformed the Es in the final grades.

The chart below shows the significance between the E-I types for the A-Term 2004 data. This shows the final grades for the four types, EJ, EP, IJ, and IP, and how each type performed.

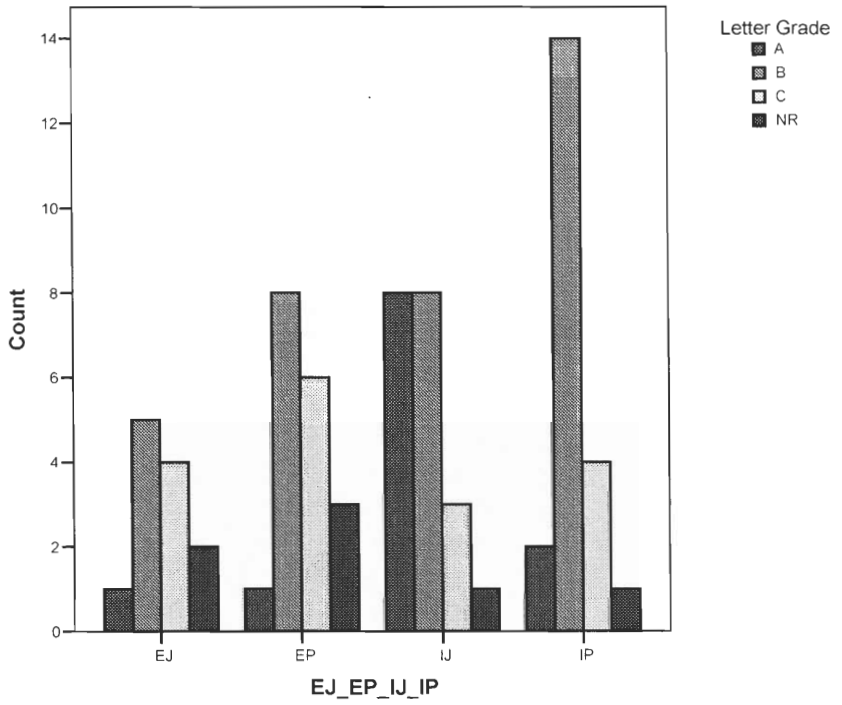

Figure 59: A Term Final Letter Grades of EI

The distribution displays statistically significant differences, the significance level is a 0.042.

Since the cut off for a C and a NR changes from term to term and between person and person, this might create an inaccuracy in the data. This was fixed by creating only three groups, letter grade A, B, and Low. Since the numbers for the cut offs for As and Bs are set, the low will incorporate everything besides A and B. This removes the bias that could occur around the C and NR cut off. The chart below shows the distribution with that A, B and Low grades only.

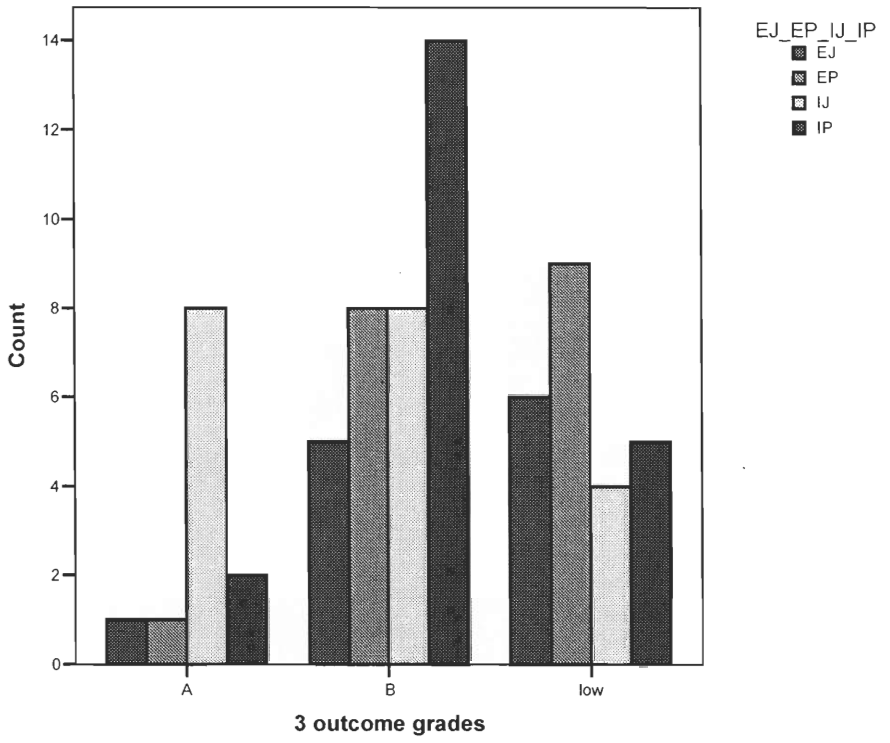

Figure 60: A Term Final Grades with Low for EI

The significance is 0.009. By reducing the grades to only three outcomes, the significance level improves, but there really is no new information here.

