WORCESTER POLYTECHNIC INSTITUTE

Change in Academic Motivation at WPI

An Interactive Qualifying Project Report
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by

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Abstract:

This project analyzed the change in academic motivation for 200 students from WPI based on data obtained from the Wabash National Study of Liberal Arts Education (WNS). This report identified factors which influence a student's change in academic motivation and examined the validity of the Academic Motivation Scale in the WNS. Academic motivation decreased over freshman year in these 200 students. It decreased further in the 17 students who retook the scale in 2011. Male students were more likely to decrease in academic motivation than female students. There was a relationship between the change in academic motivation and student-faculty interactions. Intrinsic motivation in the 200 students had a significantly greater decrease than extrinsic motivation.

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1 Executive Summary

This report explored motivation in education and examined its change in the first-year students at WPI. The data was collected from the Wabash National Study of Liberal Arts Education (WNS); WPI freshmen participated in this study in the fall of 2008 and spring of 2009. The students' academic motivation was defined as their score on the Academic Motivation Scale in the WNS.

The key classifications of motivation in education used in this report are defined below, taken from *Self-Determination Theory* by E. Deci and R. Ryan. Academic motivation could be divided into the following two classes:

- **Intrinsic motivation** is defined as an individual's innate drive to participate in a task in the absence of reward/punishment. For example, a student does more reading in a class than is required simply because it interests him/her; then the student is intrinsically motivated by his/her interest in learning.

- **Extrinsic motivation** is an individual's drive to participate in a task when there are external rewards or consequences. For example, if a student works hard in a class because he/she wants to get a good grade, the student is extrinsically motivated by the external factor of the grade.

The Academic Motivation Scale contains a set of eight questions, on the scale of 1 to 5. Each student's academic motivation score was calculated by taking the average of these eight questions. The academic motivation score ranged from 1(low motivation) to 5(high motivation). The questions in the scale were completed twice by the students, once at the beginning of their freshman year and once at the end of their freshman year. Their change in academic motivation was the difference between these two scores.

A total of 731 WPI freshmen participated in the first round of the WNS in the fall of 2008 (denoted as T1). Of the 731 students, 200 returned to participate in the second round at the end of their freshman year in the spring of 2009 (denoted as T2). It should be noted that only these 200 students' data provide information about the changes from T1 to T2. Within these 200 students, 27.5% (55 students) had an increase in academic motivation, 64.5% (129 students) had a decrease and 8% (16 students) had no change. This trend was not unique to WPI - from the 19

institutions that participated in the 2006 WNS, 27% of students had an increase, 66% had a decrease and 7% had no change (Center of Inquiry, 2009).

Only considering the 200 students who returned for the second round of the WNS, the average academic motivation was 3.68 at T1 and 3.45 at T2, thus the change was -0.23.

For our analysis, the "Academic Motivation Scale" was grouped into 2 different sets: three questions that measured *extrinsic motivation* and five that measured *intrinsic motivation*. By this classification, the 200 students had a change of -0.32 in intrinsic motivation. In contrast, their extrinsic motivation had a very small change at -0.09.

Table 1 below summarizes this basic information.

Average Academic Motivation	Number of Students	T1	T2	Change
Academic Motivation (8 questions)	731	3.63	-	-
Academic Motivation (8 questions)	200	3.68	3.45	-0.23
Extrinsic Academic Motivation (3 questions)	200	3.97	3.88	-0.09
Intrinsic Academic Motivation (5 questions)	200	3.49	3.17	-0.32

Table 1: Basic Information of Academic Motivation

From the data above, a statistical analysis was done on the 200 students and the following results were found:

- There was a relationship between how the students view the faculty and their change in academic motivation over freshmen year. This result came from correlation tests done on students' academic motivation and their responses to a set of 28 questions asking about the faculty.

- There was a weak relationship between gender and change in academic motivation. In the 184 students whose academic motivation changed, 102 were male (25 increased, 77 decreased), 82 were female (30 increased, 52 decreased). There were 5 more males who decreased than expected and 5 more females who increased than expected.

As part of this IQP, an additional Academic Motivation Scale survey was given in the spring of 2011 (denote this time as T3) to 17 of the 200 students. Subsequently, a focus group session was held with these 17 students in order to gain perspective on their opinion regarding academic motivation. The average change in academic motivation of the 17 students was -0.117

from T2 to T3. This was attributed to 2 of the 17 students having a decrease greater than or equal to -1. Disregarding these 2 students, an average change of 0.02 from T2 to T3 was observed. This was in accordance with change in academic motivation observed in the 19 institutions which participated in the 2006 WNS.

