Learning Styles and Lead Indicators of Academic Performance: The Class of 2003 Study

An Interactive Qualifying Report

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By

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Abstract

The purpose of this project is to analyze Worcester Polytechnic Institute students' class of 2001-2003 freshman grade performance patterns and see if freshman lead indicators of four-year on time graduation for four types of learners can be found in the data available by the end of freshman year. The degree to which SAT scores' predict freshman year success and four year success for each type of learner is also assessed. Learning style categories are based on the students' MBTI (Myers-Briggs Type Indicator) data collected during freshman orientation. Errors in the data set assembled by a prior IQP student on the class of 2003 MBTI data were found and fixed. Hence, the pattern of results for class of 2001-2002 replicate, but not as previously reported that had been the focus of earlier studies.

Acknowledgments

I would like to thank you Professor John Wilkes who has been very helpful and patient in guiding me through this project. Also I would like to thank you Sayan Mondal for his help on our collaborative data processing and WPI Helpdesk for installing SPSS version 17.0 on several campus computers. Lastly, I would like to thank Tara Murphy, Kevin Rogerson, Alfred Navato, and others, for their work on the WPI classes of 2001, 2002, and 2003 data sets before this project began.

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Introduction

Predicting student performance in the freshman year using lead indicators such as the admission department could provide was an interest of the WPI Office of Academic Advising under Ann Garvin 15 years ago. When Dale Snyder took over, she maintained the theoretical interest. But, Ms. Snyder also stressed the development of the Insight program which she helped start in 2000. Ms. Garvin was motivated by frustration due to the lack of predictive power in the SAT data for freshman grades and encouraged learning style studies to see if the SAT had greater power if students of the same learning style were being rank ordered relative only to one another using the SAT.

The first analysis of this type was done using the class of 2001 data set, in the summer of 1998, and showed promise. The SAT was correlating 0.4-0.6 reasonably well with freshman GPA for 8 of the 16 MBTI types, and not at all (or even negatively) for the other 8 types. Further analysis indicated that high school data on the degree of difficulty of high school science courses combined the S-N variable of the MBTI explained all the variance associated with SAT's. So SAT's worked as a predictor about half the time. WPI faith in the value of SAT's began to erode and submitting SAT's finally was optional in 2007.

The analysis of the class of 2002 data set took things in a new direction by directing attention to the term by term pattern of performance for four types of learners based on MBTI data. This analysis by Doerschler in 1999, who is now an institutional researcher at Clark University, was the beginning of concern about the so called B-term plunge, of the sensing-perceiving (SP) type of learner.

It is not controversial that every student is unique in their learning style and some will succeed more than the others; due to the fit between the academic task environment in engineering college and the individual's cognitive style. But it is controversial whether a typology involving only 4-8 types of learners, based on Myers-Briggs Type Indicator (MBTI), is refined enough to encompass the bulk of differences of interest in explaining the experience of a range of college students. The focus of this paper is to analyze students' performance pattern by looking at the experience of the WPI classes of 2001-2003 during their freshman years (1997-2000) and determine what will be the best predictor of the outcome of four years of study at WPI. The analysis is based on the students' MBTI and their performance throughout their years at WPI. This study will provide useful information for the office of Academic Advising and academic advisors in general to understand WPI students better. The goal is to provide more appropriately targeted support for the students who are most likely to struggle or fail in the freshman year without assistance.

Previous studies such as done by Derick Fors[1] (2002) and Tara Murphy[2] (2001) have reported a replicated B-term performance drop. It was reported from both in the freshman years of the class of 2002 and 2003. Students with SP preference (in MBTI term) were shown to have a notable drop in average grades during B-term of the freshman year, but in both cases of classes of 2002 and 2003 the SPs recovered by the end of the year. Unfortunately, the MBTI data used in Tara Murphy's class of 2003 paper was mixed up during her data processing; i.e. the type data were scrambled and assigned to the wrong cases. This led to error and confusion in several following papers which continued using the corrupted data and producing results

[1] Derick Fors and Jason Casimiro: Success Trends and Personality Types at WPI
[2] Tara Murphy: First Year Experience for Class of 2003

that did not jibe with the class of 2001 and 2002 findings. At last Chris Colamussi[3] determined that there was a problem with the 2003 data set itself and the job fell to me to fix it (Colamussi 2006).

Colamussi was looking over the freshman year experience with Introductory Physics for the classes of 2002 and 2003, comparing it to the experience in other courses. He determined that while the SJ students were unusually likely to be the "stars" in most freshman courses, but that was not the case in PH1010 Introductory Physics. At this course, the NJ students were the stars and the SJ's were not outperforming the NP's as much usual either. However, the SP's were struggling even more than usual.

This same NJ dominant pattern had been reported for the Signal Analysis course in Electrical and Computer Engineering (ECE) and in Linear Algebra course in mathematics by Nathan Shuler[4]. These are normally sophomore classes, so the possibility that the WPI curriculum shifts over time, from one favoring one type of learner to another pattern as more advanced and abstract courses are encountered, had to be considered. Hence, my original project was going to look at the sophomore year grade data, for the classes of 2002 and 2003, to see if the rank ordering of which type was flourishing and which type was struggling was different, for the sophomore year experience of these two classes.

The class of 2003 data set has now been fixed and organized for the reanalysis during this project. Use caution if you see previous project reports referring to the class of 2003 data reporting different patterns than that reported here, especially if the refer to a B-term plunge in the SP learning style category.

[3] Christopher Colamussi: Critical Class Study – Characterizing Trends in Specific Courses
[4] Nathan Shuler: Timely Feedback Study

Kevin Rogerson's[5] class of 2001 data (Rogerson 2004) and Alfred Navato's *et al.*[6] class of 2002 data (Navato *et al*. 2005), as reported in their IQP reports, will be used throughout this study to be compared to the findings produced using the recently repaired class of 2003 data set. Significant proportions (85-95%) of the class of 2001-2003 students participated in MBTI data gathering effort during their new student orientation. These are the students who arrived in August 1997, 1998, and 1999 excluding transfer students. There were other tests and surveys taken by the freshmen at that time, including CIRP (Cooperative Institutional Research Program) and GMCS, but this project will only focus on MBTI as a learning style indicator results. However, there are interesting findings previously reported using those other data. For example Hoosick and Marzullo[7] examined the CIRP-MBTI relationship and found that 'confidence' and 'drive to achieve' as well as other self image items in the CIRP are correlated with MBTI variables, especially extraversion and introversion (Hoosick and Marzullo 2002).

MBTI is not simply a personality test, but a well-known indicator of cognitive preferences related to people's career choice, learning style, and leadership behavior. There are 16 possible outcomes on this indicator, but this analysis will be focused on only 4 types of learners which can be defined using 2 of the 4 dichotomous factors measured by the MBTI. Students with MBTI preference of SJ (sensing-judging), NJ (intuition-judging), SP (sensing-perception), and NP (intuition-perception) are compared in this study. The WPI student population is about 40% NP and 20% each of the other 3 types. By knowing one's MBTI learning type, students could know themselves better, be empowered, and better understand what

[5] Kevin Rogerson: Predicting Academic Success at WPI
[6] Alfred Navato et al.: The Experience of the WPI Classes of 2002 and 2003: A Graduation Outcomes Study by Learning Styles
[7] Shannon Hoosick and Jesse Marzullo: Exploring the Potential of Data Mining at WPI.

study practices and what task environments are associated with success for them. They may also come to appreciate the different needs of other types of students and compensatory strategies that are needed by themselves and by other types of learners, if WPI resumes the practice of gathering such data from freshmen and arranging feedback session for them.

Original Project

The project started off as a "WPI Sophomore Year Study" for the WPI class 2002-2003 with myself and another student, Sayan Mondal who had a related interest, in choice of major, teaming up to assemble a suitable data set to cover both of our needs. This project would have been the follow up for of "WPI Freshman Year Study" that has been done by several prior IQP project students. Questions had recently been raised about whether the WPI class of 2003 MBTI data and freshman transcript data were linked correctly. Another problem was that the raw transcript data was no longer available. The goal of the project was to see if in their second year, the same students that were studied during their freshman year would replicate their performance pattern term by term, on whether trends established in the freshman year would project into the sophomore year for each of the four types of learners.

Unfortunately, even though the freshman data set of 2003 could be fixed with available materials, the sophomore year grade data was withheld by the registrar's for too long. After a month of waiting for data, Sayan and I ended up doing two different projects resulting in separate reports. Sayan started with the class of 2002 data set and focused on a study of major change and MBTI, while I fixed the class of 2003 data set and thought about four year outcome data that was publically available – published and announced. We both still shared most data for our individual project reports. So he redid the major change analysis for the class of 2003 to see if it replicated, and I referred to the 2002 data set to see if the class of 2003 pattern replicated. This exact same problem has occurred before with Alfred Navato and his project partners who were also initially interested in analyzing the sophomore year data. They ended up coding 4 year outcome data into each data set based on the graduation program of the

classes of 2001-2004; this was data in the public domain, which I decided I could also use as soon as the class of 2003 data set for MBTI data was repaired.

Future teams should be forewarned that the legal environment has changed since the MBTI data was collected in 1997-2000 and getting WPI archive data to go with the cognitive style data will require extensive documentation to the Institutional Review Board (IRB) before it will be released. We were caught in the period of rule change and unable to understand the administrative delays in setting up meetings to review our data requirements. Now there is a process and the challenge is to figure out what was done in the past and document the state of the data set before one can get approval to augment these data sets with sophomore, junior, and senior year course grade data.

History of the Project Series and Overview of MBTI Theory

MBTI (Myers-Briggs Type Indicator) is an instrument widely utilized by schools and companies to describe the personality types of students and employees. It is useful to help choose and understand career options, learning styles, and leadership behavior. The instrument that produced the typology was developed by Isabel Myers and Katharine Cook Briggs based on personality theories of Carl Gustav Jung, a Swiss psychiatrist.

Carl Jung is known for his work on the sub-conscious mind, but invented this conscious personality typology in early 1920s to understand personality clashes. He categorized personality based on introversion and extraversion as the energy source in conjunction with variables of sensing-intuition (two modes of perceiving) and thinking-feeling[8] (modes of coming to decision). Jung believed that each person has basic preference for how they perceive the world and relate to other people or work. For example, an introvert would prefer working individually or a small close-knit team in a job that does not require much social interaction, whereas an extravert would prefer a job that involves contact with many people even if it is superficial contact of a periodic nature. How the introverts and extraverts would handle people, process information, or engage tasks will depend on their other personality preferences. He also theorized that either the way one processed information or come to decision would be the "dominant: aspects of one's personality and that identifying the dominant and auxiliary function were important.

[8] Myers, MBTI Manual

Myers and her mother developed the MBTI instrument in the 1950s by studying over 5000 medical students from 45 different schools for 5 years[9]. Myers and Briggs used Jung's theories and expanded them to much more detailed sixteen types mental processing that were measured from four scales of preference: Extraversion/Introversion (E/I), Sensing/Intuition (S/N), Thinking/Feeling (T/F), and Judgment/Perception (J/P). The last dimension they invented to determine which of the prior two was "dominant" as opposed to "auxiliary" in Jung's sense of what the term dominant means. It does not mean it is the most visible part of the personality to an outsider. That would be the case only for extravert; the visible part for an introvert is their auxiliary. Since the J-P dimension determine what is visible to the outsider, it allows one to figure out what the dominant cognitive preference is for both extraverts and introverts, though it directly points to be dominant only of extraverts.

Whatever its original purpose, the J-P dimension is an especially valuable aspect of the MBTI for those interested in learning styles. The J's gather information to make decisions, limit input and prefer to work in structured environment with a plan, stick to it, and bring things to closure. Their emphasis is on being productive, getting things done, and moving on to the next work. By contrast, P's gather information for its own sake and avoid making decisions that close off other options as long as possible. They maximize input, delay committing to a plan, are only tentatively committed to the plan and will change direction easily based on new information. They avoid planning as it seems confining and emphasize flexibility inspiration, and seizing opportunities as they arise. They do not have a strong need for closure and emphasize the learning process over tangible products.

[9] Ibid.

There is no better or worse preference in MBTI parlance and all sixteen types are equally valued. The MBTI factors describe preference, not skills or abilities, a common misconception of people who are aware of the performance variables that correlate with various MBTI dimensions[10]. Having a certain type overrepresented does not necessarily mean that only people of certain psychological types could succeed in a specific field of study or work. However, Myers and Briggs were motivated to help people understand that they certainly will have improved odds of being successful in the long run in a task environment where they feel comfortable and which fits their pattern of personality preferences. In the short run they can learn to do anything competently. But staying in a job that constantly calls on one's less preferred modes of behavior is stressful over the long run. In the Jungian conceptualization of psychological type, each person has all eight traits, but they have preferences, some are dominant. People's preferences rarely change. They are like left or right handedness.

People can and do change personality in the sense that over time they develop their less preferred qualities to the point of competence so they can act in ways appropriate to the situation. However, when exposed in to an extreme work environment that is not in line with one's preference for a period of time, like a four-year college program, people can temporarily shift their behavior and even their self image to adjust to their coworkers or organizational demands, but this comes at a price in term of energy expended. However effective someone is in their less preferred mode, it is important to be aware of one's preference and seek opportunities to express the preferred side of one's personality in one's private life if not in one's work life. Since it takes more energy to function in other modes, in the long run needing

[10] Ibid.

to exert extra energy to do a job will be a competitive disadvantage, and take away from job satisfaction and engagement in one's profession.

Data was collected on all four scales of preference mentioned above, but this project's analysis is based on the S/N and J/P MBTI preferences which have been used to identify four types of learners: sensing-judging (SJ), sensing-perceiving (SP), intuition-judging (NJ), and intuition-perceiving (NP). This decision was made to bring the class of 2003 analysis into line with existing students' performance analyses using freshman year data from the classes of 2001-2002. Sensing and intuition relate to ways people obtain their information; students with a sensing preference tend to use their five senses and understand tangible evidence, observable facts or present situations better, whereas students with a preference for intuition tend to use their "sixth sense" and read between the lines in subjective data gathering[11]. They also understand theories and abstract concepts well and rapidly tune into future possibilities rather than practical constraints in the present. Judging and perception relate to how students' live their lives. Students with a judging preference would prefer to have everything planned and organized, whereas students with perception preference would prefer to be relaxed and keep their options open[12]. For more detailed descriptions of all sixteen types, refer to Myer's MBTI Manual or previous IQP reports[13].

[11] Ibid.

[12] Hirsh and Kummerow, 4.

[13] Peter Kline *et al.*'s "Class of 2001 SAT Study", Tara Murphy's "First Year Experience for Class 2003", The basic idea of the MBTI dimension that we are downplaying (T-F) is that It is a preferred way of coming to decision about things based on Thinking: logical abstract rules or principle that can be applied dispassionately to many cases with an emphasis on equality and justice or Feeling: a case by case mode of decision based on making an empathy connection with those affected and seeing it subjectively from their point of view. Then one can seek the win-win solution case by case and emphasize harmony for all rather than justice, and equal treatment. It does not seem to matter for academic performance in a college environment which way one tends to come to decision, but it does matter for career choice. Indeed, the T-F dimension has already impacted WPI before the students arrive here as freshmen. The F's are the majority of the general population, 75% of the female and nearly 50% of the males, but

Data gathered from the classes of 2001-2003's freshman year experience are compared in order to carry out an analysis of student performance patterns as a part of a search for lead indicators of later academic performance. The result will be useful for the office of academic advising as its staff tries to identify the larger pattern behind the struggles of the students in academic difficulty. It would be valuable to know what types of students one tends to deal with and when one is dealing with a rare instance in which the usual organizational response would be inappropriate or unhelpful. The compensatory strategies that "work" for the different types of learners will not be the same, and identifying them starts with identifying the outstanding performer of each type. This can only be done against the background of establishing the normal pattern for each type as they go through WPI. It is the mission of this study to establish these norms and look for lead indicator of academic success and struggle to pass classes and maintain a good GPA. The goal of academic advising is to come to understand the struggles of certain types of students and find better ways to support them to the point of success in graduating.

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they are less likely to apply to WPI and train for a technical career. The WPI student body is about 75-80% "Thinking" in preference; that is more than 80% of the males and 50% of the females have a Thinking preference. The percentages are quite a bit higher than one finds in the general US population.