The I type outperforms the E type in both A-Term 2004 and in B-Term 2001 data. The B-Term 2001 data was almost identical to the A-Term 2004 data. The chart below shows the B-Term grade distribution.

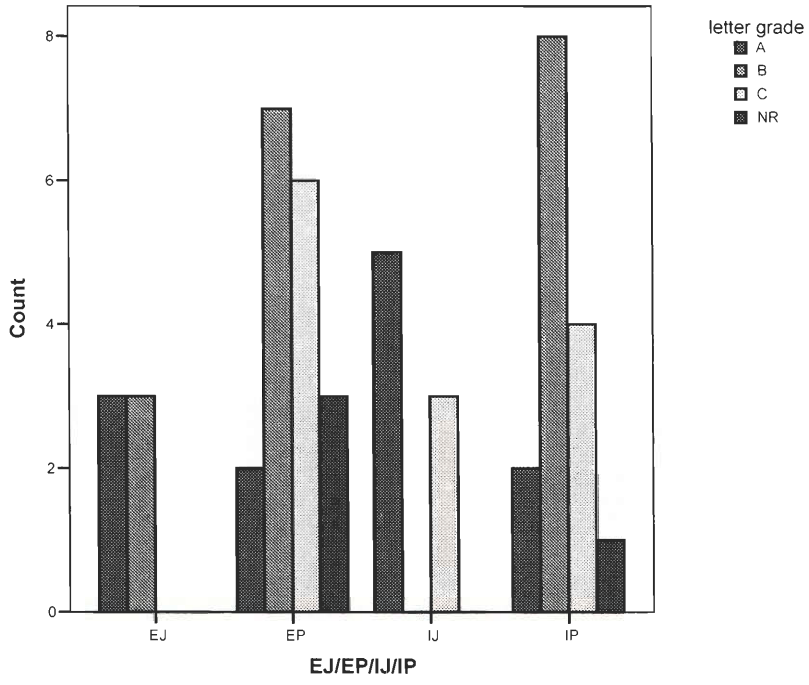

Figure 61: B Term Final Grades of EI

The significance for this is 0.05. This is almost the same as the A-Term 2004 figure. The graph below shows the distribution for the three outcome grade adjustment. The significance level is once again indicative of a highly reliable difference at 0.005.

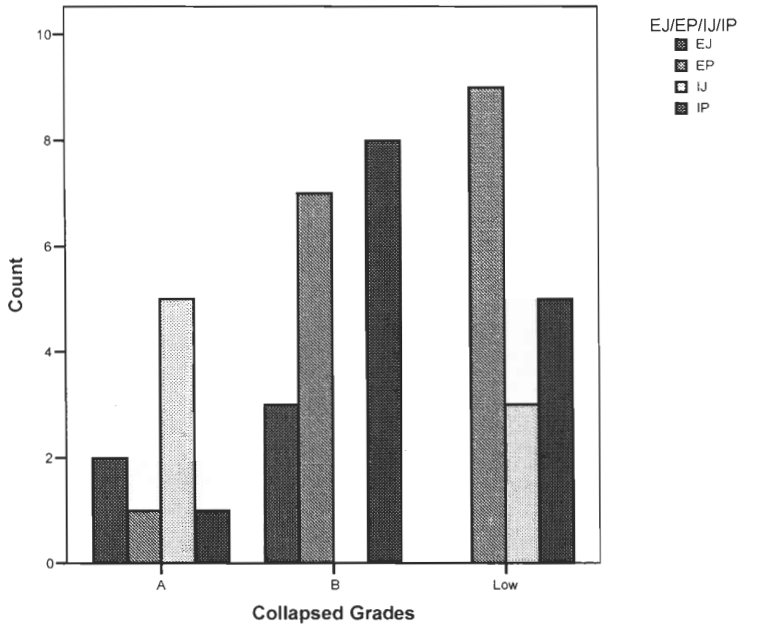

Figure 62: B Term Final Grades with Low of EI

The next couple of graphs show just the E-I dimensions and their breakdown. The one is from A-Term 2005.