During the focus group sessions, there was a general consensus among the 17 participating students on two issues:

- Freshman year courses on basic math and science were detrimental to their academic motivation they were too broad and impractical to hold their attention (this can be backed up by the data with the decrease in intrinsic motivation over freshman year).
- Once they began taking courses that were related to their major in sophomore and junior year, their motivation increased.

Our report used background literature reviews to study academic motivation and statistical tools such as Chi-square tests and correlations to explore possible causes behind the change in academic motivation. There was a decrease among WPI students in academic motivation over freshman year, with intrinsic motivation decreasing more than extrinsic motivation. The most significant results were more males decreased in motivation than expected and there was a strong correlation between how students viewed faculty and their change in academic motivation.

2 Introduction

The Wabash National Study of Liberal Arts Education (WNS) is a collection of surveys and tests taken by students that aim to assess the quality of their college experience. It compares individual students' responses at three different times in their college career. Even though this study is primarily designed for liberal arts institutions, it can be useful to WPI to identify academic practices which contribute to student engagement and learning and those which need improvement.

WPI's class of 2012 participated in the WNS in 2008. They completed the first round of the study in August 2008, the second round in April 2009, and are scheduled to complete the third round in the spring of 2012. Their responses to the tests and survey questions were collected and organized by the WNS.

The WNS defines 26 "scales" by grouping questions that measure levels of interest or engagement in specific areas. These scales include Openness to Diversity/Challenge, Political Involvement, Importance of Contribution to Arts/Sciences, Academic Motivation, etc.

The research presented in this report focuses on the Academic Motivation Scale. This scale includes 8 questions which ask the student to indicate the extent to which they agree or disagree with a statement. For each student, the average of his/her responses to these 8 items was defined as his/her academic motivation score.

This project compared the academic motivation score obtained from this scale with various student background and academic factors to determine any significant relationships. It also reviewed the results from focus group discussions that were held with participants of the WNS to find out how they believed their motivation had changed and what factors attributed to the change.

3 Background Information

3.1 About the Wabash National Study

The WNS is a multi-university study which analyzes factors that affect the outcome of a Liberal Arts education. The two fundamental goals of WNS are (Center of Inquiry, 2009):

- To learn what teaching practices, programs, and institutional structures support liberal arts education.
- To develop methods of assessing liberal arts education.

The WNS is a survey and test based longitudinal study which has been administered at 49 different institutions between 2006 and 2011. The study was developed by the Center of Inquiry at Wabash College in Indiana with the aim of aiding insitutions in improving student learning and enhancing the scholastic impact of their program (Center of Inquiry, 2009). The study has been supported by generous donations from:

- Lilly Endowment Inc., an Indiana-based charitable organization created in 1937 that puts special emphasis on projects aimed at the development of financial self-sufficiency and promote leadership education that benefit young people.
- Teagle Foundation, an organization established in 1944 by Walter C. Teagle (former president of Exxon Mobil Corporation) that utilizes the financial and intellectual resources necessary to promote challenging and enriching college education for students.
- Davis Educational Foundation, a public philanthropic organization founded in 1985 which supports various undergraduate programs in colleges located in New England. The Davis Educational Foundation funded the study for WPI in 2008.

The Center of Inquiry collaborates with institutions in order to strengthen liberal arts education and, until recently, the WNS has been the primary mechanism they have used to achieve this goal. Building on the findings of the WNS, the Center of Inquiry has commenced a new study titled “Wabash Study 2010”. This new study, which lasts for three years, will come with a few additional improvements that take into account the participant’s work in college, standardized tests (SAT, ACT, Compass) along with their results on the surveys. In this new study, the results will be actively implemented to make changes to the participating institutions.

The WNS focuses on the development of seven outcomes that are observed from a liberal arts education and inspects the educational factors that nurture these outcomes. These outcomes are (Center of Inquiry, 2009):

- Critical thinking
- Need for cognition
- Interest in diversity
- Attitudes toward diversity
- Leadership
- Moral reasoning
- Well-being

Considering these key outcomes, the WNS explores the extent to which students grow as a result of their college experiences, the conditions that contribute to their development, and ways that institutions can more readily assess and act on this knowledge for a better impact of the undergraduate education.

The WNS is a longitudinal study; this means that it uses repeated observations of the same group of subjects over an extended period of time. The WNS investigates the same group of students for four years, surveying them a total of three times and tracks individual changes over the period.

3.2 The WNS Compared to Other Educational Assessment Tools

There are several educational assessment tools used by institutions today to measure qualities of their students or programs. Some of the major assessment tools are the Collegiate Learning Assessment (CLA), surveys from Educational Benchmarking, Inc. (EBI), and the National Survey of Student Engagement (NSSE). These assessment tools are all similar in that each uses samples of students and curricula and seeks to provide information that can be used to improve the quality of education.