Original Year Comparison

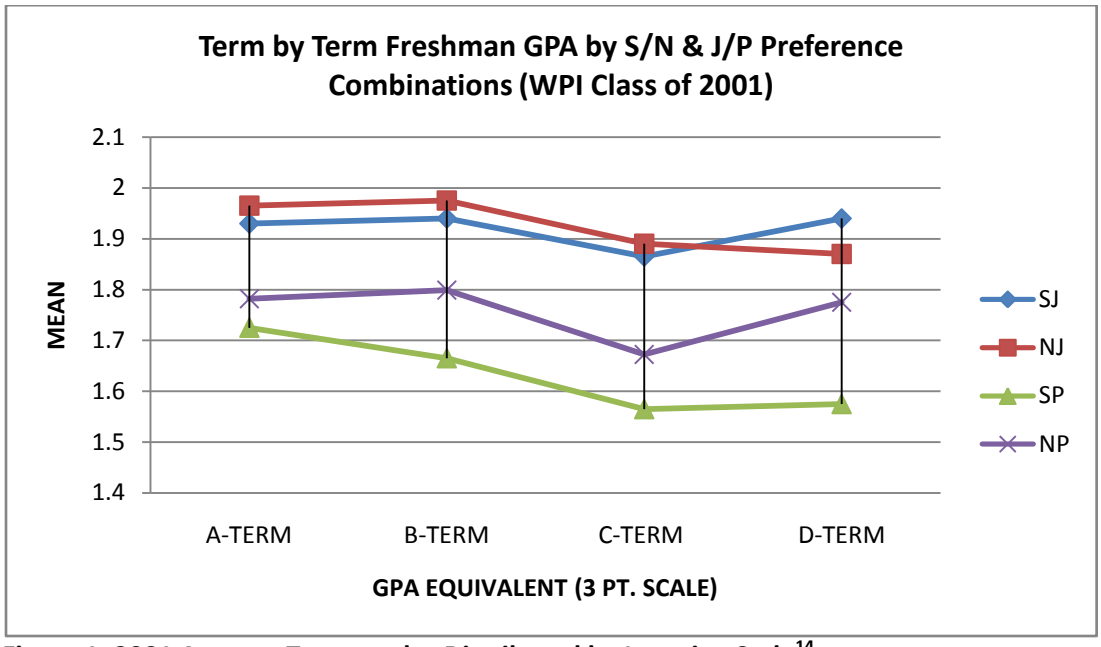


Figure 1. 2001 Average Term grades Distributed by Learning Style[14]

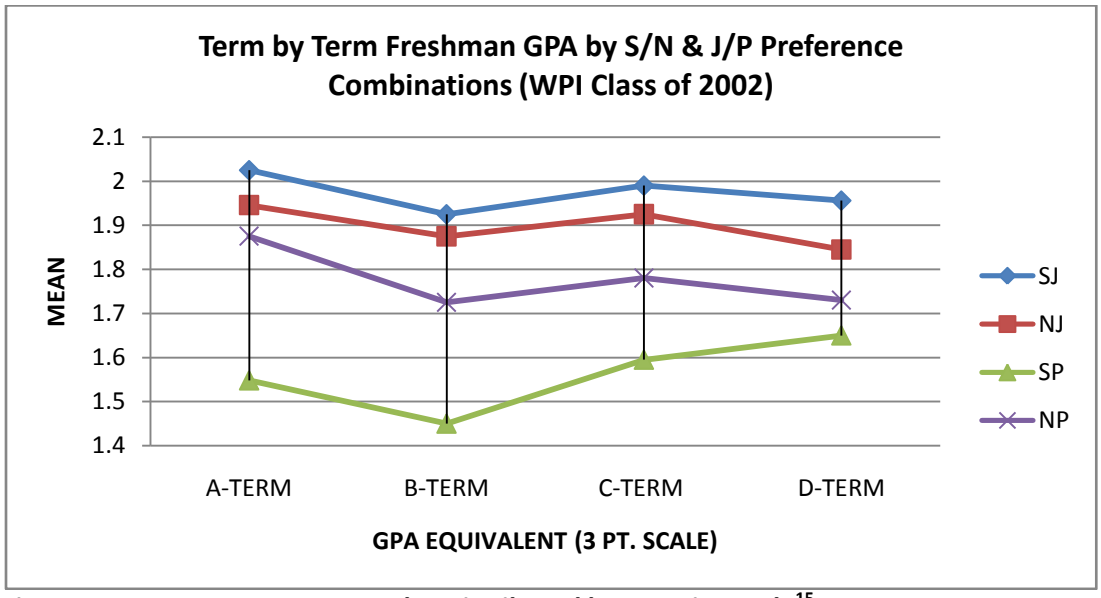


Figure 2. 2002 Average Term grades Distributed by Learning Style[15]

[14] Kevin Rogerson
[15] Hoosick and Marzullo

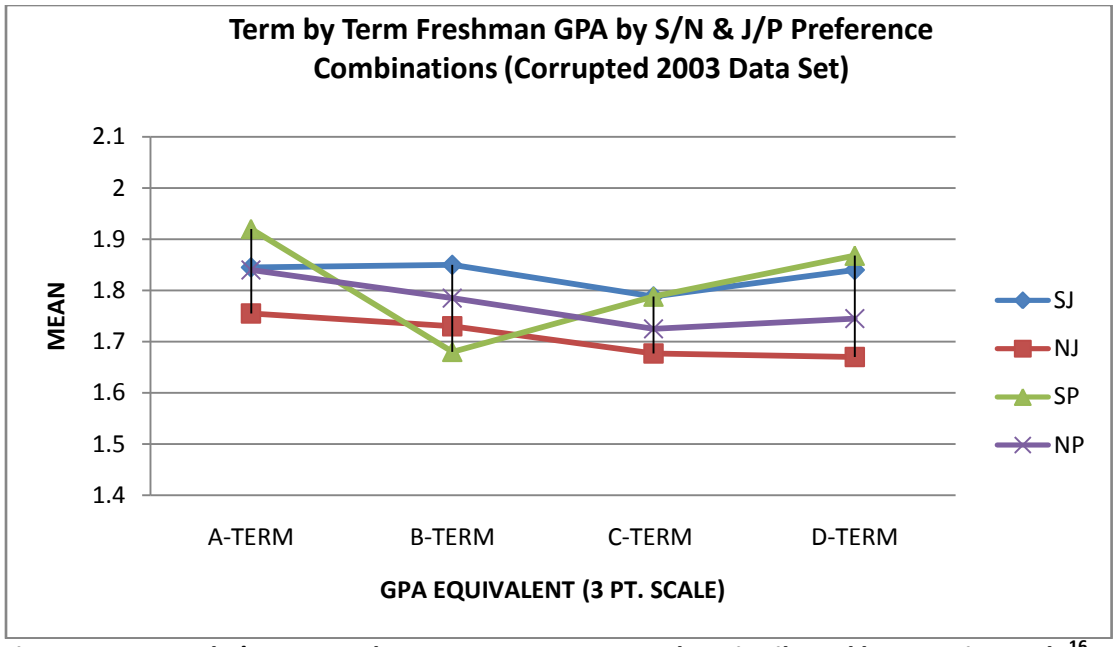


Figure 3. T. Murphy's Reported 2003 Average Term grades Distributed by Learning Style[16]

Three previous IQPs found that there is existed pattern between WPI students' learning styles with their term grades in the freshman year. Figure 1 is the relationship between four learning styles defined by the SN and JP dimensions and average term by term GPA in 2001 as reported by Kevin Rogerson (2004). It shows that although SJ's started second best of all four types, they came out as the stars at the end, in D-term. All other three types show similar paths in that they maintain their relative position though there is a C-term drop that affects all four types, though two types (SJ and NP) recover from it in D-term.

Figure 2 is the relationship between SN-JP's learning styles and average term by term GPA in 2002 as reported by Hoosick and Marzullo (2002) but worked out by then WPI alumnus Greg Doerschler. The figure shows that overall the SJ's were the stars in all four terms, followed by NJ's, NP's, and SP's. During this year, there was an obvious performance slump during B-term for all four types although all but the NP's completely recovered in C-term. At the end of

[16] Tara Murphy

the year, it was only the SP's who sharply improved after B-term and registered their best GPA for the year in D-term; all the rest did better in A-term than in D-term. However, the SP students had been in the cellar, performing relatively poorly, and their gain was especially notable and welcome. In the end, the erosion of NP performance and the improvement of SP performance put their averages close enough to not be significantly different (in statistical terms) by D-term. In A and B-term the SP average had been significantly different from the other three learning style groups. This was the first WPI class year pattern to be displayed in these terms. Hence, it was taken as the "norm" on a tentative basis, leading to curiosity about the B-term "plunge" in several reports. The reason for this focus was the pattern originally presented for the class of 2003 by Tara Murphy, which is to be found in figure 3.

Figure 3 is the relationship between SN-JP's learning styles and average term GPA in 2003 reported by Tara Murphy. In this the data set (that proved to have been corrupted), shows a consistent path of performance for the SJ's, NJ's, and NP's which all of them perform rather consistently term by term. What is odd is the strikingly changed rank ordering with the SJ and NP group – cognitive opposites of the SP's of the year before as the group with the lowest average grades. However, the SP's are the exception. The SP's were the stars in A-term but had a sudden drop in performance during B-term which placed them at the bottom. The SP's did not stay at the bottom and in C-term they rise and are equal to SJ's and in D-term again ties with them for the highest grade type once more. Their pattern was surprising and confusing. The only commonality seemed to be a B-term plunge for the SP type with SJ's as steady performers having a good year.

By comparing all three SN-JP's average freshman year term grades in 2001, 2002, and unfixed data 2003, it can be seen that there is a striking B-term plunge pattern in 2002 and 2003, although it was not present in 2001 data set. Colamussi (2006) working with course by course grades in the 2002 and 2003 data sets concluded that there was an error in the 2003 data set. This raised the question of whether there ever was a B-term plunge that year and whether there was any reoccurring pattern at all during freshman year of classes of 2001, 2002, and 2003. It fell to me to repair the WPI class of 2003 data set, redo the analysis and look for consistencies and differences over the 3 years.

Methodology

The original plan for this project was to answer the question of what happened after freshman year, i.e. would the freshman pattern in classes of 2002-2003 reoccur, using sophomore year data which was requested of the registrar. Having data for classes of 2002-2003 freshman years, and faced with the reality that the sophomore year data was late and might never arrive, the project needed to move in another direction.

Chris Colamussi had established that there was a mix up inside the class of 2003 data, and I accepted the task of reassembling and reanalyzing that data set. The class of 2003 data was investigated to check for name duplications, mistyped input, and misplaced input. The investigation was done by comparing, examining, and linking the class of 2003 data with "raw" MBTI data which fortunately had been preserved. I was also given WPI Commencement programs for the years of 2002-2005.

The raw MBTI data showed the original information before any changes was made by Murphy and the commencement programs provided information on who graduated, when they graduated, and whether they graduated with "distinction". The collected information then entered and processed by using SPSS (Statistical Packaged for the Social Science), an analytic software tool that can be used to reveal correlations between different variables and establish statistical significance levels.

At this point, a valid comparison can be made of classes of 2001, 2002, and 2003 to investigate whether the class of 2003 B-term GPA plunge was an artifact of coding error and whether there is a real replicated pattern on how students perform during their first year at WPI, over these 3 years.

The class of 2002 data did reveal a B-term plunge for the SP students, and that data set was examined first. When the data for class of 2001 were later reorganized to see if this pattern would replicate, there was a B-term decline for the SP students, but no recovery. They declined further in C-term and then leveled off, staying at the same level in D-term. The groups to recover from C-term low points were the SJ's and NP's, and there was nothing like the strong recovery documented in the class of 2002 for the SP students. So which was the normal pattern? Was there a normal pattern? There did seem to be a replicated rank ordering of average grade by type of learner SJ, NJ, NP, SP, however the SJ and NJ groups were neck and neck both years.

As is turn out the corrected class of 2003 pattern is more like that of the class of 2001 than the class of 2002. However, there is a different consistent finding that emerges in all 3 data sets. Though the path by which the four types reach their D-term average grade differs from year to year, the same end of year 4th quarter (D-term) grade average pattern emerges in all three classes freshman year. This finding just begs the question of how predictive the D-term freshman grades are of overall success at WPI. This new question will be the basis for structuring the class of 2003 data set to do further analysis[17].

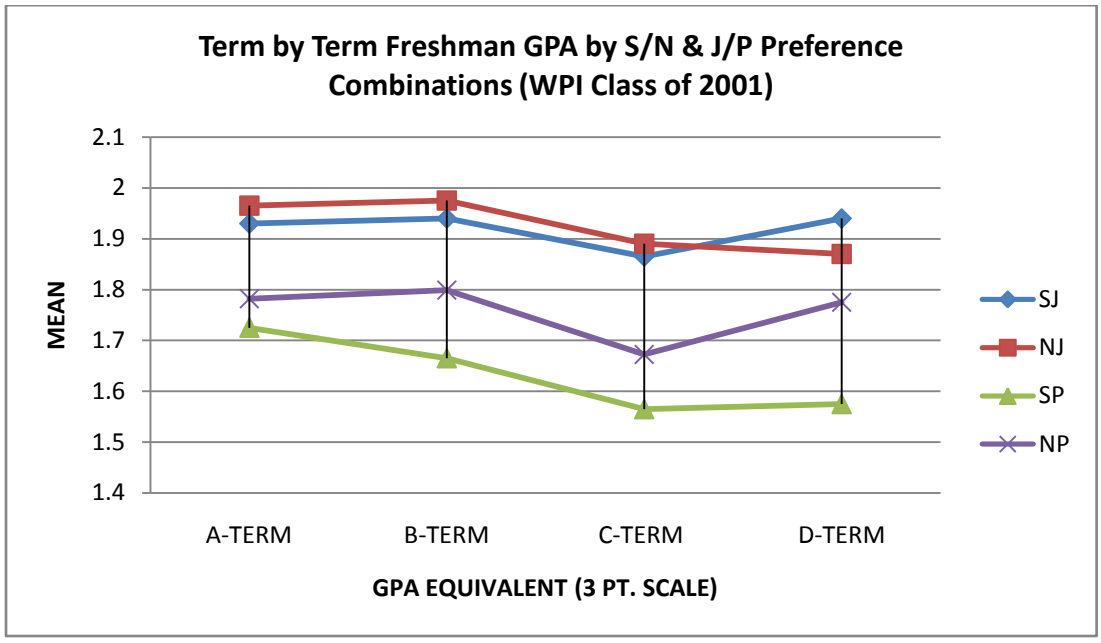
Luckily, Alfred Navato's class of 2002 analysis (2005) focused on these same outcome variables by learning style and he defined learning style in the same way. However, he had no reason to focus on D-term grades. Hence, his tables will allow me to see if the outcome pattern by type is the same for these two class years. Seeing whether D-term grades are a better lead

[17] It is worth noting that these are the three WPI classes to enter WPI prior to the phasing in of the Insight program. Hence, there is a consistent pattern of freshman performance documented for the Pre-Insight period, in the next year (2004) about 40% of the incoming class experienced Insight and it was school-wide for the classes of 2005 and 2006. MBTI data was collected but never compared to freshman year performance data for the classes of 2004-2006. This is a research opportunity that future IQP team should look into.

indicator than the A-term grades will be examined only with the class of 2003 data set at this time. But, in principle, one could attempt to replicate my finding with the class of 2002 data set if it is interesting. Additional information would be required from the registrar to improve the class of 2001 data set along the lines of Navato's class of 2002 data set if this analysis was to be carried out for all three years.

The only four-year outcome variable reported for the class of 2001 is a simple hand tally of the proportion of each type of learner to graduate in four years. No data set with this variable coded into it has been found. So, that is all can be reported for that class year in terms of four-year outcomes at this time. Hence, it will be possible to see if this four-year finding replicates across all 3 data sets and in principle it should be possible in the future to code all 3 data sets to support the same group of analyses. I will examine with the class of 2003 data set in this report, to see if there are promising relationships between freshman year data and four-year outcomes to justify upgrading the 2001 data set to use in parallel studies of this kind.

Actual Year Comparison



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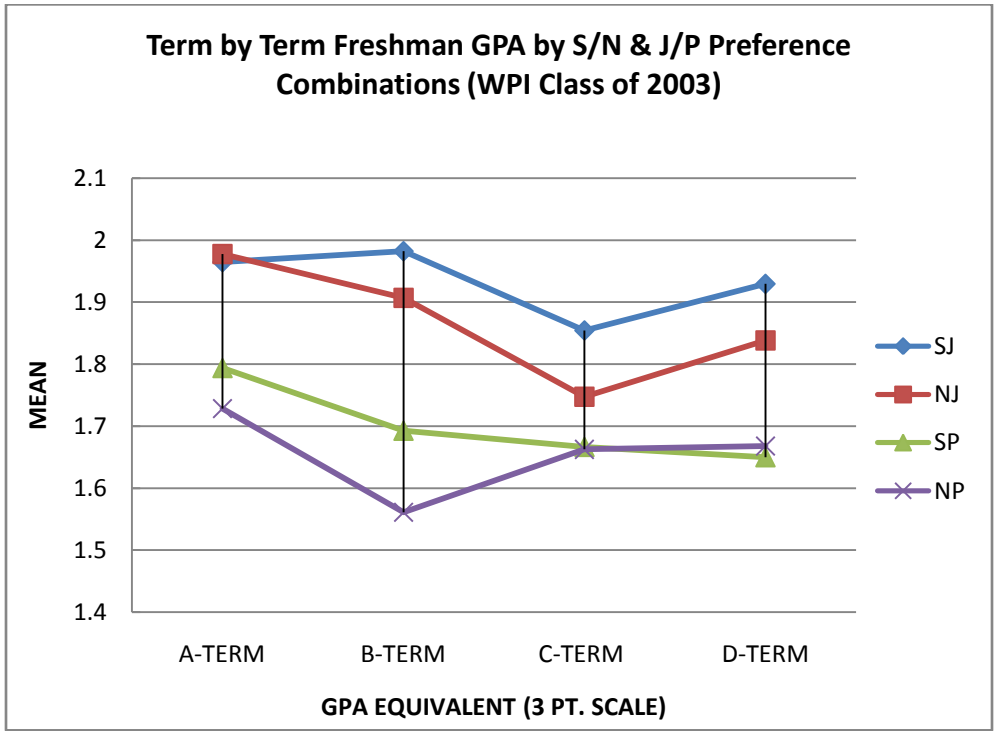
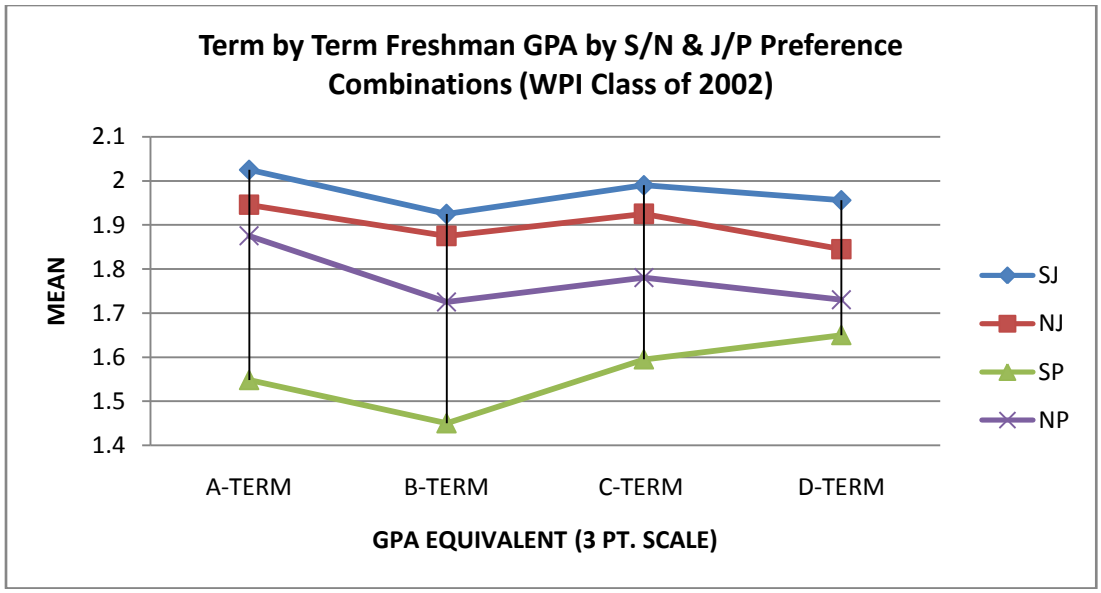


Figure 4. 2003 Average Term grades Distributed by Learning Style



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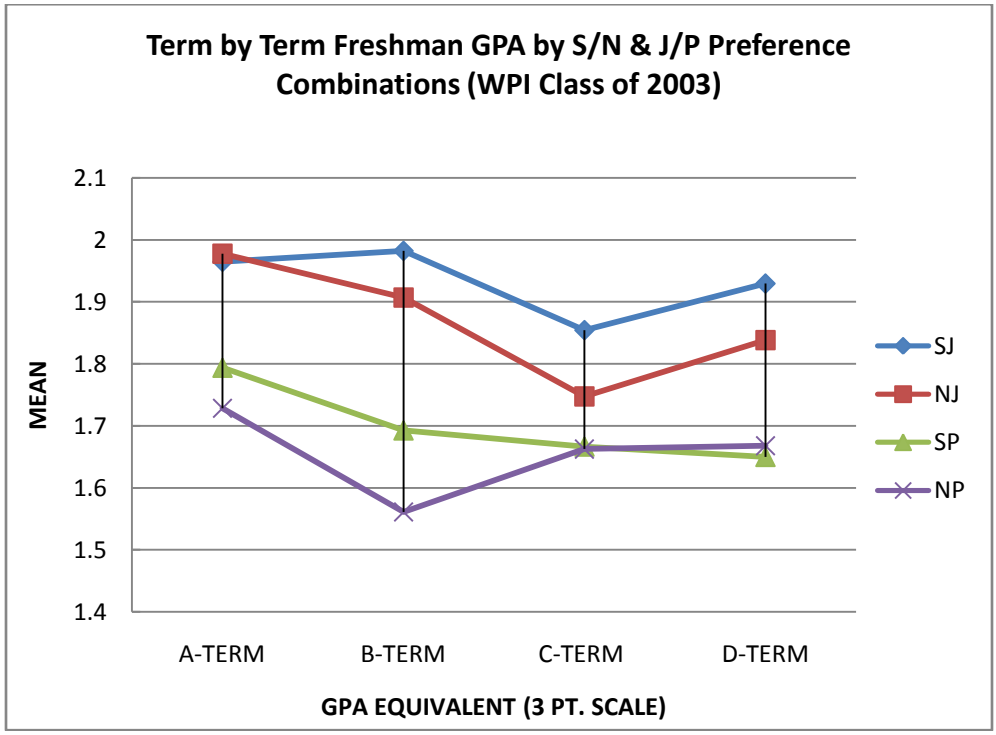

Same as figure 4

With the new findings from the fixed data set, it can be seen that there is a pattern running through the 3 data sets, but the original B-term plunge focus was misplaced. For one thing the drop could be C-term rather than B-term. For another it could be the NP's that have the B-term plunge and recovery, but by D-term things have sorted themselves out into a familiar rank ordering by type of learner and the averages from year to year are similar as well as the rank ordering of types. It is true that there are still signs of struggle for perceiving students during B-term in 2002 and 2003, but it was not a consistent pattern within any particular type always at the bottom of the grade curve from year to year in B-term.