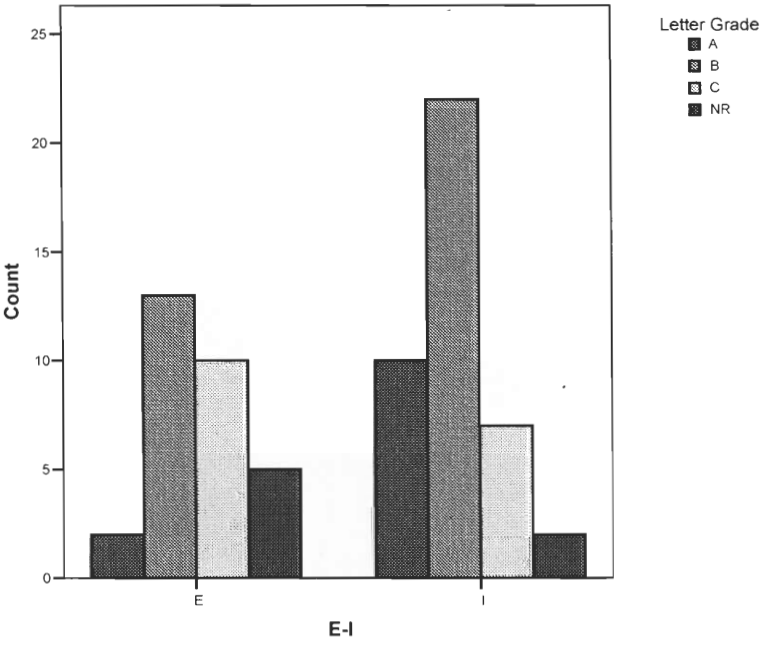

Figure 63: E and I Final Letter Grades A Term

The I's solidly outperform the E's in terms of the proportion getting A's and B's. The next graph is for B-Term 2001. The difference in the letter grades is more subtle than A-Term 2004 but it still is noticeable.

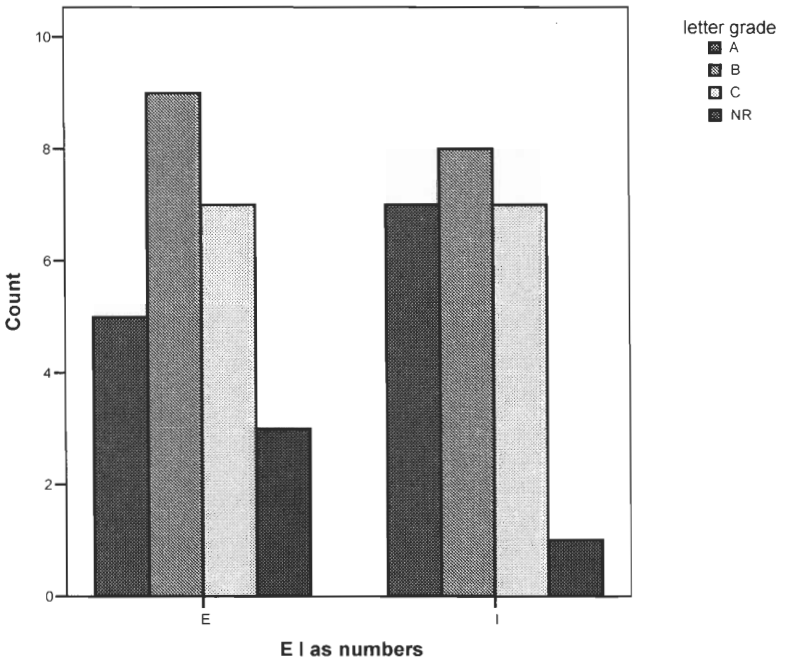

Figure 64: E and I Letter Grades B Term

The difference for this graph is primarily the higher number of A' for the I type and the lower number of NR's for the Is.

5. Conclusion & Recommendations

After doing a thorough analysis of the class there are many conclusions and recommendations that we have for Professor Demetry. First, our biggest finding was the EI relationship. As seen in the previous sections the Is outperformed the Es. This was surprising to us because in our hypothesis we said that the Es had an advantage based on the structure of the class. Therefore, it is very difficult to make a recommendation to improve the ability of the extraverts in the class.