3.2.1 CLA

The CLA was first administered in 2002, and more than 500 institutions have already participated till 2011. Similar to the WNS, the CLA is a longitudinal study, meaning it tracks individual student progress over an extended period of time. A unique feature of the CLA is that "it uses direct measures of student learning rather than proxies for it; typical proxies include input or actuarial data (e.g., entrance examination scores or faculty salaries), student self-assessments of growth, or college faculty and administrator opinion surveys" (Benjamin, 2003). It aims to assess the curriculum through open-ended questions to allow the student more freedom in expressing their response when compared to multiple-choice questions.

The CLA does not focus on discipline-specific content but on general learning skills such as critical thinking, analytical reasoning, and written communication skills (Benjamin, 2003). One of the main foci of the CLA is to determine the students' growth in their practical skills regardless of the institutions which they attend. One way it assesses practical knowledge is by using the two different Analytical Writing Measures that are in the Graduate Record Examination.

By focusing on general education, CLA compares many institutions across different academic disciplines. Its goal is to determine the similarities and differences between educational programs offered at participating institutions and use them to improve the educational system at each school.

3.2.2 EBI

EBI was established in 1996 to compare management schools. It has grown to evaluate over 1300 institutions across several disciplines, while delivering over 12,000 customized reports. The EBI uses an additional technique to analyze institutions: it asks students in each institution about their opinion on satisfaction levels of students from three other "peer schools" (EBI, 2011). For example, a student from WPI might get the following question:

"How happy/satisfied do you think the students are at Holy Cross?"

One unique aspect of EBI is that it offers evaluations based on the type of school that is being analyzed. These include programs specific to Teacher Education, Nursing Education, Engineering Education and Management Education. By having specialized programs, EBI provides a more extensive comparison between two "peer" institutions. Another feature of EBI is that it collaborates with the Association of College and University Housing Officers International (ACUHO-I) to provide schools with student perspective on housing.

3.2.3 NSSE

The NSSE is the largest assessment tool in use as of 2011. It has had over 1400 participating institutions since 2000 and over 2 million students have completed it (NSSE, 2011). Unlike the WNS or EBI, which tend to keep results private, NSSE is public with most of its findings. For example, it posts a journal titled "Annual Results", in which it publishes combined trends and statistics from participating institutions. NSSE also administers the Beginning College Survey of Student Engagement (BCSSE) and the Faculty Survey of Student Engagement (FSSE).

The BCSSE aims to evaluate (NSSE, 2011):

- First-year students' pre-college academic and co-curricular experiences.
- Students' attitudes towards participating in educationally purposeful activities during their first year.

The FSSE aims to evaluate (NSSE, 2011):

- Faculty perceptions of how often students engage in different activities.
- The importance faculty place on various areas of learning and development.
- The nature and frequency of faculty-student interactions.
- How faculty members organize their time, both in and out of the classroom.

Results from NSSE findings have been published numerous times and have been referenced in college assessment journals nationwide, making it the most well-known educational assessment tool available to colleges and universities (NSSE, 2011). In contrast with the WNS, the NSSE does not keep track of individual student progress, but rather seeks general results from students at each institution.

3.3 Participating Institutions in the Study

Each institution's students participate in the WNS a total of three times: shortly before their first semester, at the end of their freshman year and at the end of their senior year. The timeline of the study is shown in Figure 1 (Center of Inquiry, 2009).