During B-term in 2002, all four types had a slight slump in performance with SP's clearly at the bottom, and during 2003 all except SJ's also had a slump this time with the NP's at the bottom until C-term. But this B-term drop is not the main point of this revised year comparison. In summary, take note of where each of the 4 learning types ended up at the end of their freshman academic year for all the three years. Somehow in D-term, SJ's always come back to GPA ~ 1.95, NJ's at ~1.85, NP's around 1.7, and SP's around 1.6. With all the different paths from the beginning of the year represented by these three classes, all four types of learners always have their D-term performance rank in the order of SJs, NJ's, NP's and SP's.

Hypotheses

The purpose of this study was to determine if there was a lead indicator for all the four types of learners that could be used to predict how well they will perform at WPI over 4 years until graduation happens or does not, on time or not. Taking a cue from the first class of 2001 study which focused on the SAT as a predictor of success in the first year I will also consider whether SAT's could be used to predict which group would most likely be thriving or struggling during freshman year (Kline et al. 1998). I can also consider whether the SAT is more useful in predicting the first year experience or the four-year outcome. However, I start from their finding in the class of 2001 study that the SAT's predictive power is variable and only works for half of the sixteen MBTI types. And over the later years, I also know that the types of learners with the highest SATs were not the top performers during their freshman year for either the class of 2001 or 2002. The question becomes for what type of learners SAT's would be a good lead indicator student of performance in the freshman year and can it tell one about the odds of excellent grades and likelihood of graduating on time in 4 years for any type of learner?

Theoretically, the students with the highest SATs would be expected to be the most promising (high aptitude) members of their class and it should be correlated with grades throughout at least the first year at WPI. However, Garvin reported that this was not the case and wanted to know why it was not. Her interest led to sponsoring the class of 2001 study that indicated a combination of MBTI and SAT data could improve its predictive power for about half of the class. Since high SAT scores are one of the main reasons why these "high aptitude" students got accepted to WPI in the first place, I do not want to give up on the indicator too soon. It is possible that "aptitude" does not correlate with conceptual mastery or preparedness

for college and SAT is a better long term four-year outcome predictor than a short term freshman year prediction of performance. As it turns out, the NP's have the highest average SAT scores, most years, and nearly always have a higher average scores than the SJ's.

Looking at the four learner types, SAT theory leads one to expect that the NP's and NJ's would be most likely to perform the best by the end of the freshman year because they are the students that will best understand abstract theories and concepts in their engineering and science classes. The NJ's should have an advantage over the NP's however based on how they carry out their studies. The J type is noted for emphasis or careful planning and organization of time which is very important to keep up in WPI's fast paced 7-week program and finish one's courses. Students without those tendencies would have a tendency to fall behind and not able to finish their class assignments and projects on time. Sensing students might not be able to grasp the new concepts rapidly enough to get to the point of mastery needed to apply them and understand how to put together a prototype or design based on a theory.

Hypothetically, SP's should be the group that will most likely to struggle with abstraction and get things finished because they are more comfortable and understand subject matters that can be sensed through their five senses, but most of the time students will not able to see, feel, or smell the biological, chemical and mechanical processes of various things the students will be working on. With a greater likelihood of struggling with abstraction, time organization problem, and less developed study habits the SP's students have only one thing going for them. They are good at troubleshooting, i.e. fixing problems, getting things to work. SP's will need to developed habits of discipline and be hardworking to avoid trouble in keeping up with the 7-week system that often goes by quickly and demand students' utmost undivided attention,

dedication, and organization. Lastly, the NJ's with their high SATs and good planning and organization skills should be graduating on-time and most likely to receive their degrees with distinction. But are these hypotheses about the value of abstract reasoning and its relationship to SAT scores true?

Can it be safely said that students who are most likely to be graduating late are the same types of learners who struggled during their freshman year? If one is running late will one also not graduate with distinction? One thing to remember is that WPI has a policy that will not show any NR (no record) grades in students' transcripts, so this allows students to retake the courses they have failed on to get higher grades. Some students likely to get a C purposely take the NR so as to be able to retake the course a second time hoping for an A or B.

Another issue is that some students take double majors or several minors or even change their majors throughout the years. Those that change their minds will be most likely to have a late graduation whether or not they struggled to pass classes. Another non-related education issue that will cause later graduation is economy; some students might have to take some time off to work before going back to WPI. For all these reasons above, students who are not graduating on-time might have the same chance with other students of earning distinction, particularly if they earn A's in two out of three major projects of sufficiency, IQP, and MQP. Then their coursework grades along the way are secondary. Hence, it is not clear that graduating on time will be associated with higher average grades, but it seems likely that the two are related.

Lastly, another indicator that needed a close observation is gender. Even though females are the minority in gender, their number should be still large enough to affect the

overall relationship between the four types of learners with their performance data. But are females likely to behave differently from males that are the same types of learners?

Overall, females are outperforming males in the freshman year. It remains to be seen if that is due to there being a different distribution of learning styles among the males and females of WPI or whether females outperform males across the board, in all four learning style groups.

Findings

Of the 650 students of class of 2003, the data set has 642 students whose freshman grades are available and 605 students (87.7% of total population) whose MBTI type are known; with 147 females (24.3% of total sex population) and 458 males (75.7% of total sex population). In figure 5, it is shown that the major type of learner is NP's as they make up 43.47% (263 students) of total population, followed by SJ's (22.31%, 135 students), NJ's (17.19%, 104 students), and SP's (17.02%, 103 students). These proportions have been fairly consistent for the years of 2001, 2002, and 2003[18].

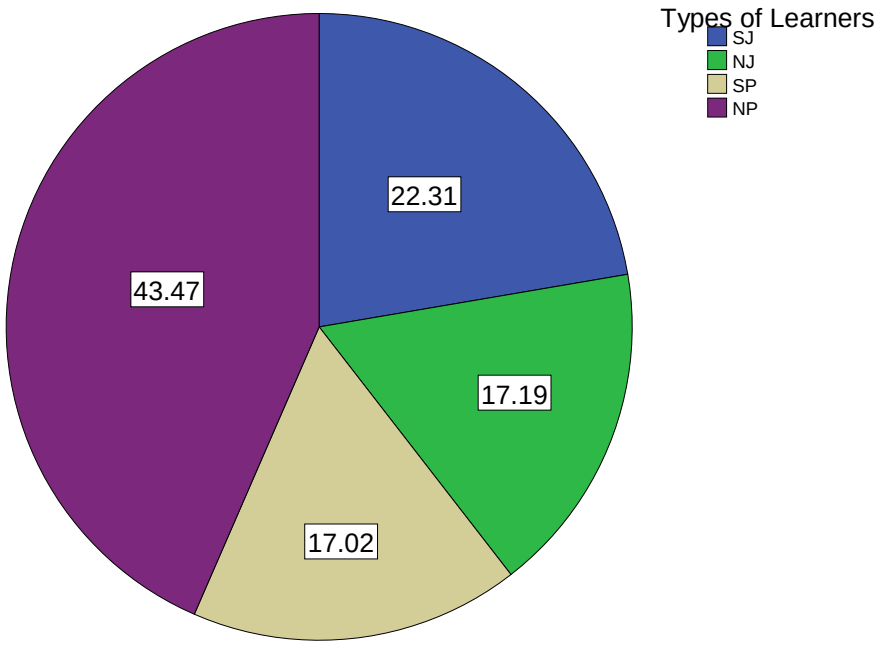

Figure 5. Frequency of WPI Class of 2003 Type of Learners

[18] Refer to appendix A for Kevin Rogerson's IQP report for 2001 and 2002.

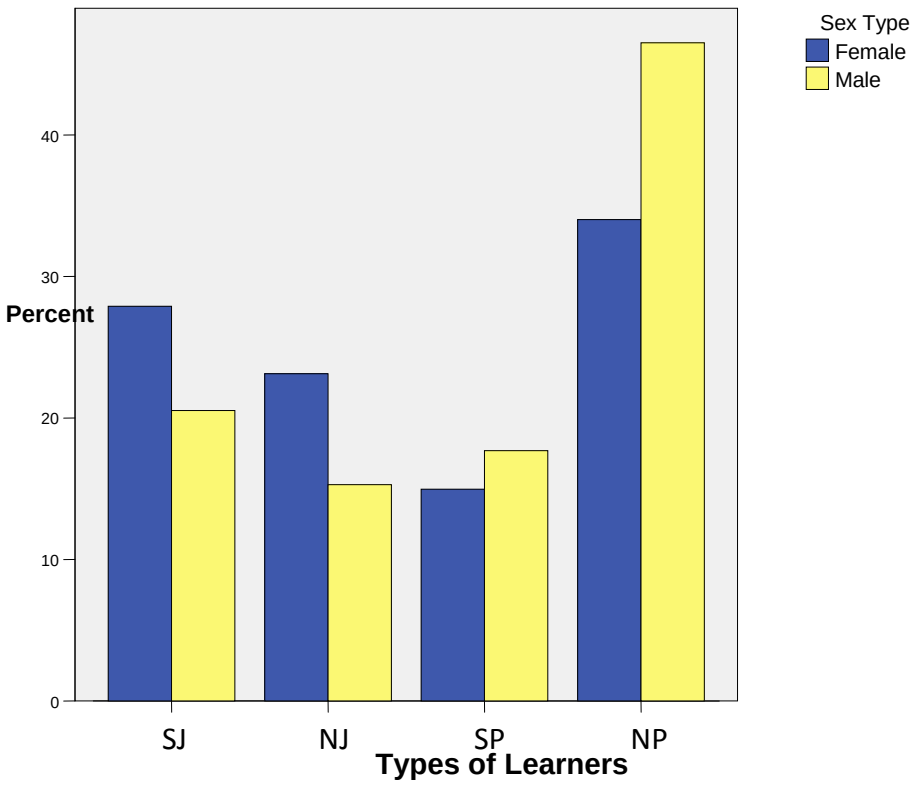

Figure 6. Percentages of MBTI Types of Learners within Sex Types, Class of 2003

Figure 6 indicates the distribution of MBTI types of learners for female and male students respectively. The most common type of learner in male and female populations of the class of 2003 are the NP's. The least common type in the male population is the NJ's and the least common for females is the SP's.

My literature review of past projects produced a list of candidates for lead indicators that had been considered and assessed at least once before. So, if something that was promising for the Class of 2001 or 2002 also proves useful in understanding the experience of the class of 2003, it is a replicated finding that should be considered likely to be predictive in the future as well. When trying to predict how the freshman year would go SAT scores and CIRP survey data, sex and type of learner have all been examined. When trying to predict how all 4 years will go courses passed in the freshman year, various terms of overall freshman GPAs are added to that list. In general one is looking for HS performance based lead indicators for students' academic performance as freshmen and freshman year performance data to predict 4 year success at WPI, but some indicators promise to be useful in both cases. This study focuses on the following outcome variables:

- Predicting freshman year performance as measured by term by term GPA and number of courses passed
- Predicting 4-year outcomes as measured by time to graduation and graduating with distinction

So over the next few chapters, I will show my cross-tabulations, note the significant differences, and report my correlation findings. This will set the stage for discussing my level of success variables and predicting freshman year and four year outcomes. This is my strategy for identifying the most promising lead indicator candidates. Before we take a look at tables and coefficients, there are some terms that need to be defined:

Chi-Square Statistical Significance Test:

A Chi-Square test is used when one needs to see whether there is a difference between two categorical variables based on a sample randomly drawn from a "universe" of cases. One does this when one wants to generalize findings from analysis of the sample to the whole population. The SPSS version (14.0) that I am using in this project includes a Pearson Chi-Square test algorithm that assumes the expected value for each cell is five or higher. Hence, on some occasions I have had to collapse categories to meet this minimum requirement for reliable findings. Only the Fisher's exact test is considered reliable with fewer than 5 cases. Although the conventional significance criterion is .05 for significance testing, I plan to use the same criterion of .08 that Navato *et al*. did in their analysis of the class of 2002 data for the sake of consistency. (I would not be comfortable with anything yielding more than 1/10 chance of error, but find this criterion acceptable).

In Chi-Square test, the significance value (Asymp. Sig.) has some of the information we are looking for. The lower the significance value, the less likely it is that the proportions of cases in two categories in a variable are different. In this study therehave been significance value is so low that it is displayed as .000 (1 chance in 10,000 of being due to random variation), it means that the two variables are, indeed, different, but in this study .08 (8 chances in 100) will be taken as the threshold of "significance".

Gamma Statistic:

The gamma statistic shows whether there is a relationship between two variables, in this case SAT scores and freshman year term D GPA, on number of courses passed. For a strong relationship, it is considered high when the absolute *value* of gamma is closer to +1.0 or -1.0 (zero means no relationship) and if the *significance* is *low* (closer to zero).

The sign (+/-) simply shows which way the correlation goes. Positive means that the main diagonal of the table is dominant (upper left cell to lower right), and negative means that the off-diagonal of the table is dominant (upper right to lower left),

The strength of gamma in absolute values is roughly as follows:

.10-.19: probably no relationship
.20-.30: small relationship
.31-.45: moderate relationship
.46-.59: strong relationship
.60-.85: very strong relationship
.86-1.0: identity

Freshman Year Outcomes:

SAT as predictor of freshman year performance

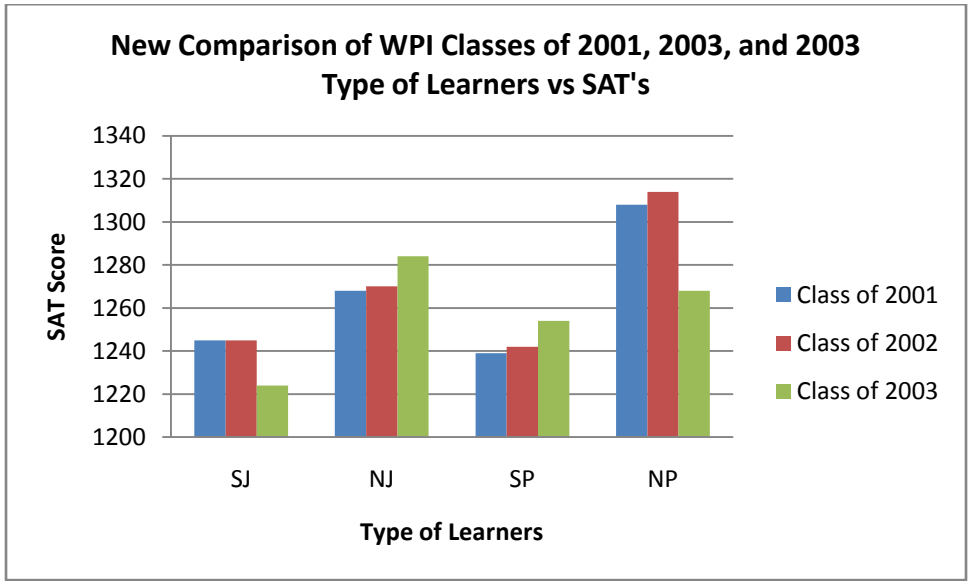

Figure 7. Comparison of Type of Learners' SAT Scores in Classes of 2001, 2002, and 2003.

Figure 7 indicates the comparison of SAT scores for classes of 2001, 2002, and 2003. It can be seen that class of 2003 is somewhat different than two previous years in the pattern of average combined verbal and math scores by type of learner. It is also worth noting that this class had the lowest average SAT scores for the whole class of the three years under study, but the overall average difference is not great. What is worth noting is that this is the lowest year for SJ's and NP's, but it is the highest year for NJ's and SP's. The order of SAT scores of class of 2003 from highest to lowest are NJ's, NP's, SP's and SJ's. In previous 2 years it was NP's, NJ's, SJ's and SP's. It will be interesting to see if the SJ group continues to get the highest average grades when they have the lowest average SAT scores.

When looking at the SAT to term GPA correlation, comparing term A to term D, it can be seen that the predictive power of SAT gets weaker as the academic year progresses. This is unfortunate since it is the D-term GPA averages by type of learner that are consistent from year to year. However, it is the A term grades for each type of learner that are most correlated with the SAT, with only one exemption involving math SAT scores for the NJ's. The next four tables (1-4) show the Pearson's correlation of SAT verbal, math, and total for A-term, D-term, and courses passed in freshman year for each type of learner.

The Pearson's correlation is used to find a correlation between at least two continuous variables. The value for a Pearson's can fall between 0.00 (no correlation or not a linear relationship) and 1.00 (perfect correlation or perfect linear relationship). Generally, correlations above 0.80 are considered quite high because it explains more than half of variance. The actual percentage of variance explained is calculated by finding the square of the Pearson's correlation. For example, the percentage of variance explained by a 0.80 correlation equates to a .64 or 64% of variance explained.