The results we got from the B term 2001 data displayed a J-P finding which is inconsistent with the results from the A term class. The Js outperformed the Ps by quite an evident amount. Judgers take their homework assignments seriously regardless of topic because they know it is important, but perceivers like to follow their curiosity. If they are interested then they may have a hard time completing the homework assignments. This shows that the perceivers in this class may not have been interested in the material at hand, which caused them to possibly miss a couple assignments and drop their overall grade and detriment their ability to perform well on the exams. We feel that if the professor could make the class more interesting or maybe more interactive and fun, the perceivers would fare better. Also, the professor could keep a closer eye on the grades of the perceivers early in the class to see how they do. If they are having trouble then they could be informed to get help with the material before it was too late.

The comparison between gender and the overall performance in the class was another significant finding. In the analysis you can see that the females in the course did a much better job throughout every aspect of the course. There are several possibilities of

why this happened which are stated earlier. It is difficult to recommend anything because of the ratio of males to females.

Another finding that we came across was the significance of lead indicators. We discovered that in the A term data that Homework #2 and Homework #4 were the lead indicators. The students' grades on these two specific homework assignments represented a large correlation with their final grade. If they did poorly on these assignments there was a high possibility of not performing well overall in the class, and vice versa with good homework grades. If this study was a part of a lower form of education, i.e. high school, we would recommend the teacher to approach the individual students who performed poorly on the assignment. Seeing how this is being done for a higher level of education it is not expected of the professor to do this. We would suggest that the professor make the students aware of the situation and stress the importance of the assignment. Another way of handling this situation would be to spend more time on the material that is taught for the assignment just to make sure everyone has a complete understanding.

The specific types in the A term class had a more balanced performance and had similar averages. However, the distribution of grades was varied. Types would have similar averages, but they were reached differently. One type received mostly B's, while another type received a percentage of A's and a percentage of C's causing them to have a similar average as the type that received mostly B's.

A recommendation that we have for the students would be to complete the optional project. The project takes away from the importance of the exams and the homework assignments; it decreases the exams by 15% and homework by 5%. It is

proven that many of the students that completed the project improved by a full letter grade. Therefore, if a student is on the path to fail the course they have a chance to save themselves by doing the project. We would also recommend to the students to perform the preparation assessments and to attend class regularly. These two sections combine to 20% of the overall grade and are usually graded on "clear thinking" and not directly right/wrong answers. Also, by completing these tasks students are more often to receive better grades.

We recommend that the VARK could help in the ES2001 class. If at the beginning of the term the teacher is aware of all the students learning preferences, they will be able to modify the way the class is taught so it appeals to everyone. Another idea would be to have extra help sessions. These help sessions could revolve around the hard sections of the course and could be taught towards a different learning preference than what is taught during class.

In conclusion, there are many things that can be done to improve the students experience in the class and things they can do to improve their overall grade. There are also situations that the professor can do to improve the experience for specific types. Overall, this has been a great learning experience for all of us and we hope that it is beneficial to the faculty of WPI.

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Appendix A

Correlations

		Homework 1	Homework 2	Homework 3	Homework 4	Homework 5	Homework 6	Homework 7	Homework 8	Exam Average	Project Grade	Final Average
Homework 1	Pearson Correlation	1	.380**	.532**	.421**	.349**	.452**	.412**	.315**	.415**	.377*	.488**
	Sig. (2-tailed)	.	.001	.000	.000	.001	.000	.000	.005	.000	.036	.000
	N	84	79	84	81	84	83	83	78	84	31	84
Homework 2	Pearson Correlation	.380**	1	.364**	.430**	.431**	.363**	.375**	.513**	.519**	.483**	.611**
	Sig. (2-tailed)	.001	.	.001	.000	.000	.001	.001	.000	.000	.007	.000
	N	79	80	80	77	80	79	80	75	80	30	80
Homework 3	Pearson Correlation	.532**	.364**	1	.413**	.509**	.249*	.338**	.479**	.288**	.264	.485**
	Sig. (2-tailed)	.000	.001	.	.000	.000	.022	.002	.000	.007	.152	.000
	N	84	80	85	82	85	84	84	78	85	31	85
Homework 4	Pearson Correlation	.421**	.430**	.413**	1	.571**	.482**	.429**	.441**	.503**	.634**	.635**
	Sig. (2-tailed)	.000	.000	.000	.	.000	.000	.000	.000	.000	.000	.000
	N	81	77	82	82	82	81	81	75	82	30	82
Homework 5	Pearson Correlation	.349**	.431**	.509**	.571**	1	.267*	.398**	.552**	.355**	.435*	.603**
	Sig. (2-tailed)	.001	.000	.000	.000	.	.014	.000	.000	.001	.014	.000
	N	84	80	85	82	85	84	84	78	85	31	85
Homework 6	Pearson Correlation	.452**	.363**	.249*	.482**	.267*	1	.554**	.257*	.493**	.585**	.501**
	Sig. (2-tailed)	.000	.001	.022	.000	.014	.	.000	.023	.000	.001	.000
	N	83	79	84	81	84	84	83	78	84	31	84
Homework 7	Pearson Correlation	.412**	.375**	.338**	.429**	.398**	.554**	1	.333**	.472**	.553**	.578**
	Sig. (2-tailed)	.000	.001	.002	.000	.000	.000	.	.003	.000	.002	.000
	N	83	80	84	81	84	83	84	78	84	30	84
Homework 8	Pearson Correlation	.315**	.513**	.479**	.441**	.552**	.257*	.333**	1	.386**	.334	.521**
	Sig. (2-tailed)	.005	.000	.000	.000	.000	.023	.003	.	.000	.076	.000
	N	78	75	78	75	78	78	78	78	78	29	78
Exam Average	Pearson Correlation	.415**	.519**	.288**	.503**	.355**	.493**	.472**	.386**	1	.810**	.837**
	Sig. (2-tailed)	.000	.000	.007	.000	.001	.000	.000	.000	.	.000	.000
	N	84	80	85	82	85	84	84	78	86	32	86
Project Grade	Pearson Correlation	.377*	.483**	.264	.634**	.435*	.585**	.553**	.334	.810**	1	.757**
	Sig. (2-tailed)	.036	.007	.152	.000	.014	.001	.002	.076	.000	.	.000
	N	31	30	31	30	31	31	30	29	32	32	32
Final Average	Pearson Correlation	.488**	.611**	.485**	.635**	.603**	.501**	.578**	.521**	.837**	.757**	1
	Sig. (2-tailed)	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.
	N	84	80	85	82	85	84	84	78	86	32	86

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

Appendix B

Correlations

			Homework 1	Homework 2	Homework 3	Homework 4	Homework 5	Homework 6	Homework 7	Homework 8	Exam Average	Project Grade	Final Average
Spearman's rho	Homework 1	Correlation Coefficien	1.000	.346**	.564**	.475**	.338**	.356**	.436**	.314**	.352**	.278	.457**
		Sig. (2-tailed)	.	.002	.000	.000	.002	.001	.000	.005	.001	.130	.000
		N	84	79	84	81	84	83	83	78	84	31	84
	Homework 2	Correlation Coefficien	.346**	1.000	.386**	.560**	.456**	.334**	.381**	.446**	.496**	.478**	.610**
		Sig. (2-tailed)	.002	.	.000	.000	.000	.003	.000	.000	.000	.008	.000
		N	79	80	80	77	80	79	80	75	80	30	80
	Homework 3	Correlation Coefficien	.564**	.386**	1.000	.459**	.589**	.390**	.479**	.576**	.340**	.441*	.550**
		Sig. (2-tailed)	.000	.000	.	.000	.000	.000	.000	.000	.001	.013	.000
		N	84	80	85	82	85	84	84	78	85	31	85
	Homework 4	Correlation Coefficien	.475**	.560**	.459**	1.000	.621**	.392**	.444**	.566**	.546**	.467**	.698**
		Sig. (2-tailed)	.000	.000	.000	.	.000	.000	.000	.000	.000	.009	.000
		N	81	77	82	82	82	81	81	75	82	30	82
	Homework 5	Correlation Coefficien	.338**	.456**	.589**	.621**	1.000	.232*	.430**	.596**	.359**	.426*	.620**
		Sig. (2-tailed)	.002	.000	.000	.000	.	.034	.000	.000	.001	.017	.000
		N	84	80	85	82	85	84	84	78	85	31	85
	Homework 6	Correlation Coefficien	.356**	.334**	.390**	.392**	.232*	1.000	.500**	.241*	.453**	.494**	.487**
		Sig. (2-tailed)	.001	.003	.000	.000	.034	.	.000	.034	.000	.005	.000
		N	83	79	84	81	84	84	83	78	84	31	84
	Homework 7	Correlation Coefficien	.436**	.381**	.479**	.444**	.430**	.500**	1.000	.358**	.449**	.471**	.572**
		Sig. (2-tailed)	.000	.000	.000	.000	.000	.000	.	.001	.000	.009	.000
		N	83	80	84	81	84	83	84	78	84	30	84
	Homework 8	Correlation Coefficien	.314**	.446**	.576**	.566**	.596**	.241*	.358**	1.000	.343**	.380*	.528**
		Sig. (2-tailed)	.005	.000	.000	.000	.000	.034	.001	.	.002	.042	.000
		N	78	75	78	75	78	78	78	78	78	29	78
	Exam Average	Correlation Coefficien	.352**	.496**	.340**	.546**	.359**	.453**	.449**	.343**	1.000	.695**	.865**
		Sig. (2-tailed)	.001	.000	.001	.000	.001	.000	.000	.002	.	.000	.000
		N	84	80	85	82	85	84	84	78	86	32	86
	Project Grade	Correlation Coefficien	.278	.478**	.441*	.467**	.426*	.494**	.471**	.380*	.695**	1.000	.759**
		Sig. (2-tailed)	.130	.008	.013	.009	.017	.005	.009	.042	.000	.	.000
		N	31	30	31	30	31	31	30	29	32	32	32
	Final Average	Correlation Coefficien	.457**	.610**	.550**	.698**	.620**	.487**	.572**	.528**	.865**	.759**	1.000
		Sig. (2-tailed)	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.
		N	84	80	85	82	85	84	84	78	86	32	86