There are two tests of significance tests used with correlation coefficients: one-tailed test is used when there is specific direction to the hypothesis being tested and two-tailed test is used when a relationship is expected, but the direction of the relationship is not predicted. In tables 1-4, * means correlation is significant at the .5 level or 2-tailed test, and ** means correlation is significant at the .1 level or 1-tailed test. When the probability is less than or equal to the significance level, then the null hypothesis (contradicting hypothesis) is rejected, and the outcome is said to be statistically significant[19].

[19] Petruccelli, et al.

Table 1. Pearson's Correlation of SJ's SAT Scores Class of 2003

Sensing-Judging (SJ)	A-Term GPA	D-Term GPA	Fr. Courses Passed
SAT Verbal	.40 *	.11	.13
SAT Math	.30 *	.14	.05
SAT Total	.41 *	.15	.10

* Correlation is significant at the .5 level (2-tailed)
** Correlation is highly significant at the .01 level (2-tailed)

Table 1 indicates that it is primarily the SAT verbal scores that have predictive value in terms of how the freshman year will go for a member of WPI class of 2003 who is an SJ. Note that only A-term grades are predictable. The SAT's does not have much predictive value as far as D-term grades go or for the total number of courses passed during freshman year. In other words, in D-term and overall freshman, the performance of SJ's students are scattered or not linear in distribution.

Table 2. Pearson's Correlation of NJ's SAT Scores Class of 2003

Intuition-Judging (NJ)	A-Term GPA	D-Term GPA	Fr. Courses Passed
SAT Verbal	.18	.16	.06
SAT Math	.39 **	.42 **	.21 *
SAT Total	.33 **	.33 **	.16

* Correlation is significant at the .5 level (2-tailed)
** Correlation is highly significant at the .01 level (2-tailed)

Table 2 indicates that it is primarily the SAT math scores that have predictive value in terms of how freshman year will go for a member of WPI class of 2003 who is an NJ. Unlike the SJ's SAT math not only predicts A-term grades, but it predicts D-term slightly better. The correlation with overall courses passed is not as strong, but still a significant finding. The SAT verbal score does not have much predictive value, in fact when put together with SAT math as an SAT total score, the verbal scores reduced the predictive strength of the math scores.

Table 3. Pearson's Correlation of SP's SAT Scores Class of 2003

Sensing-Perceiving (SP)	A-Term GPA	D-Term GPA	Fr. Courses Passed
SAT Verbal	.32 **	.30 **	.40 **
SAT Math	.36 **	.32 **	.20 *
SAT Total	.40 **	.37 **	.36 **

* Correlation is significant at the .5 level (2-tailed)
** Correlation is highly significant at the .01 level (2-tailed)

Table 3 indicates that SAT total scores have the greatest predictive value in terms of how freshman year will go for a member of WPI class of 2003 who is an SP. SAT verbal and math scores are both valuable indicators to predict both early and late freshman year grades.

Table 4. Pearson's Correlation of NP's SAT Scores Class of 2003

Intuition-Perceiving (NP)	A-Term GPA	D-Term GPA	Fr. Courses Passed
SAT Verbal	.11	.04	.02
SAT Math	.35 **	.19 **	.18 **
SAT Total	.28 **	.14 *	.11

* Correlation is significant at the .5 level (2-tailed)
** Correlation is highly significant at the .01 level (2-tailed)

Table 4 indicates that SAT math scores again have the greatest predictive value in terms of how freshman year will go for a member of WPI class of 2003 who is an NP. Just like NJ's, SAT math scores not only predict A-term grades, but it predicts D-term grades and overall courses passed although NJ's were more predictable. The SAT verbal does not give much predictive value, in fact when put together with SAT math as SAT total, the prediction strength went down. As with the SJ's there is a marked erosion of predictive power from A term to D term.

Overall, there is a pattern in these findings which indicates the potential value of the SAT scores as a freshman year lead indicator. However, it seems to have little value without the MBTI based learning styles to separate the data before it is used. Further, it is more useful for some types than others, if one wants to know how the first term will go. For all types of learners except the NP's one can explain about 16% of the variance in A-term grades, for the

NP's it is about 10%. Even to do this well, one needs to know which kind of SAT score to look at. If one wants to know how the last term will go, it is less valuable for nearly all types and really only useful in predicting how things will turn out for the NJ's and the SP's. In terms of progress toward graduation (probably the most important freshman year indicator) the SAT is completely useless for the SJ's, and explains a mere 4% of variance for both intuitive groups. It has moderate value only for predicting the success of the SP's in passing courses, which is useful since they were the group most likely to struggle in freshman year for 2 of the 3 years under study. For students with intuition (N) as a preference, it seems that SAT math will predict their performance better than SAT verbal, and on the contrary, one can learn more about students with a sensing (S) preference by just looking at SAT verbal scores. In summary, the SAT will not tell one much beyond A-term grades for student body as a whole. At WPI, it loses predictive power as the freshman year progresses.

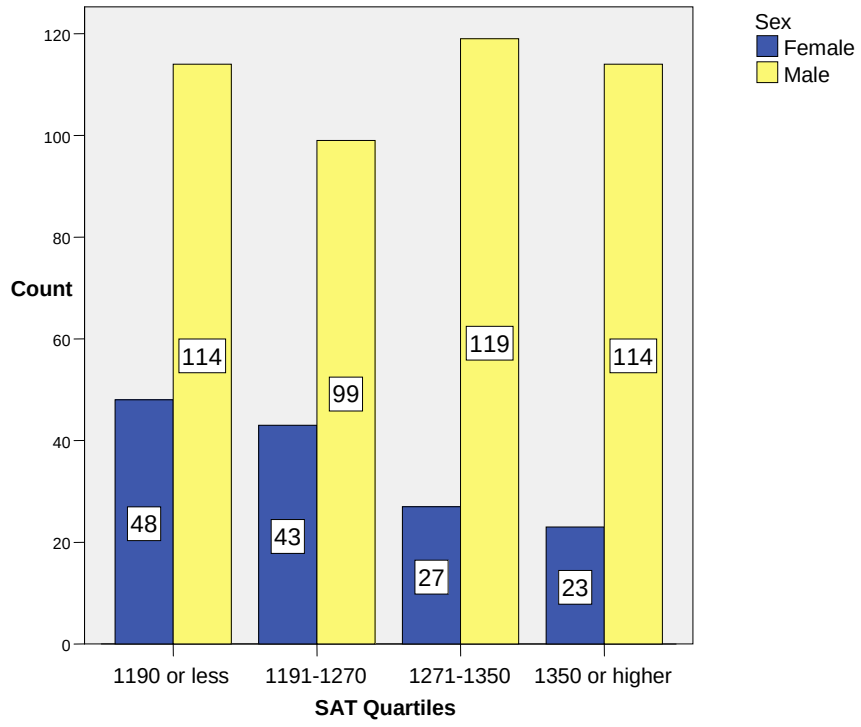

Figure 8. Distribution of SAT Scores by Sex in the Class of 2003

Figure 8 indicates that 65% of the females who entered WPI for class of 2003 have SAT scores in the bottom half of the distribution of WPI freshmen that year. The majority of females with lowest SATs (1190-1270) are SJ's and NP's. Males seem to be more equally distributed throughout SAT quartiles. But majority of males who had highest SATs are NP's, males SJ's mostly had low SAT scores.[20] GPA is in 0 to 3.0 scale (A= 3.0, B= 2.0, C=1.0, No Record/NR = 0).

[20] Refer to appendix B.

Table 5. Report of Average A and D-term GPAs and Number of Courses Passed in Freshman Year of Class of 2003

Sex Type	MBTI Types of Learners		A-term GPA equivalent	D-term GPA equivalent	Courses passed freshman year
Female	SJ	Mean	**1.9268**	**2.0407**	**11.3659**
		N	41	41	41
		Std. Deviation	.80799	.60183	1.35566
	NJ	Mean	**1.9706**	**1.9118**	**11.2647**
		N	34	34	34
		Std. Deviation	.71712	.72152	1.60130
	SP	Mean	**1.9524**	**1.7460**	**10.3636**
		N	21	21	22
		Std. Deviation	.74748	.68236	3.10982
	NP	Mean	**1.5374**	**1.6522**	**9.7400**
		N	49	46	50
		Std. Deviation	.80742	.76322	3.11553
	Total	Mean	**1.8092**	**1.8404**	**10.6395**
		N	145	142	147
		Std. Deviation	.79519	.70874	2.50190
Male	SJ	Mean	**1.9819**	**1.8804**	**10.7553**
		N	92	92	94
		Std. Deviation	.74185	.78537	2.49596
	NJ	Mean	**1.9810**	**1.8019**	**10.4286**
		N	70	69	70
		Std. Deviation	.73093	.78657	2.36871
	SP	Mean	**1.7531**	**1.6245**	**10.0617**
		N	81	79	81
		Std. Deviation	.81100	.88894	2.67089
	NP	Mean	**1.7730**	**1.6717**	**9.7042**
		N	210	200	213
		Std. Deviation	.77700	.83775	3.05945
	Total	Mean	**1.8440**	**1.7273**	**10.0939**

		N	453	440	458
		Std. Deviation	.77364	.83146	2.80784
Total	SJ	Mean	**1.9649**	**1.9298**	**10.9407**
		N	133	133	135
		Std. Deviation	.76019	.73518	2.22524
	NJ	Mean	**1.9776**	**1.8382**	**10.7019**
		N	104	103	104
		Std. Deviation	.72297	.76393	2.17613
	SP	Mean	**1.7941**	**1.6500**	**10.1262**
		N	102	100	103
		Std. Deviation	.79885	.84802	2.75709
	NP	Mean	**1.7284**	**1.6680**	**9.7110**
		N	259	246	263
		Std. Deviation	.78671	.82286	3.06422
	Total	Mean	**1.8356**	**1.7549**	**10.2264**
		N	598	582	605
		Std. Deviation	.77839	.80414	2.74464

Table 5 shows the average academic performance of the four types of learners at the beginning and end of the freshman year for males and females separately. Just looking at the types of learners, it can be seen that SJ's have the best average performance with highest GPAs and most courses passed, followed by NJ's, SP's and NP's. Notice that SJ's and NJ's are performing at about the same level as are the SP's and NP's performing at about the same, though lower, level. . By looking at the sex differences,, for SJ's and NJ's during A-term, the females of these types were outperformed by the males of these types. However, by the end of the year (and by overall freshman GPA) the, females outperformed the males. Among the SP's the females always outperformed males, and among the NP's males and females performed at the same average level throughout the year.

Table 6. Pearson's Correlation of MBTI Types of Learners of Freshman Year Class of 2003

	A-Term GPA	D-Term GPA	Fr. Courses Passed
MBTI Type of Learners	-.14 **	-.14 **	-.19 **

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

In table 5, there was a visible pattern, but table 6 indicates that MBTI types of learners' differences do not produce a strong correlation with A or D terms grades, though at least they are as predictive of the end of the year as the beginning. . The result of table 6 can be explained by computers' tendency to just look at numbers without any other influence. For example, to generate correlation data, I used '1' to represent SJ's, '2' for NJ's, '3' for SP's and '4' for NP's. This is not theory based nor is it based on the rank ordering of average grades found in the Class of 2002 study. It is just the order used in the last study which I adopted. So the correlation between MBTI types of learners and freshman year performance was complicated by, for example, the NJ's outperforming the SJ's among females during A-term. This results in a "lumpy" pattern among females in A-term. But overall, the correlation numbers are negative and significant because of the relationship between J-P variables (refer to table 5), in which the students with a Judging preference (1 and 2) are outperforming the students with a Perceiving preference (3 and 4). However, the difference is small in terms of percentage of variance explained.

Table 7. Pearson's Correlation of Sex Difference of Freshman Year Class of 2003

	A-Term GPA	D-Term GPA	Fr. Courses Passed
Sex Difference	.02	-.06	-.09 *

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

Table 7 indicates that sex difference did not strongly correlate with performance during freshman year. This might be partly explained by the skewed distribution of types of learners within each sex type (refer to figure 6). Majority of males (2) are NP's while the females (1) are disproportionately represented in two groups, the strongly performing SJ's and NJ's. In A-term, .02 there is essentially no difference by sex if one does not control by type of learner. However, the positive number indicates that the male students had a slight edge, By D-term the female students had started to outperform their male peers in every learning style group resulting in the small correlation shifting to negative numbers. Remember that the SAT is more predictive of the A-term grade rank order in grades than it is by the end of the year. On average the females had the lower SAT scores in the class (refer to figure 8) yet overall outperformed the males. By D-term SAT's were not predictive for the SJ's in particular, who were disproportionately female. But maybe the WPI freshman year course environment provides perfect working conditions for SJ's and NJ's resulting in female performance that keeps on improving. Colamussi (2006) reported that in most freshman year courses the SJ's were the top performers, but that the NJ's were the stars in Introductory Physics. This is consistent with the overall GPA findings.

Are the "graduating on time" variable and "distinction" variables associated?

Below is a table (table 6) showing data for members of the entering class of 2003 who graduated on-time and their honors categories, as well as the statistical significance data. The variable "graduating on time?" represents the students who graduated and who did not graduate within 4 years or less. For the class of 2003, there were 359 students who graduated on time, and nearly half 48.7% of them graduated with "distinction" (including high distinction). Among the 246 students who did not graduate on time, only 10.1% of them graduated with distinction in a later graduating class. This finding shows that there is strong relationship between graduating on time and receiving honors with one's degree. This .77 Gamma correlation is quite robust, meaning that almost 60% of the variance in getting honors is explained by graduating on time. The finding is also highly significant with a Pearson Chi-Square .0001 significance level. In a way that is unfortunate since it would be nice to have two independent outcome measures for 4 year performance. However, average grades and passing courses are in fact highly correlated.

Table 8. Cross-tabulation of Class of 2003 "Graduating on Time" by Honors Categories for Distinction

			Honors Categories			Total
Graduated on time?			No Distinction	Distinction	High Distinction	
	Yes	Count	184	97	78	359
		% within graduation in 4 years or less	**51.3%**	**27.0%**	**21.7%**	100.0%
	No	Count	221	19	6	246
		% within graduation in 4 years or less	**89.8%**	**7.7%**	**2.4%**	100.0%
Total		Count	405	116	84	605
		% within graduation in 4 years or less	**66.9%**	**19.2%**	**13.9%**	100.0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	99.923(a)	2	**.000**
Likelihood Ratio	112.734	2	**.000**

a 0 cells (.0%) have expected count less than 5. The minimum expected count is 34.16.

Symmetric Measures

		Value	Asymp. Std. Error(a)	Approx. T(b)	Approx. Sig.
Ordinal by Ordinal	Gamma	**-.771**	.046	-12.025	**.000**

a Not assuming the null hypothesis.

b Using the asymptotic standard error assuming the null hypothesis.

Four-Year Outcomes:

Sex differences as a predictor of four-year outcomes

Of the 605 eligible cases of class of 2003, 59.3% of the population graduated on-time. Among females, 71.4% graduated on-time, and among males the proportion graduating on time was 55.5% (figure 9). Could this striking difference in proportion graduating on time suggest the possibility that sex of the students could be a lead indicator 4 year success? I will examine this possibility further in the next section.

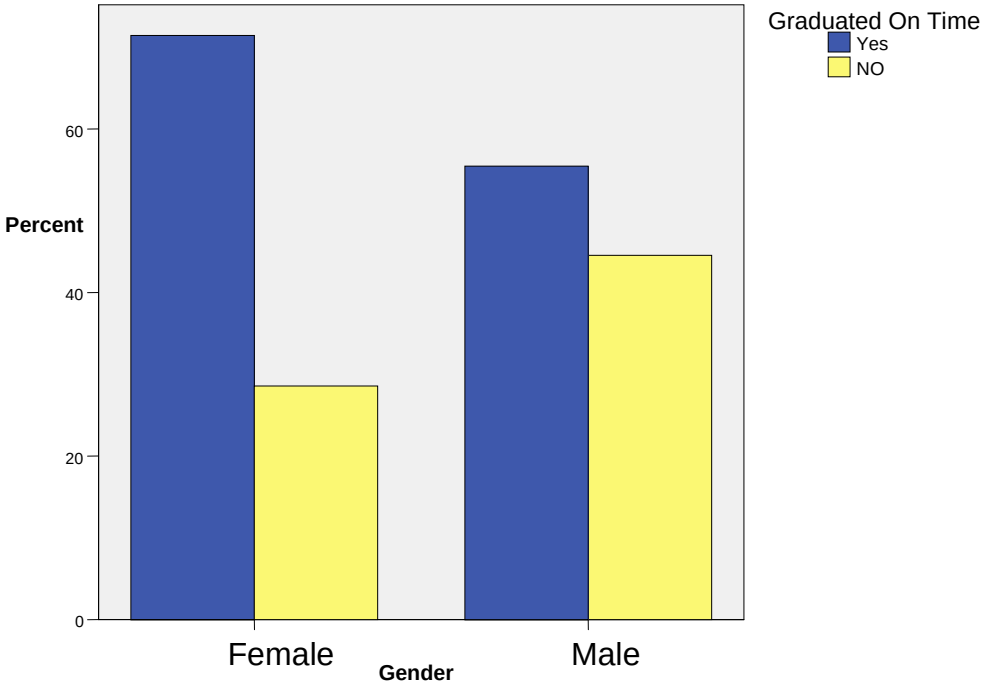

Figure 9. Percentage of "Graduation On-Time" by Sex for the Class of 2003.

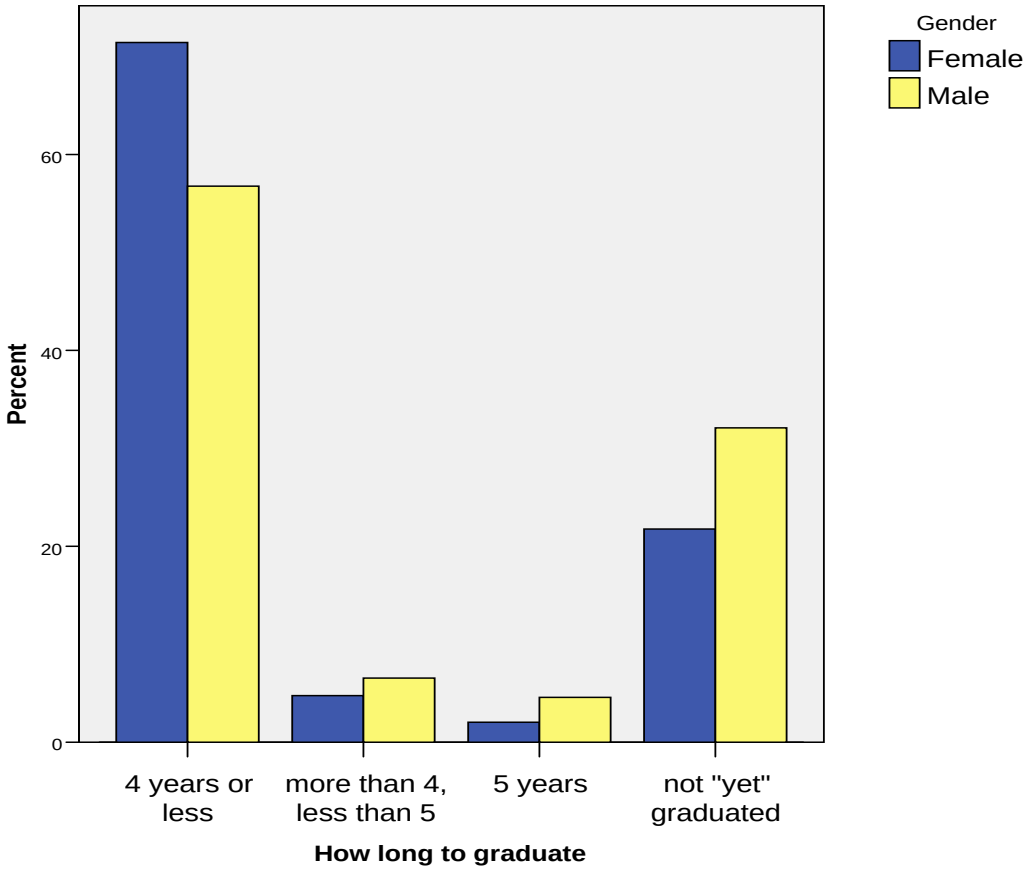

Figure 10. Chart of Time to Graduate by Sex; (in percents) Class of 2003.

Table 9.Sexes by Time to Graduate; Class of 2003.

Sex	Class of 2002	Class of 2003
Male	60%	56%
Female	78%	71%

Figure 10 and table 9 indicate that 71% of females in the WPI Class of 2003 graduated on time, and only 56% of the males graduated on time. This is striking because it suggests that the minority group in the population, not only started to outperform their male peers at the end of the freshman year, but that they continued to do so producing a striking cumulative advantage over 4 years. They did this despite their relatively low SAT scores and hence sex

differences in performance tended to erode the value of the SAT as a predictor of success over time. Can sex differences take the place of the failed predictor or is this really an indirect correlation caused by another factor?

A similar gender difference was noted in the case of the WPI class of 2002[21]. Note the students who are not "yet" graduated, might include students who transferred to different schools, took some time off, or dropped out. There is a significant drop in the percentage of students who graduated on time in the Class of 2003 compared to the class of 2002. Though the admissions office cannot confirm it, Prof. Wilkes suspects that the class of 2003 was recruited amidst a transition in rules dealing with Early Admission that left WPI scrambling and resulted in the admission of the entire pool of "wait listed" students in 1999. Basically, as he recalls, WPI tried the hold to the rule that if one applied for "Early Admission" one could not apply to any other colleges. It was a commitment that if accepted, one would come. However, WPI's competitors had moved to the concept of "Early Action" in which the HS student gets the news early that they are admitted, but can still consider other Early Action offers. In short, there were going to be two rounds of competitive admissions and applying for Early Admission was not something done only with one's first choice institution.

Hence, some of the strongest applicants to WPI that year, especially those with high SAT scores, refused to accept WPI's version of Early Admission and went elsewhere. Though the rules were changed to conform with the new reality in the next catalog, 1 or 2 years of recruiting were affected, and on paper the classes of 2001 and 2002 were stronger than 2003.

[21] Refer to appendix A or Alfred Navato's project report.

Hence, there was an inadvertent experiment with the admission of more students than usual, especially women, with relatively low SAT scores, and their success rate was impressive.

Table 10 shows more details on how sex differences relate to the variable of graduating on time. From the results of Pearson Chi-Square of .001 and the Fisher's exact test of .000, there is clearly a statistically significant sex difference. How strong is it? The Gamma correlation coefficient is .3, thus explaining more than 10% of the variance. It can be said that the sex difference does partly account for the outcome and has a moderately strong relationship with students graduating on time.

Table 10. Cross-tabulation of Sex by Graduating on Time for Class of 2003

			Graduating on time?		Total
			Yes	No	
Sex	Female	Count	105	42	147
		% within sex	**71.4%**	**28.6%**	100.0%
	Male	Count	254	204	458
		% within sex	**55.5%**	**44.5%**	100.0%
Total		Count	359	246	605
		% within sex	**59.3%**	**40.7%**	100.0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	11.763(b)	1	**.001**		
Likelihood Ratio	12.133	1	**.000**		
Fisher's Exact Test				**.001**	**.000**

a Computed only for a 2x2 table
b 0 cells (.0%) have expected count less than 5. The minimum expected count is 59.77.

Symmetric Measures

		Value	Asymp. Std. Error(a)	Approx. T(b)	Approx. Sig.
Ordinal by Ordinal	Gamma	**.335**	.091	3.582	**.000**

a. Not assuming null hypothesis
b Using the asymptotic standard error assuming the null hypothesis.

The next 4 year out come issue that needs to be examined to see if there is a sex difference is how likely males and females are to graduate with distinction or with high distinction. Table 11 indicates the percentages of males and females with high distinction for classes of 2002 and 2003. The male performance seems to be relatively low but consistent for the two years, while for females, there is a significant drop for class of 2003 compared with the class of 2002 (with a ratio of almost 3:2) but in both year the females are at about twice as likely to perform at the highest level in terms of average grades in course and project work.

Table 11. Percentages Class of 2002 and 2003 Graduating with High Distinction by Sex

Sex	Class of 2002	Class of 2003
Male	12%	12%
Female	28%	20%

Table 12 indicates the relationship between sex and honors categories. 43.5% of female population receives honors, while only 29.7% of male population does. Knowing that females outperform males from late in the freshman year on to graduation time, and given the relationship between sex and honor categories, it seems appropriate that sex be part of the group of lead indicators or success, even though the correlations involved are only moderately strong. The Chi-Square test indicates that the difference is real and persistent. The Gamma correlation's in the .25 to .4 range shows that there is only small relationship, and in the case of honors, sex explains only about 7% of the variance, but in the case of on time graduation and getting high distinction sex is a stronger predictor explain 10-15% of the variance in collegiate success. These are small but significant relationships.

Table 12. Cross-tabulation of Sex by Honors Categories for Distinction in the Class of 2003

			Honors Categories			Total
			No Distinction	Distinction	High Distinction	
Sex	Female	Count	83	35	29	147
		% within sex	**56.5%**	**23.8%**	**19.7%**	100.0%
	Male	Count	322	81	55	458
		% within sex	**70.3%**	**17.7%**	**12.0%**	100.0%
Total		Count	405	116	84	605
		% within sex	**66.9%**	**19.2%**	**13.9%**	100.0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	10.138(a)	2	**.006**
Likelihood Ratio	9.792	2	**.007**

a 0 cells (.0%) have expected count less than 5. The minimum expected count is 20.41.

Symmetric Measures

		Value	Asymp. Std. Error(a)	Approx. T(b)	Approx. Sig.
Ordinal by Ordinal	Gamma	**-.269**	.080	-3.017	**.003**

a. Not assuming the null hypothesis

b Using the asymptotic standard error assuming the null hypothesis.

Learning styles as predictor of four-year outcomes

Figure 11 indicates the distribution of honor categories for each of four types of learners and the whole overall class of 2003. Probably the most striking part of this figure is that NP's are the largest learning style group in the population by far, and tend to get high SAT scores, yet are least likely to graduate and are also the most likely to graduate without distinction. This goes far to explain why the SAT is such a poor predictor of 4 year outcomes if one does not restrict the comparison to students who are the same type of learner. It is the SJ's and NJ's who are most likely to do well, and they are about equally matched but the SJ's usually are the stars in terms of having the overall of highest GPAs and number of passed courses, but the NJ's are unusually likely to be the stars in terms of graduating with high distinction. Only the NJ's tend to do well on the SAT.

The best clues as the why the NJ's emerge as the top performers comes out of studies of what classes they tend to outperform the SJ's in. In class studies involving the proportion of key concepts in fairly abstract classes that they mastered, the NJ's outperform the SJ's. The NJ's are the stars in classes like Introductory Physics, Signal Analysis and Linear Algebra. Using EE2311 (Signal Analysis) term B of 2002 as an example, only 5% of the NJ's failed to pass and 47% got A's. Among the SJ's, 9% failed to pass. Among the NP's, 26% failed to pass. Among the SP's, 32% failed to pass (Shuler 2004). In the introductory EE course studied by Denise Nicoletti there were 6 major concepts to master. About 25-35% of the class mastered each of the 5 easier concepts and 12 % of the class mastered the toughest concept. On average 60% of the 10 NJ's mastered each of the easier concepts and 20% mastered the toughest one. The 11 SJ's and 6 NP's did about equally well, typically 33% of each group mastered 3 concepts. The SP's

struggled the most with this material, about 17% mastering 4 of the 6 concepts, and none of the 6 students of this type mastered the toughest most abstract concept (Nicoletti and Wilkes 2004).

The study of the MQP experience of the Class of 2002 suggests that by itself the MBTI of an individual student is not enough to understand the pattern of MQP grades (Gauntt 2005). One has to have the group mix and the nature of the task specified or one has to have information on cognitive abilities as well as cognitive preferences to make sense of those grades. However, the MBTI gets you half way to a useful student classification system for project performance studies. However, that is beyond the scope of the current study of college success based on class based performance data as the outcome variable, to get into the findings of the studies thus far of project performance on the MQP. The IQP outcomes have never been studied.

High distinction at WPI as much based on project work as coursework, but since MQPs often require grasping and applying abstract and complex theories and concepts to project and laboratory work I suspect that the combination of intuition and a tendency to want closure, to complete things would be a major advantage in a project based system. This would explain the tendency of the NJ's to appear disproportionately among the students graduating with high distinction.

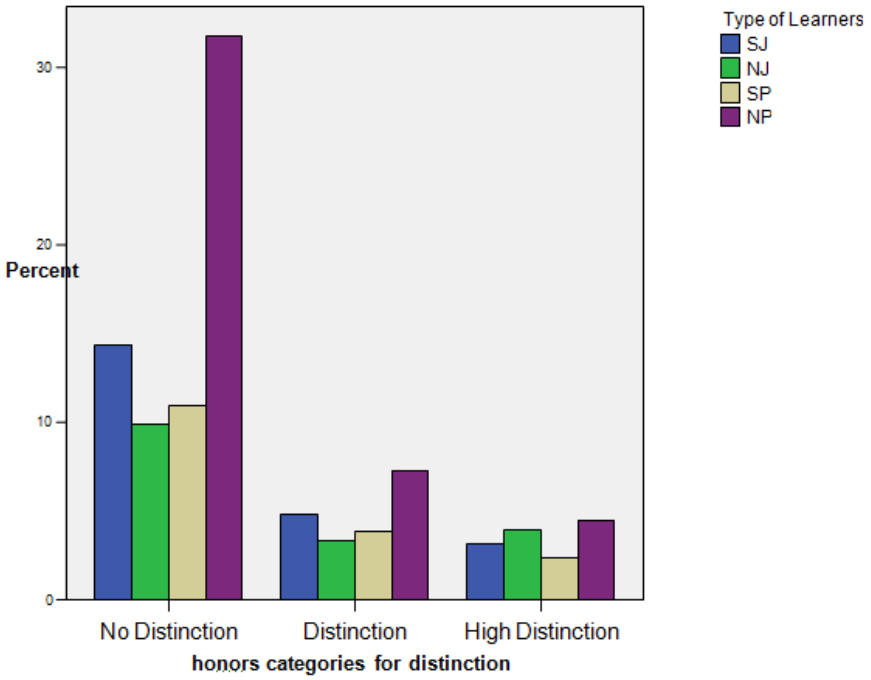

Figure 11. Percentages of Type of Learners by Honors Categories; Class of 2003

Table 13 compares the distribution students achieving high distinction by type of learners in the classes of 2002 and 2003. There is significant drop in the percentage of students getting high distinction among both the SJ's and NJ's from class of 2002 to class of 2003 despite the fact that the NJ's are still the types of students who are most like to succeed In their class at WPI.

Only the SP's do better proportionately in the Class of 2003 than they did in the Class of 2002. Percentage of females in the class is a bit higher in 2003 (24.3%) than in 2002 (22.7%), but that is a small difference and unlikely to have affected the outcome for the class as a whole

Table 13. Comparison of High Distinction Receivers by Type of Learner.

Type of learners	Class of 2002	Class of 2003
SJ	21%	14%
NJ	29%	23%
SP	9%	14%
NP	11%	10%

Table 14 indicates the relationship between types of learners and honors categories for class of 2003. Within each type, SJ's have 35.6% receiving honors (distinction and high distinction) compared to NJ's 42.3%, SP's 35.9%, and NP's 27.0%. Based on the Chi-Square and Gamma statistics, there are clearly differences but they are primarily in the "high distinction" category, and the relationship gets blurrier with the "distinction" category mixed in. It is also clear that the numerical order of the categories (SJ=1, NJ=2, SP=3, NP=4) is not running NJ-Sensing- NP as it would have to reflect the actual pattern of results. Hence, the reported relationship between the J and P types of learners and honors is not very strong. The low correlation could be explained by the way the statistical program works, it only sees rank in numbers rather than reordering the categories to maximize the relationship. However, we can see from figure 11 that NP's are the most likely to not receive any honors, and the NJ's were the most likely to do so for the class of 2003.

Table 14. Cross-tabulation of Types of Learner by Honors Categories (Class of 2003)

Type of Learners			Honors categories			Total
			No Distinction	Distinction	High Distinction	
	SJ	Count	87	29	19	135
		% within types	**64.4%**	**21.5%**	**14.1%**	100.0%
	NJ	Count	60	20	24	104
		% within types	**57.7%**	**19.2%**	**23.1%**	100.0%
	SP	Count	66	23	14	103
		% within types	**64.1%**	**22.3%**	**13.6%**	100.0%
	NP	Count	192	44	27	263
		% within types	**73.0%**	**16.7%**	**10.3%**	100.0%
Total		Count	405	116	84	605
		% within types	66.9%	19.2%	13.9%	100.0%

Chi-Square Tests

	Value	Df	Asymp. Sig. (2-sided)
Pearson Chi-Square	13.574(a)	6	**.035**
Likelihood Ratio	12.783	6	**.047**

a 0 cells (.0%) have expected count less than 5. The minimum expected count is 14.30.

Symmetric Measures

		Value	Asymp. Std. Error(a)	Approx. T(b)	Approx. Sig.
Ordinal by Ordinal	Gamma	**-.151**	.057	-2.582	**.010**

a. Not assuming the null hypothesis
b Using the asymptotic standard error assuming the null hypothesis.

Table 15 compares the distribution of students graduating on time by type of learner in classes of 2001, 2002, and 2003. The SJ's and SP's percentages were consistent across the three years. The NJ's and NP's both have a 7% jump in percentage of people graduating on time that starting in the class of 2002 compared to 2001 but by 2003 they are back to around the percentages one finds in 2001. Overall, all four types of learners seem to have consistency in the rank order of the portion of students graduating on time with SJ's ~70%, NJ's ~65%, SP's ~62%, and NP's ~52%. Table 16 indicates that the two variables are related, with ~5% of variance explained, and the relationship is significant. In this case, the types of learners are in the right order to test the strength of the relationship.

Table 15. Comparison of Graduation "On Time" for Classes of 2001, 2002, & 2003 by Type of Learners

Type of Learners	Class of 2001	Class of 2002	Class of 2003
SJ	70% (116)	71% (85)	71% (96)
NJ	66% (68)	73% (70)	64% (66)
SP	62% (63)	61% (65)	63% (65)
NP	52% (122)	59% (140)	53% (138)
Total	61 % (369)	64% (360)	60% (365)

Table 16. Cross-tabulation of Types of Learners by How Long to Graduate with Categories, Class of 2003

Type of Learner			How long to graduate with 4 categories				Total
			4 years or less	more than 4, less than 5	5 years	not "yet" graduated	
MBTI Based Types	SJ	Count	96	9	4	26	135
		% within type	**71.1%**	**6.7%**	**3.0%**	**19.3%**	100.0%
	NJ	Count	66	7	4	27	104
		% within type	**63.5%**	**6.7%**	**3.8%**	**26.0%**	100.0%
	SP	Count	65	6	7	25	103
		% within type	**63.1%**	**5.8%**	**6.8%**	**24.3%**	100.0%
	NP	Count	138	15	9	101	263
		% within type	**52.5%**	**5.7%**	**3.4%**	**38.4%**	100.0%
Total		Count	365	37	24	179	605
		% within type	**60.3%**	**6.1%**	**4.0%**	**29.6%**	100.0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	21.656(a)	9	**.010**
Likelihood Ratio	21.483	9	**.011**

a 2 cells (12.5%) have expected count less than 5. The minimum expected count is 4.09.

Symmetric Measures

		Value	Asymp. Std. Error(a)	Approx. T(b)	Approx. Sig.
Ordinal by Ordinal	Gamma	**.238**	.057	4.162	**.000**

b Using the asymptotic standard error assuming the null hypothesis.
c Based on normal approximation.

Courses-passed in freshman year as predictor of four-year outcomes

Table 17 indicates that the relationship between the number of courses passed during freshman year with graduating on time (yes or no) is very strong, significant, and indeed linear, with 46% of the variance explained.

Table 17. Statistics on Courses Passed in Freshman Year Class of 2003 by "Graduating On Time"

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	204.772[a]	15	**.000**
Likelihood Ratio	234.478	15	**.000**

a. 11 cells (34.4%) have expected count less than 5. The minimum expected count is .41.

Symmetric Measures

		Value	Asymp. Std. Error[a]	Approx. T[b]	Approx. Sig.
Ordinal by Ordinal	Gamma	**-.682**	.039	-14.639	**.000**

a. Not assuming the null hypothesis.

b. Using the asymptotic standard error assuming the null hypothesis.

c. Based on normal approximation.

Table 18 indicates that the relationship between the number of courses passed during freshman year with time to graduation (4 years, 4.5 years, 5 years, etc.) is very strong, significant, and indeed linear, with 44% of the variance in time to graduation explained by a lead variable available by the end of the first year at WPI. However, is it equally predictive for all 4 types of learners? Note that, the further refinement of the outcome variable into 4 categories has not increased the strength of the relationship. The graduate in 4 years yes or no is a bit more strongly related to getting distinction than taking into account how late one is in graduating. Missing by a little is not increasing the proportion of people who in the end perform well.