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

Appendix C

Correlations

			Exam 1 Grade	Exam 2 Grade	Exam 3 Grade	homework average	project grade	final average
Spearman's rhc	Exam 1 Grade	Correlation Coefficie	1.000	.528**	.467**	.404**	.162	.670**
		Sig. (2-tailed)	.	.000	.000	.001	.198	.000
		N	65	65	65	65	65	65
	Exam 2 Grade	Correlation Coefficie	.528**	1.000	.551**	.286*	-.080	.637**
		Sig. (2-tailed)	.000	.	.000	.021	.527	.000
		N	65	65	65	65	65	65
	Exam 3 Grade	Correlation Coefficie	.467**	.551**	1.000	.602**	.183	.829**
		Sig. (2-tailed)	.000	.000	.	.000	.143	.000
		N	65	65	65	65	65	65
	homework averag	Correlation Coefficie	.404**	.286*	.602**	1.000	.361**	.834**
		Sig. (2-tailed)	.001	.021	.000	.	.003	.000
		N	65	65	65	65	65	65
	project grade	Correlation Coefficie	.162	-.080	.183	.361**	1.000	.250*
		Sig. (2-tailed)	.198	.527	.143	.003	.	.045
		N	65	65	65	65	65	65
	final average	Correlation Coefficie	.670**	.637**	.829**	.834**	.250*	1.000
		Sig. (2-tailed)	.000	.000	.000	.000	.045	.
		N	65	65	65	65	65	65

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

Appendix D

Correlations

		Exam 1 Grade	Exam 2 Grade	Exam 3 Grade	homework average	project grade	final average
Exam 1 Grade	Pearson Correlation	1	.489**	.411**	.367**	.176	.679**
	Sig. (2-tailed)		.000	.001	.003	.162	.000
	N	65	65	65	65	65	65
Exam 2 Grade	Pearson Correlation	.489**	1	.489**	.157	-.108	.602**
	Sig. (2-tailed)	.000		.000	.213	.392	.000
	N	65	65	65	65	65	65
Exam 3 Grade	Pearson Correlation	.411**	.489**	1	.384**	.152	.776**
	Sig. (2-tailed)	.001	.000		.002	.227	.000
	N	65	65	65	65	65	65
homework average	Pearson Correlation	.367**	.157	.384**	1	.314*	.789**
	Sig. (2-tailed)	.003	.213	.002		.011	.000
	N	65	65	65	65	65	65
project grade	Pearson Correlation	.176	-.108	.152	.314*	1	.273*
	Sig. (2-tailed)	.162	.392	.227	.011		.028
	N	65	65	65	65	65	65
final average	Pearson Correlation	.679**	.602**	.776**	.789**	.273*	1
	Sig. (2-tailed)	.000	.000	.000	.000	.028	
	N	65	65	65	65	65	65

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).