Table 18. Statistics on Courses Passed in Freshman Year Class of 2003 by Time to Graduation

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	297.298[a]	45	**.000**
Likelihood Ratio	302.101	45	**.000**

a. 43 cells (67.2%) have expected count less than 5. The minimum expected count is .04.

Symmetric Measures

		Value	Asymp. Std. Error[a]	Approx. T[b]	Approx. Sig.
Ordinal by Ordinal	Gamma	**-.660**	.037	-15.089	**.000**

a. Not assuming the null hypothesis.

b. Using the asymptotic standard error assuming the null hypothesis.

c. Based on normal approximation.

Table 19 indicates that the relationship between the number of courses passed during freshman year and graduating with honors is very strong, significant, and indeed linear, with 34% of the variance explained.

Table 19. Statistics on Courses Passed in Freshman Year (Class of 2003) by Honors Categories

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	121.181[a]	30	**.000**
Likelihood Ratio	147.863	30	**.000**

a. 28 cells (58.3%) have expected count less than 5. The minimum expected count is .14.

Symmetric Measures

		Value	Asymp. Std. Error[a]	Approx. T[b]	Approx. Sig.
Ordinal by Ordinal	Gamma	**.579**	.043	11.672	**.000**

a. Not assuming the null hypothesis.

b. Using the asymptotic standard error assuming the null hypothesis.

c. Based on normal approximation.

Four-year lead predictions based on freshman data

SAT scores quartile as predictor of four-year outcome

In the previous section I indicated that SAT scores do not have much predictive value when it comes to freshman year outcomes; an alternative question is if SAT scores will be valuable in predicting four-year outcomes? In the first part, the relationship between SAT scores and type of learners needs to be analyzed with respect to sex difference. Table 20 indicates the percentages of female and male populations and their SAT scores. The SAT quartile distribution of class of 2003 students turns out to be significantly different by sex with Chi-Square test significance of .007 and slightly related, Gamma value is .23 (~5% of variance explained), with a high significance level of .001. The majority of females (65%) are in the two bottom quartiles, while for males, the distribution for SAT scores is pretty even.

Table 20. SAT Quartile Percentages by Sex; Class of 2003.

Sex	Lowest (1190 or less)	3rd (1191-1270)	2nd (1271-1350)	Highest (1350 or more)	N of Cases
Female	34%	31%	19%	16%	141 (24%)
Male	26%	22%	27%	26%	446 (76%)
Total	28%	24%	25%	23%	587 (100%)

(Percentages are rounded up).

Table 21 indicates the percentages of female and male populations by their learning type and SAT score. The relationship between type of learner and SAT score, when broken down by sex, is interesting. The statistics tests show that there is essentially no relationship between type of learner and SAT score for the female population; Chi-Square test significance is .703 and Gamma correlation coefficient is .039 (<1% of variance explained) and .680 level of

significance (not sig.). But for the male population, the relationship is strong and indicates that type of learner is related to SAT scores in this population; Chi-Square test is .000 and the Gamma coefficient is .25 (~6% of variance explained) with a high level of significance (.0001). The lack of clear relationship in the female population might be caused by the small size of the female population given WPI's female: male ratio of 1:3, an unavoidable data limitation with a data set covering only one WPI class year. Note that both the male and female SJ's and NJ's have similar distributions, especially the SJ's.

Table 21. Percentages of SAT Quartile by Type of Learners and Sex; Class of 2003

Sex/Type of Learners	Lowest (1190 or less)	3rd (1191-1270)	2nd (1271-1350)	Highest (1350 or higher)	N of Cases
Female					
SJ	42%	27%	22%	10%	(41)
NJ	23%	29%	23%	26%	(31)
SP	41%	32%	14%	14%	(22)
NP	32%	34%	17%	17%	(47)
Male					
SJ	41%	25%	24%	10%	(92)
NJ	20%	23%	26%	31%	(70)
SP	36%	23%	14%	28%	(80)
NP	16%	21%	33%	30%	(204)

(Percentages are rounded up)

Table 22 indicates the relationship between type of learners and SAT quartiles by honors categories. When SAT scores are categorized by quartile and classified by type of learners, it has predictive value as can be seen below. All types of learners, except for the NP's, are predictable. For SJ's, NJ's and SP's the relationship between SAT scores and their four-year distinction is linear. But NP's are not predictable. There is no significant difference with Chi-

Square .513 and the Gamma coefficient of .030 is near zero and not significant (.767). Their SAT scores have nothing to do with their chances of getting distinction on their degrees. SAT quartiles have predictive value for achieving honors but not for predicting who will graduate on time[22] when it comes to predicting four-year outcomes.

Table 22. Cross-tabulation of Class of 2003 SAT Quartiles by Honors Categories and Type of Learners

Type of Learners				Honors Categories for Distinction			Total
				No Distinction	Distinction	High Distinction	
SJ	SAT quartiles	1190 or less	Count	43	9	3	55
			% within sat quartiles	**78.2%**	**16.4%**	**5.5%**	100.0%
		1191-1270	Count	18	10	6	34
			% within sat quartiles	**52.9%**	**29.4%**	**17.6%**	100.0%
		1271-1350	Count	15	9	7	31
			% within sat quartiles	**48.4%**	**29.0%**	**22.6%**	100.0%
		1351 or higher	Count	10	0	3	13
			% within sat quartiles	**76.9%**	**.0%**	**23.1%**	100.0%
	Total		Count	86	28	19	133
			% within sat quartiles	**64.7%**	**21.1%**	**14.3%**	100.0%
NJ	SAT quartiles	1190 or less	Count	13	8	0	21
			% within sat quartiles	**61.9%**	**38.1%**	**.0%**	100.0%
		1191-1270	Count	21	2	2	25
			% within sat quartiles	**84.0%**	**8.0%**	**8.0%**	100.0%
		1271-1350	Count	12	6	7	25
			% within sat quartiles	**48.0%**	**24.0%**	**28.0%**	100.0%
		1351 or higher	Count	13	4	13	30
			% within sat quartiles	**43.3%**	**13.3%**	**43.3%**	100.0%
	Total		Count	59	20	22	101
			% within sat quartiles	**58.4%**	**19.8%**	**21.8%**	100.0%

[22] Refer to appendix B.

SP	SAT quartiles	1190 or less	Count	30	7	1	38
			% within sat quartiles	**78.9%**	**18.4%**	**2.6%**	100.0%
		1191-1270	Count	15	9	1	25
			% within sat quartiles	**60.0%**	**36.0%**	**4.0%**	100.0%
		1271-1350	Count	9	1	4	14
			% within sat quartiles	**64.3%**	**7.1%**	**28.6%**	100.0%
		1351 or higher	Count	11	6	8	25
			% within sat quartiles	**44.0%**	**24.0%**	**32.0%**	100.0%
	Total		Count	65	23	14	102
			% within sat quartiles	**63.7%**	**22.5%**	**13.7%**	100.0%
NP	SAT quartiles	1190 or less	Count	32	11	5	48
			% within sat quartiles	**66.7%**	**22.9%**	**10.4%**	100.0%
		1191-1270	Count	45	10	3	58
			% within sat quartiles	**77.6%**	**17.2%**	**5.2%**	100.0%
		1271-1350	Count	56	12	8	76
			% within sat quartiles	**73.7%**	**15.8%**	**10.5%**	100.0%
		1351 or higher	Count	48	10	11	69
			% within sat quartiles	**69.6%**	**14.5%**	**15.9%**	100.0%
	Total		Count	181	43	27	251
			% within sat quartiles	**72.1%**	**17.1%**	**10.8%**	100.0%

Chi-Square Tests

Type of Learners		Value	df	Asymp. Sig. (2-sided)
SJ	Pearson Chi-Square	14.694[a]	6	**.023**
	Likelihood Ratio	17.887	6	**.007**
NJ	Pearson Chi-Square	24.236[b]	6	**.000**
	Likelihood Ratio	27.665	6	**.000**
SP	Pearson Chi-Square	20.214[c]	6	**.003**
	Likelihood Ratio	20.732	6	**.002**
NP	Pearson Chi-Square	5.240[d]	6	**.513**
	Likelihood Ratio	5.345	6	**.500**

a. 4 cells (33.3%) have expected count less than 5. The minimum expected count is 1.86.

b. 4 cells (33.3%) have expected count less than 5. The minimum expected count is 4.16.

c. 4 cells (33.3%) have expected count less than 5. The minimum expected count is 1.92.

d. 0 cells (.0%) have expected count less than 5. The minimum expected count is 5.16.

Symmetric Measures

Type of Learners		Value	Asymp. Std. Error[a]	Approx. T[b]	Approx. Sig.
SJ	Gamma	**.291**	.114	2.403	**.016**
NJ	Gamma	**.392**	.114	3.244	**.001**
SP	Gamma	**.438**	.116	3.322	**.001**
NP	Gamma	**.030**	.102	.297	**.767**

a. Not assuming the null hypothesis.

b. Using the asymptotic standard error assuming the null hypothesis.

D-term as predictor of honors or "distinction"

As the last term in freshman year, the hypothesis is that D-term will predict the performance of students in finishing up their degrees, better than A-term data or data for the year as a whole (see table 23). Note that D-term grades have more predictive value for students with a sensing preference than students with a preference for intuition. D-term grade average does have a strong relationship with getting distinction as seen in table 24; where 28% of the variance in getting strong grades for all 4 years is explained by how well the 4th quarter of freshman year went.

Table 23. Pearson's Correlation for Type of Learners and On Time Graduation by A and D Term Freshman Year Class of 2003.

Type of Learners	A Term-On Time Graduation	D Term-On Time Graduation
SJ	**.15**	**.22**
NJ	.31	.30
SP	**.39**	**.49**
NP	.35	.38

Table 24. Statistic Tests of Class of 2003 Fr. D-term GPA Equivalent by Honors Categories

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	145.642(a)	22	**.000**
Likelihood Ratio	152.239	22	**.000**

a 10 cells (27.8%) have expected count less than 5. The minimum expected count is .14.

Symmetric Measures

		Value	Asymp. Std. Error(a)	Approx. T(b)	Approx. Sig.
Ordinal by Ordinal	Gamma	**.529**	.040	11.465	**.000**

a Not assuming the null hypothesis.
b Using the asymptotic standard error assuming the null hypothesis.

Interaction effects

Table 25 indicates that female students indeed outperformed male students in class of 2003 no matter what type of learners they are, even though the ratio between males and females is 3:1. The groups that most likely to graduate with distinction are male and female NJ's but 1 in 3 Female NJ 's had high distinction and only 1 in 5 male NJ's performed at that level. Further, a majority (56%) of the Female NJ's got honors (distinction or high distinction) and a minority of 36% of the male NJ's did the same. There is a statistically significant difference among the NJ's by sex and the Gamma correlation between sexes and getting honors is .35, explaining more than 10% of the variance. Though the other differences are substantial enough to see by eye and establish a clear trend, they are not statistically significant with a data set of this size and the correlations are in the range of .2, explaining only 4% of the variable if the differences exist at all.

Table 25. Cross-tabulation of Sex by Categories for Distinction (Class of 2003)

MBTI Based learning styles				Honors categories for distinction			Total
				Not Distinguished	Distinction	High Distinction	
SJ	Sex	Female	Count	24	9	8	41
			% within sex	**58.5%**	**22.0%**	**19.5%**	100.0%
		Male	Count	63	20	11	94
			% within sex	**67.0%**	**21.3%**	**11.7%**	100.0%
	Total		Count	87	29	19	135
			% within sex	**64.4%**	**21.5%**	**14.1%**	100.0%
NJ	Sex	Female	Count	15	8	11	34
			% within sex	**44.1%**	**23.5%**	**32.4%**	100.0%
		Male	Count	45	12	13	70
			% within sex	**64.3%**	**17.1%**	**18.6%**	100.0%

	Total		Count	60	20	24	104
			% within sex	**57.7%**	**19.2%**	**23.1%**	100.0%
SP	Sex	Female	Count	12	6	4	22
			% within sex	**54.5%**	**27.3%**	**18.2%**	100.0%
		Male	Count	54	17	10	81
			% within sex	**66.7%**	**21.0%**	**12.3%**	100.0%
	Total		Count	66	23	14	103
			% within sex	**64.1%**	**22.3%**	**13.6%**	100.0%
NP	Sex	Female	Count	32	12	6	50
			% within sex	**64.0%**	**24.0%**	**12.0%**	100.0%
		Male	Count	160	32	21	213
			% within sex	**75.1%**	**15.0%**	**9.9%**	100.0%
	Total		Count	192	44	27	263
			% within sex	**73.0%**	**16.7%**	**10.3%**	100.0%

Symmetric Measures

MBTI Types of Learners			Value	Asymp. Std. Error[a]	Approx. T[b]	Approx. Sig.
SJ	Ordinal by Ordinal	Gamma	**-.187**	.167	-1.062	**.288**
NJ	Ordinal by Ordinal	Gamma	**-.347**	.160	-1.967	**.049**
SP	Ordinal by Ordinal	Gamma	**-.226**	.204	-1.019	**.308**
NP	Ordinal by Ordinal	Gamma	**-.224**	.143	-1.407	**.159**

a. Not assuming the null hypothesis.

b. Using the asymptotic standard error assuming the null hypothesis.

Discussion

Based on the analysis of the data presented above, one can see that there are strong predictors and weak predictors. There are also predictors that are strong for freshman year class of 2003 outcomes, but not for four-year outcomes, and vice versa.

My hypothesis of students with the highest SATs would be most likely to succeed in the freshman year was not supported. That made it seem very unlikely to be of any use at all in predicting 4 year outcomes, but it is more useful for some types of learners than others. NP's had the highest average for SATs of the 4 types of learners in the classes of 2001, 2002, and 2003. SJ's and SP's got the lowest SATs for those three years, but as it has been shown in previous studies and this project, SJ's are the ones that are most likely to succeed by the end of freshman year and also most likely to graduate on time. The high SAT scoring NP's are the ones that are most likely to have their performance slide from A term to D term in the freshman year and with the SP's are likely to struggle throughout their freshman year. The NP's are also the least likely to graduate on time. The data analyzed for this study also indicates that SAT only has predictive value for A-term freshman year, and after that its predictive value gets weaker after that for most types of learners. SAT math has more predictive value for the performance of students with intuition preference. SAT verbal scores have more predictive value for students with a sensing preference. Overall, SAT is a weak predictor for all four types of learners, but it does have value when it comes to A-term average grade performance.

Looking at MBTI type of learners to predict how the freshman year is likely to go would be instructive. On average it can be concluded that SJ's are likely to have high average grades in all four terms and will not slip very much as the year progresses. In D-term the rank of

performance from best to weakest was typically SJ's, NJ's, NP's and SP's in the period 1997-2000. For classes of 2001, 2002, and 2003, it has been shown that SJ's and NJ's are in competition and about equally matched in terms of the odds of being among the students with the highest freshman and overall grades in the class. The NP's and SP's perform less well on average and are more likely to struggle to pass enough courses to stay on schedule and in good standing. This is evident in the freshman year when on average they fall about one course behind their J classmates. Interestingly, all four types of learners, although they started from different places relative to one another in A-term from year to year , by the end of D-term they have their own typical mean GPA "performance-zone" with SJ's in ~1.95, NJ's ~1.85, NP's ~1.7, and SP's ~1.6.

One can improve one's predictions about how the freshman year will go by taking sex differences into account. Female performance is less likely to be related to learning styles than male performance especially in the freshman year. Looking at the sex difference in the first year, , overall females will outperform males, but in A-term of the class of 2003's experience females outperformed males in only two of the learning style groupings. By D-term there females had the edge in all four learning style groupings. The rough start for Females tended to be in the groups that had the greatest difference in average SAT scores for males and females. This partly explains the greater value of SAT score as A-term rather than D-term predictors. . The stronger female performance may be partly related to the male and female difference in the distribution of types of learners. However, this could at most account for half of the difference in performance by sex. Sex is a lead variable for predicting performance in its own right that deserves study and further explanation. However, the greater likelihood that a female

is an SJ can also lead to stereotypes. At WPI females are viewed as more likely to cooperate be more focused, organized, expressive, and play it safe, as well as more persistent and patient than males. This is also a good description of an SJ from an NP perspective. About 1 in 5 males at WPI is an SJ and 1 in 3 females at WPI are that type of learner.

Lead predictor candidates for four-year outcomes are MBTI based type of learner, sex, and freshman year performance, especially how many courses were passed in that year as a whole. However, freshman year D-term performance is a reasonably good predictor for 2 of the 4 types of learners. Looking at types of learners, again SJ's and NJ's are most likely to succeed while students with a perceiving preference are less likely to do so. SJ's are the most likely to graduate on time with 71% in 2003, and for NP's it is only 53%. In getting "distinction" at the time of graduation, however, NJ's outperform SJ's. This could be caused by the ability of NJ's to understand abstract theories better than SJ's, and this will be an increasing advantage for NJ's in higher level 3rd and 4th year classes and also in working on their junior and senior projects. Students who receive A's for both the IQP and MQP projects as well as have high grades in the courses in their major are the ones that earn high distinction.

Sex has a moderately strong relationship with four-year outcomes for class of 2003. Overall females outperform males, and this is also true for all the other classes studied so far, class of 2001 and 2002. Another useful lead predictor for four-year outcome is 'courses passed in freshman year' variable. So the students who are passing the most courses in their freshman year will also most likely to graduate on time and with distinction. Graduating on time is highly related to getting honors in one's major. Another predictor using freshman data is D-term grades, students who are doing well in terms of their grade point average in their last term of

freshman year and who have passed all their courses as Freshman will be likely to receive distinction, especially if they are NJ or SP types of learners. Some types are more predictable than others, but on the whole these are indicators likely to work for most students, unlike SAT scores which are only useful under certain circumstances and for certain types of learners.

Conclusion

This project yielded patterns of findings that were consistent for 3 years of data. Its main value was a demonstration that the class of 2003 data set is not as different (not as much of an outlier) as previously thought. The result is a replicated pattern of evidence that finding lead predictors for WPI student performance is probably possible.

Judging from freshman and four year outcomes, SATs are not the level playing field that is equally revealing about all kinds of students that they seem to be. They do not have strong predictive value even in the freshman year for most types of learners. They start to have some value regarding how things will go in the freshman year if one compares students of the same learning styles only with one another. Even they only correlated at a useful level for half of the types of learners. Used this way (to rank order students of the same learning type), the SAT has modest predictive value in determining if a student will graduate with distinction –with the exception of the NP personality type- but not regarding on-time graduation.

At WPI the type of students with the lowest average SATs usually are more successful than the type of students with the highest average SATs. The students with an SJ preference will be most likely to succeed- yet they tend to have the lowest average SAT scores. By contrast, the students with the highest average SAT scores, the NP's are likely to struggle along with the SP's to pass courses and get good grades in the freshman year, especially toward the end of it.

On average, the females of WPI will outperform the males, not necessarily on arrival, but starting by the end of the freshman year. They are especially likely to look stronger on the 4 year outcome measures. This might be caused by skewed distribution of male students, which

is disproportionately NP compared to the females who are disproportionately SJ in most years. However, even comparing the same types of learners, the females are likely to outperform the males in 3 of the 4 learning styles group and tie them in the last learning styles group.

My recommendation to Academic Advising Office is to reach out to the SP's and NP's students to work on study habits and organizational skills early in the Freshman year (during the Insight program) so that they to stay on track with the fast paced 7-week term system of WPI. One wants them to do well enough to pass their freshman courses and get off to a good start in terms of progress towards graduation. A program to help students in planning and organizing their studies will be helpful and crucial because majority of WPI students have preference for perceiving in their personality. Those with an Intuitive Perceiving preference have an advantage on the SAT which is helpful in getting admitted to WPI but not necessarily helpful in passing courses during the freshman year. The reason for the discrepancy is that NP students can score above their subject mystery levels on multiple choice exams like the SAT and SJ students cannot. Hence, with an SJ, what you see is what you get. It is less clear whether the NP's who have tested well really understand the concepts well enough to apply them to problem solving on arrival. Math and Science courses at WPI rarely use multiple choice tests.

This project will also be helpful for future projects as a baseline for pre-Insight program freshman year performance. Since MBTI data was also gathered from the Classes of 2004-2006 (which were the classes that experienced the phasing in of the Insight program) a major opportunity exists to see what types of learners benefited most from that program. There is evidence that the dropout rate after freshman year was reduced from over 10% to under10% and it is unlikely that its impact was random by type of learner.

In the future, when the sophomore year GPA term by term study is finally done, the stable D-term freshman year GPA by type finding would be the logical starting point for predicting how the four types of learners will perform in their second year relative to one another. At least this can be the basis for prediction in the pre-Insight period.

The post-Insight period class of 2004- 2006 studies to be done in the future will require access to freshman year GPA data, but why stop there? All 4 years should be compared in one study.

Now that we know that D-term average freshman grades represent a fairly stable starting point for later predictions about what the experience of the 4 types of learners will be, it is time to theorize about what happened in between the freshman pattern and the 4-year outcome pattern that was examined in this study.

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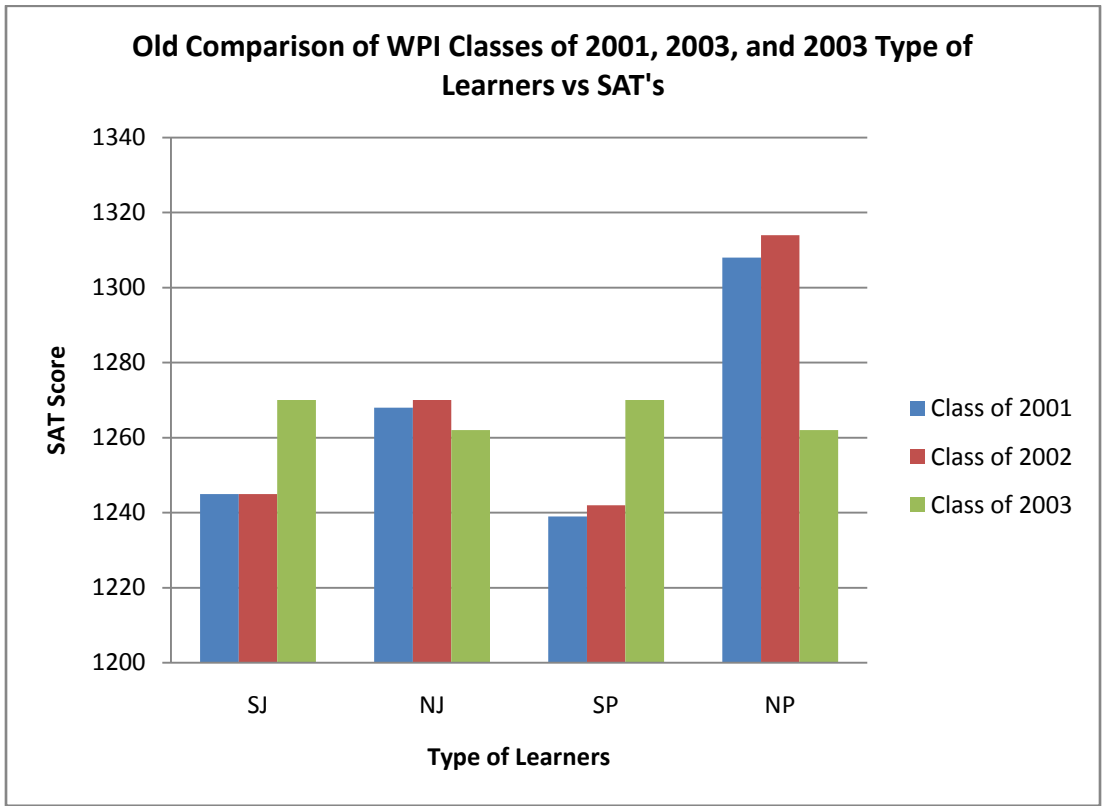
Appendix A: 2001- 2002 Data Sets

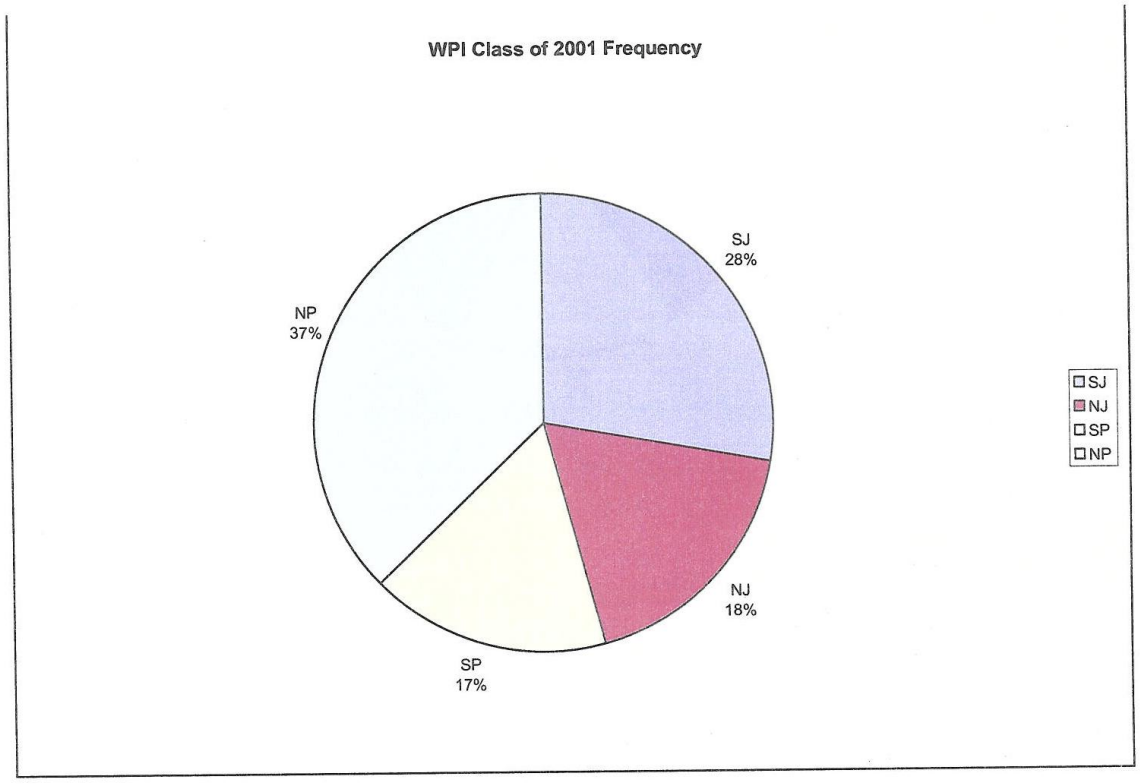
Class of 2001 data set



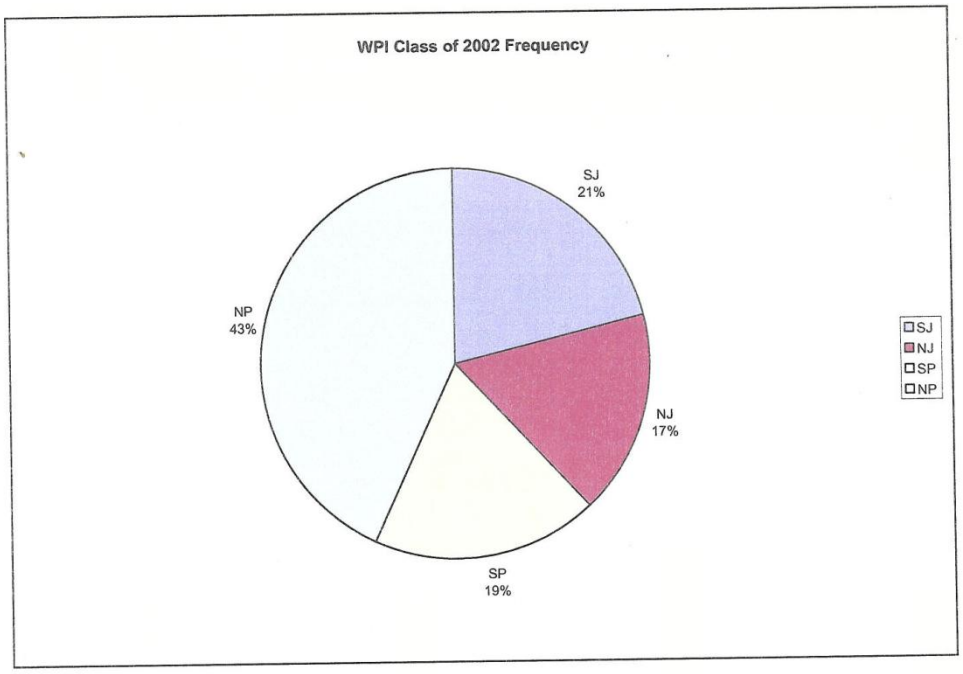
MBTI (F) and "On Time" College Graduation (in 4 years) at WPI
WPI Class of 2001 (57% officially graduate "On Time")

SJ (166 cases)	70%	(116)
SP (102 cases)	62%	(63)
NJ (103 cases)	66%	(68)
NP (234 cases)	52%	(122)
Total (605 cases)	61% (369) of those who filled out the MBTI	

The extreme types	
ESFJ (18)	78%
ENFP (47)	40%


WPI Class of 2001 Frequency
SJ
28%
NJ
18%
SP
17%
NP
37%
SJ
NJ
SP
NP

Class of 2002 data sets



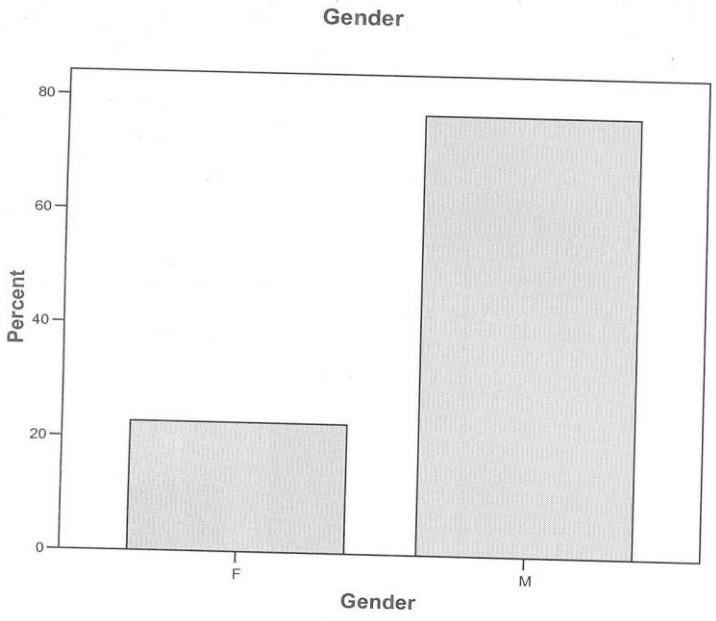


Figure 3: 2002 Gender Frequencies

Table 2: 2002 MBTI and How Long SN/JP vs howlong 2002 Crosstab

			5 category grad variable					
			four yrs or less	more than 4, less than 5	5 years	6 or more years	not "yet" graduated	Total
S/N & J/P preference combinations	-S-J	Count	85	8	6	1	20	120
		% within S/N & J/P preference combinations	70.8%	6.7%	5.0%	.8%	16.7%	100.0%
	-N-J	Count	70	2	4	2	18	96
		% within S/N & J/P preference combinations	72.9%	2.1%	4.2%	2.1%	18.8%	100.0%
	-S-P	Count	65	7	9	1	25	107
		% within S/N & J/P preference combinations	60.7%	6.5%	8.4%	.9%	23.4%	100.0%
	-N-P	Count	140	24	12	1	62	239
		% within S/N & J/P preference combinations	58.6%	10.0%	5.0%	.4%	25.9%	100.0%
Total		Count	360	41	31	5	125	562
		% within S/N & J/P preference combinations	64.1%	7.3%	5.5%	.9%	22.2%	100.0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	17.516(a)	12	.131
Likelihood Ratio	18.279	12	.107
Linear-by-Linear Association	5.375	1	.020
N of Valid Cases	562		

a 4 cells (20.0%) have expected count less than 5. The minimum expected count is .85.

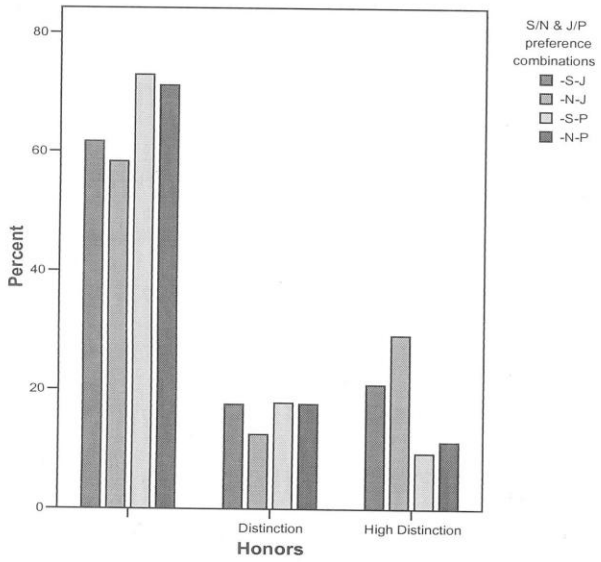


Table 6: Type vs. Honors (2002)

			Honors			Total
			Distinction	High Distinction		
S/N & J/P preference combinations	SJ	Count	21	25	74	120
		% within S/N & J/P preference combinations	17.5%	20.8%	61.7%	100.0%
	NJ	Count	12	28	56	96
		% within S/N & J/P preference combinations	12.5%	29.2%	58.3%	100.0%
	SP	Count	19	10	78	107
		% within S/N & J/P preference combinations	17.8%	9.3%	72.9%	100.0%
	NP	Count	42	27	170	239
		% within S/N & J/P preference combinations	17.6%	11.3%	71.1%	100.0%
Total		Count	94	90	378	562
		% within S/N & J/P preference combinations	16.7%	16.0%	67.3%	100.0%

Table 8: Gender vs. How Long (2002)

			How long									
			less than 4 years	4 years	4 years and summer (October grad)	4.5 years (Feb. grad)	5 year (may grad 1 year late)	5 years and summer (October grad)	5.5 years (Feb. grad.)	6 years (may grad 2 years late)	unknown	Total
Gender	F	Count	2	98	2	1	3	0	0	2	20	128
		% within Gender	1.6%	76.6%	1.6%	.8%	2.3%	.0%	.0%	1.6%	15.6%	100.0%
	M	Count	2	259	19	19	25	1	2	3	105	435
		% within Gender	.5%	59.5%	4.4%	4.4%	5.7%	.2%	.5%	.7%	24.1%	100.0%
Total		Count	4	357	21	20	28	1	2	5	125	563
		% within Gender	.7%	63.4%	3.7%	3.6%	5.0%	.2%	.4%	.9%	22.2%	100.0%

Appendix B

2003 Data Set

Cross-tabulation of Sex and Type of Learners by Honor Categories

Sex				Honors			Total
				No Distinction	Distinction	High Distinction	
Female	Type of Learner	SJ	Count	24	9	8	41
			% within type	58.5%	22.0%	19.5%	100.0%
		NJ	Count	15	8	11	34
			% within type	44.1%	23.5%	32.4%	100.0%
		SP	Count	12	6	4	22
			% within type	54.5%	27.3%	18.2%	100.0%
		NP	Count	32	12	6	50
			% within type	64.0%	24.0%	12.0%	100.0%
	Total		Count	83	35	29	147
			% within type	56.5%	23.8%	19.7%	100.0%
Male	Type of Learner	SJ	Count	63	20	11	94
			% within type	67.0%	21.3%	11.7%	100.0%
		NJ	Count	45	12	13	70
			% within type	64.3%	17.1%	18.6%	100.0%
		SP	Count	53	17	11	81
			% within type	65.4%	21.0%	13.6%	100.0%
		NP	Count	160	32	21	213
			% within type	75.1%	15.0%	9.9%	100.0%
	Total		Count	321	81	56	458
			% within type	70.1%	17.7%	12.2%	100.0%

Chi-Square Tests

Sex		Value	df	Asymp. Sig. (2-sided)
Female	Pearson Chi-Square	5.927[a]	6	.431
	Likelihood Ratio	5.778	6	.449
	N of Valid Cases	147		
Male	Pearson Chi-Square	6.955[b]	6	.325
	Likelihood Ratio	6.677	6	.352
	N of Valid Cases	458		

a. 1 cells (8.3%) have expected count less than 5. The minimum expected count is 4.34.

b. 0 cells (.0%) have expected count less than 5. The minimum expected count is 8.56.

Symmetric Measures

Sex			Value	Asymp. Std. Error[a]	Approx. T[b]	Approx. Sig.
Female	Ordinal by Ordinal	Gamma	-.116	.105	-1.101	.271
	N of Valid Cases		147			
Male	Ordinal by Ordinal	Gamma	-.137	.069	-1.928	.054
	N of Valid Cases		458			

a. Not assuming the null hypothesis.

b. Using the asymptotic standard error assuming the null hypothesis.

Cross-tabulation of Type of Learners and Sex by Graduation on Time?

Type of Learners				Graduation on Time? Yes	Graduation on Time? No	Total
SJ	Sex	Female	Count	30	11	41
			% within sex	73.2%	26.8%	100.0%
			% within grad4yr	31.9%	26.8%	30.4%
		Male	Count	64	30	94
			% within sex	68.1%	31.9%	100.0%
			% within grad4yr	68.1%	73.2%	69.6%
	Total		Count	94	41	135
			% within sex	69.6%	30.4%	100.0%
			% within grad4yr	100.0%	100.0%	100.0%
NJ	Sex	Female	Count	27	7	34
			% within sex	79.4%	20.6%	100.0%
			% within grad4yr	41.5%	17.9%	32.7%
		Male	Count	38	32	70
			% within sex	54.3%	45.7%	100.0%
			% within grad4yr	58.5%	82.1%	67.3%
	Total		Count	65	39	104
			% within sex	62.5%	37.5%	100.0%
			% within grad4yr	100.0%	100.0%	100.0%
SP	Sex	Female	Count	17	5	22
			% within sex	77.3%	22.7%	100.0%
			% within grad4yr	26.6%	12.8%	21.4%
		Male	Count	47	34	81
			% within sex	58.0%	42.0%	100.0%
			% within grad4yr	73.4%	87.2%	78.6%
	Total		Count	64	39	103
			% within sex	62.1%	37.9%	100.0%
			% within grad4yr	100.0%	100.0%	100.0%
NP	Sex	Female	Count	31	19	50

		% within Sex	62.0%	38.0%	100.0%
		% within grad4yr	22.8%	15.0%	19.0%
	Male	Count	105	108	213
		% within Sex	49.3%	50.7%	100.0%
		% within grad4yr	77.2%	85.0%	81.0%
	Total	Count	136	127	263
		% within Sex	51.7%	48.3%	100.0%
		% within grad4yr	100.0%	100.0%	100.0%

Chi-Square Tests

Type of Learners		Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
SJ	Pearson Chi-Square	.349[a]	1	.555		
	Continuity Correction[b]	.150	1	.698		
	Likelihood Ratio	.354	1	.552		
	Fisher's Exact Test				.685	.353
	Linear-by-Linear Association	.347	1	.556		
	N of Valid Cases	135				
NJ	Pearson Chi-Square	6.164[c]	1	.013		
	Continuity Correction[b]	5.139	1	.023		
	Likelihood Ratio	6.505	1	.011		
	Fisher's Exact Test				.017	.010
	Linear-by-Linear Association	6.105	1	.013		
	N of Valid Cases	104				
SP	Pearson Chi-Square	2.724[d]	1	.099		
	Continuity Correction[b]	1.968	1	.161		
	Likelihood Ratio	2.883	1	.090		
	Fisher's Exact Test				.137	.078
	Linear-by-Linear Association	2.698	1	.100		
	N of Valid Cases	103				
NP	Pearson Chi-Square	2.617[e]	1	.106		

	Continuity Correction[b]	2.133	1	.144		
	Likelihood Ratio	2.643	1	.104		
	Fisher's Exact Test				.118	.072
	Linear-by-Linear Association	2.607	1	.106		
	N of Valid Cases	263				

a. 0 cells (.0%) have expected count less than 5. The minimum expected count is 12.45.

b. Computed only for a 2x2 table

c. 0 cells (.0%) have expected count less than 5. The minimum expected count is 12.75.

d. 0 cells (.0%) have expected count less than 5. The minimum expected count is 8.33.

e. 0 cells (.0%) have expected count less than 5. The minimum expected count is 24.14.

Symmetric Measures

Type of Learners			Value	Asymp. Std. Error[a]	Approx. T[b]	Approx. Sig.
SJ	Ordinal by Ordinal	Gamma	.122	.205	.603	.547
	N of Valid Cases		135			
NJ	Ordinal by Ordinal	Gamma	.529	.175	2.696	.007
	N of Valid Cases		104			
SP	Ordinal by Ordinal	Gamma	.422	.229	1.780	.075
	N of Valid Cases		103			
NP	Ordinal by Ordinal	Gamma	.253	.151	1.635	.102
	N of Valid Cases		263			

a. Not assuming the null hypothesis.

b. Using the asymptotic standard error assuming the null hypothesis.

Cross-tabulation of Type of Learners and Sex by Honors Categories

Type of Learners				Honors			
				No Distinction	Distinction	High Distinction	Total
SJ	Sex	Female	Count	24	9	8	41
			% within sex	58.5%	22.0%	19.5%	100.0%
			% within honors	27.6%	31.0%	42.1%	30.4%
		Male	Count	63	20	11	94
			% within sex	67.0%	21.3%	11.7%	100.0%
			% within honors	72.4%	69.0%	57.9%	69.6%
	Total		Count	87	29	19	135
			% within sex	64.4%	21.5%	14.1%	100.0%
			% within honors	100.0%	100.0%	100.0%	100.0%
NJ	Sex	Female	Count	15	8	11	34
			% within sex	44.1%	23.5%	32.4%	100.0%
			% within honors	25.0%	40.0%	45.8%	32.7%
		Male	Count	45	12	13	70
			% within sex	64.3%	17.1%	18.6%	100.0%
			% within honors	75.0%	60.0%	54.2%	67.3%
	Total		Count	60	20	24	104
			% within sex	57.7%	19.2%	23.1%	100.0%
			% within honors	100.0%	100.0%	100.0%	100.0%
SP	Sex	Female	Count	12	6	4	22
			% within sex	54.5%	27.3%	18.2%	100.0%
			% within honors	18.5%	26.1%	26.7%	21.4%
		Male	Count	53	17	11	81
			% within sex	65.4%	21.0%	13.6%	100.0%
			% within honors	81.5%	73.9%	73.3%	78.6%
	Total		Count	65	23	15	103
			% within sex	63.1%	22.3%	14.6%	100.0%
			% within honors	100.0%	100.0%	100.0%	100.0%
NP	Sex	Female	Count	32	12	6	50

		% within sex	64.0%	24.0%	12.0%	100.0%
		% within honors	16.7%	27.3%	22.2%	19.0%
	Male	Count	160	32	21	213
		% within sex	75.1%	15.0%	9.9%	100.0%
		% within honors	83.3%	72.7%	77.8%	81.0%
	Total	Count	192	44	27	263
		% within sex	73.0%	16.7%	10.3%	100.0%
		% within honors	100.0%	100.0%	100.0%	100.0%

Chi-Square Tests

Type of Learners		Value	df	Asymp. Sig. (2-sided)
SJ	Pearson Chi-Square	1.562[a]	2	.458
	Likelihood Ratio	1.498	2	.473
	N of Valid Cases	135		
NJ	Pearson Chi-Square	3.982[b]	2	.137
	Likelihood Ratio	3.947	2	.139
	N of Valid Cases	104		
SP	Pearson Chi-Square	.883[c]	2	.643
	Likelihood Ratio	.866	2	.649
	N of Valid Cases	103		
NP	Pearson Chi-Square	2.817[d]	2	.245
	Likelihood Ratio	2.657	2	.265
	N of Valid Cases	263		

Symmetric Measures

Type of Learners			Value	Asymp. Std. Error[a]	Approx. T[b]	Approx. Sig.
SJ	Ordinal by Ordinal	Gamma	-.187	.167	-1.062	.288
	N of Valid Cases		135			
NJ	Ordinal by Ordinal	Gamma	-.347	.160	-1.967	.049
	N of Valid Cases		104			
SP	Ordinal by Ordinal	Gamma	-.196	.205	-.894	.371
	N of Valid Cases		103			
NP	Ordinal by Ordinal	Gamma	-.224	.143	-1.407	.159
	N of Valid Cases		263			

a. Not assuming the null hypothesis.

b. Using the asymptotic standard error assuming the null hypothesis.

Correlations of Sex, Graduation "on-time", Graduation Categories, and Honors Categories

		Sex	Graduation On Time?	How long to graduate with 4 categories	Honors categories for distinction
Sex	Pearson Correlation	1	.139**	.112**	-.127**
	Sig. (2-tailed)		.001	.006	.002
	N	605	605	605	605
Graduation on time?	Pearson Correlation	.139**	1	.876**	-.392**
	Sig. (2-tailed)	.001		.000	.000
	N	605	605	605	605
How long to graduate with 4 categories	Pearson Correlation	.112**	.876**	1	-.425**
	Sig. (2-tailed)	.006	.000		.000
	N	605	605	605	605
Honors categories for distinction	Pearson Correlation	-.127**	-.392**	-.425**	1
	Sig. (2-tailed)	.002	.000	.000	
	N	605	605	605	605

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

Cross-tabulation of Class of 2003 Sex by SAT Quartiles

Sex			SAT Quartiles				Total
			1190 or less	1191-1270	1271-1350	1351 or higher	
	Female	Count	48	43	27	23	141
		% within sex	34.0%	30.5%	19.1%	16.3%	100.0%
		% within SAT quartiles	29.6%	30.3%	18.5%	16.8%	24.0%
	Male	Count	114	99	119	114	446
		% within sex	25.6%	22.2%	26.7%	25.6%	100.0%
		% within SAT quartiles	70.4%	69.7%	81.5%	83.2%	76.0%
Total		Count	162	142	146	137	587
		% within sex	27.6%	24.2%	24.9%	23.3%	100.0%
		% within SAT quartiles	100.0%	100.0%	100.0%	100.0%	100.0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	12.213[a]	3	.007
Likelihood Ratio	12.398	3	.006

a. 0 cells (.0%) have expected count less than 5. The minimum expected count is 32.91.

Symmetric Measures

		Value	Asymp. Std. Error[a]	Approx. T[b]	Approx. Sig.
Ordinal by Ordinal	Gamma	.227	.069	3.234	.001

a. Not assuming the null hypothesis.

b. Using the asymptotic standard error assuming the null hypothesis.

Cross-tabulation of SAT Quartiles and Type of Learners by 4-Year Graduation

Type of Learners				Graduating on time? Yes	Graduating on time? No	Total
SJ	sat quartiles	1190 or less	Count	40	15	55
			% within sat quartiles	72.7%	27.3%	100.0%
			% within grad4yr	43.0%	37.5%	41.4%
		1191-1270	Count	26	8	34
			% within sat quartiles	76.5%	23.5%	100.0%
			% within grad4yr	28.0%	20.0%	25.6%
		1271-1350	Count	21	10	31
			% within sat quartiles	67.7%	32.3%	100.0%
			% within grad4yr	22.6%	25.0%	23.3%
		1351 or higher	Count	6	7	13
			% within sat quartiles	46.2%	53.8%	100.0%
			% within grad4yr	6.5%	17.5%	9.8%
	Total		Count	93	40	133
			% within sat quartiles	69.9%	30.1%	100.0%
			% within grad4yr	100.0%	100.0%	100.0%
NJ	sat quartiles	1190 or less	Count	15	6	21
			% within sat quartiles	71.4%	28.6%	100.0%
			% within grad4yr	24.2%	15.4%	20.8%
		1191-1270	Count	13	12	25
			% within sat quartiles	52.0%	48.0%	100.0%
			% within grad4yr	21.0%	30.8%	24.8%
		1271-1350	Count	12	13	25
			% within sat quartiles	48.0%	52.0%	100.0%
			% within grad4yr	19.4%	33.3%	24.8%
		1351 or higher	Count	22	8	30
			% within sat quartiles	73.3%	26.7%	100.0%
			% within grad4yr	35.5%	20.5%	29.7%
	Total		Count	62	39	101

			% within sat quartiles	61.4%	38.6%	100.0%
			% within grad4yr	100.0%	100.0%	100.0%
SP	sat quartiles	1190 or less	Count	19	19	38
			% within sat quartiles	50.0%	50.0%	100.0%
			% within grad4yr	29.7%	50.0%	37.3%
		1191-1270	Count	20	5	25
			% within sat quartiles	80.0%	20.0%	100.0%
			% within grad4yr	31.3%	13.2%	24.5%
		1271-1350	Count	8	6	14
			% within sat quartiles	57.1%	42.9%	100.0%
			% within grad4yr	12.5%	15.8%	13.7%
		1351 or higher	Count	17	8	25
			% within sat quartiles	68.0%	32.0%	100.0%
			% within grad4yr	26.6%	21.1%	24.5%
	Total		Count	64	38	102
			% within sat quartiles	62.7%	37.3%	100.0%
			% within grad4yr	100.0%	100.0%	100.0%
NP	sat quartiles	1190 or less	Count	26	22	48
			% within sat quartiles	54.2%	45.8%	100.0%
			% within grad4yr	19.7%	18.5%	19.1%
		1191-1270	Count	24	34	58
			% within sat quartiles	41.4%	58.6%	100.0%
			% within grad4yr	18.2%	28.6%	23.1%
		1271-1350	Count	41	35	76
			% within sat quartiles	53.9%	46.1%	100.0%
			% within grad4yr	31.1%	29.4%	30.3%
		1351 or higher	Count	41	28	69
			% within sat quartiles	59.4%	40.6%	100.0%
			% within grad4yr	31.1%	23.5%	27.5%
	Total		Count	132	119	251
			% within sat quartiles	52.6%	47.4%	100.0%
			% within grad4yr	100.0%	100.0%	100.0%

Chi-Square Tests

Type of Learners		Value	df	Asymp. Sig. (2-sided)
SJ	Pearson Chi-Square	4.461[a]	3	.216
	Likelihood Ratio	4.173	3	.243
NJ	Pearson Chi-Square	5.519[b]	3	.138
	Likelihood Ratio	5.575	3	.134
SP	Pearson Chi-Square	6.308[c]	3	.098
	Likelihood Ratio	6.537	3	.088
NP	Pearson Chi-Square	4.319[d]	3	.229
	Likelihood Ratio	4.331	3	.228

a. 1 cells (12.5%) have expected count less than 5. The minimum expected count is 3.91.

b. 0 cells (.0%) have expected count less than 5. The minimum expected count is 8.11.

c. 0 cells (.0%) have expected count less than 5. The minimum expected count is 5.22.

d. 0 cells (.0%) have expected count less than 5. The minimum expected count is 22.76.

Symmetric Measures

Type of Learners			Value	Asymp. Std. Error[a]	Approx. T[b]	Approx. Sig.
SJ	Ordinal by Ordinal	Gamma	.195	.146	1.289	.197
	N of Valid Cases		133			
NJ	Ordinal by Ordinal	Gamma	-.061	.146	-.418	.676
	N of Valid Cases		101			
SP	Ordinal by Ordinal	Gamma	-.211	.155	-1.347	.178
	N of Valid Cases		102			
NP	Ordinal by Ordinal	Gamma	-.117	.094	-1.246	.213
	N of Valid Cases		251			

Cross-tabulation of SAT Quartile and Type of Learners by How Long to Graduate

Types of Learners				How long to graduate with 4 categories: 4 years or less	more than 4, less than 5	5 years	not "yet" graduated	Total
SJ	sat quartiles	1190 or less	Count	41	5	1	8	55
			% within sat quartiles	74.5%	9.1%	1.8%	14.5%	100.0%
		1191-1270	Count	26	2	1	5	34
			% within sat quartiles	76.5%	5.9%	2.9%	14.7%	100.0%
		1271-1350	Count	22	1	2	6	31
			% within sat quartiles	71.0%	3.2%	6.5%	19.4%	100.0%
		1351 or higher	Count	6	1	0	6	13
			% within sat quartiles	46.2%	7.7%	.0%	46.2%	100.0%
	Total		Count	95	9	4	25	133
			% within sat quartiles	71.4%	6.8%	3.0%	18.8%	100.0%
NJ	sat quartiles	1190 or less	Count	15	3	0	3	21
			% within sat quartiles	71.4%	14.3%	.0%	14.3%	100.0%
		1191-1270	Count	13	1	1	10	25
			% within sat quartiles	52.0%	4.0%	4.0%	40.0%	100.0%
		1271-1350	Count	13	2	3	7	25
			% within sat quartiles	52.0%	8.0%	12.0%	28.0%	100.0%
		1351 or higher	Count	22	1	0	7	30
			% within sat quartiles	73.3%	3.3%	.0%	23.3%	100.0%
	Total		Count	63	7	4	27	101
			% within sat quartiles	62.4%	6.9%	4.0%	26.7%	100.0%
SP	sat quartiles	1190 or less	Count	19	2	3	14	38
			% within sat quartiles	50.0%	5.3%	7.9%	36.8%	100.0%
		1191-1270	Count	21	0	1	3	25
			% within sat quartiles	84.0%	.0%	4.0%	12.0%	100.0%
		1271-1350	Count	8	2	2	2	14
			% within sat quartiles	57.1%	14.3%	14.3%	14.3%	100.0%

		1351 or higher	Count	17	2	1	5	25
			% within sat quartiles	68.0%	8.0%	4.0%	20.0%	100.0%
	Total		Count	65	6	7	24	102
			% within sat quartiles	63.7%	5.9%	6.9%	23.5%	100.0%
NP	sat quartiles	1190 or less	Count	27	1	2	18	48
			% within sat quartiles	56.3%	2.1%	4.2%	37.5%	100.0%
		1191-1270	Count	24	8	3	23	58
			% within sat quartiles	41.4%	13.8%	5.2%	39.7%	100.0%
		1271-1350	Count	42	3	2	29	76
			% within sat quartiles	55.3%	3.9%	2.6%	38.2%	100.0%
		1351 or higher	Count	41	3	2	23	69
			% within sat quartiles	59.4%	4.3%	2.9%	33.3%	100.0%
	Total		Count	134	15	9	93	251
			% within sat quartiles	53.4%	6.0%	3.6%	37.1%	100.0%

Chi-Square Tests

Types of Learners		Value	df	Asymp. Sig. (2-sided)
SJ	Pearson Chi-Square	10.314[a]	9	.326
	Likelihood Ratio	9.265	9	.413
NJ	Pearson Chi-Square	13.375[b]	9	.146
	Likelihood Ratio	13.791	9	.130
SP	Pearson Chi-Square	12.965[c]	9	.164
	Likelihood Ratio	13.689	9	.134
NP	Pearson Chi-Square	11.265[d]	9	.258
	Likelihood Ratio	10.261	9	.330

a. 9 cells (56.3%) have expected count less than 5. The minimum expected count is .39.

b. 8 cells (50.0%) have expected count less than 5. The minimum expected count is .83.

c. 9 cells (56.3%) have expected count less than 5. The minimum expected count is .82.

d. 8 cells (50.0%) have expected count less than 5. The minimum expected count is 1.72.

Symmetric Measures

Types of Learners			Value	Asymp. Std. Error[a]	Approx. T[b]	Approx. Sig.
SJ	Ordinal by Ordinal	Gamma	.212	.137	1.481	.139
NJ	Ordinal by Ordinal	Gamma	-.036	.132	-.276	.783
SP	Ordinal by Ordinal	Gamma	-.222	.143	-1.549	.121
NP	Ordinal by Ordinal	Gamma	-.078	.085	-.916	.360

a. Not assuming the null hypothesis.

b. Using the asymptotic standard error assuming the null hypothesis.