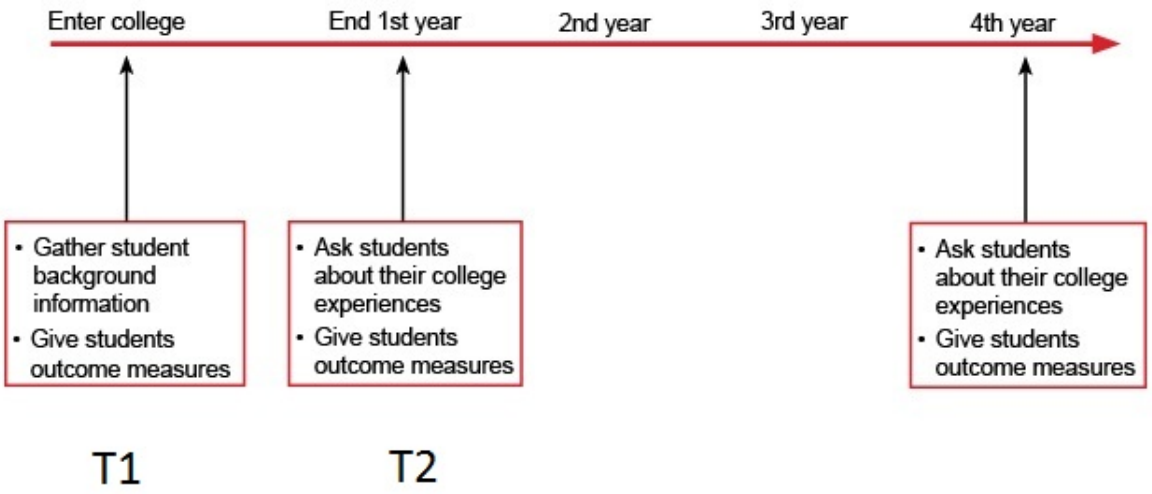

Figure 1: Wabash Time Line

Students at WPI participated in the first round of the study in the fall of 2008, which we labeled T1. The second round of the survey happened in the spring of 2009, which we labeled T2 (as shown in Figure 1).

3.3.1 The WNS in 2006

The WNS was launched in the fall of 2006 with 19 institutions including small liberal arts colleges, community colleges and universities (universities are defined by institutions with graduate/Ph.D. programs). The list of these institutions is provided below (Center of Inquiry, 2009).

Small Colleges:

- Alma College
- Bard College
- Coe College
- Columbia College (SC)
- Connecticut College
- Gustavus Adolphus College
- Hamilton College
- Hampshire College
- Hope College
- Wabash College
- Whittier College

Community Colleges:

- Ivy Tech Community College
- Kirkwood Community College

Universities:

- Butler University
- San Jose State University
- University of Kentucky
- University of Michigan
- University of North Carolina Wilmington
- University of Notre Dame

Approximately 60 students were selected and interviewed from some of these institutions in order to better understand the ways educational experiences affect students' achievement and see how the students interpret their educational experiences. These interviews were both open-ended and structured, enabling the participating students to recount their experiences as they see fit while relating them to the study. The interviews ran for about 90 minutes for each student.

The students had been interviewed three times as well as surveyed in order to develop hypotheses to test against the quantitative component of the study.

3.3.2 The WNS in 2007

The following institutions joined the study in the fall of 2007. Two institutions already in the study, Wabash College and Hampshire College, started a new round of the WNS with a freshman class.

Small Colleges:

- Allegheny College
- Franklin College
- Hampshire College
- Vassar College
- Wabash College

Universities:

- Delaware State University
- Fairfield University
- North Carolina Agricultural and Technical State University
- University of Rhode Island

3.3.3 The WNS in 2008

This is the year WPI entered the study.

Small Colleges:

- Alverno College
- Augustana College
- Bard College at Simon's Rock
- Bennington College
- Blackburn College
- Carleton College
- College of the Holy Cross
- Hampshire College
- Hobart and William Smith Colleges
- Lasell College
- Marlboro College
- New College of Florida
- Oxford College of Emory University
- Prescott College
- Ripon College
- Wabash College
- Warren Wilson College

- Wheelock College

Community Colleges:

- Community College of Rhode Island

Universities:

- Brandeis University
- Drew University
- Millersville University
- Salem State College
- University of Rhode Island
- Worcester State College
- **Worcester Polytechnic Institute**

3.4 Instruments Used by the WNS

The WNS uses a number of different assessment tools as well as students' information provided by the individual institutions. During the summer before the study, all of the participating institutions give general information on each incoming freshman. This information includes high school credits, transcripts, college credits earned and enrollment as a transfer or graduate student.

During the first round of the study, the institutions provide some specific information about each student such as race, gender, financial aid, major and test scores (ACT, SAT, Compass). This is also the first time when students complete the items listed below: (Center of Inquiry, 2009)

1. **Registration Form**: provides information such as demographics, high school experience and family information.

2. **Wabash National Study Student Survey**: asks beginning views on topics such as diversity, politics, life/career goals, academic motivation and attitude toward reading. It also provides information on the student's health issues such as smoking, drinking, exercise and sleep habits.

3. **Wabash National Study Student Assessment**: assesses student's leadership role (via *Social Responsibility Leadership Scale*), intercultural development (via *Miville-Guzman Universality Diversity Scale*), well-being (via *Ryff Psychological Scales of Well-being*) and the need for cognition.

4a. **ACT's Collegiate Assessment of Academic Proficiency, Critical Thinking (CAAP)**: assesses student's critical thinking skills through use of standardized problem sets.

-or-

4b. **Defining Issues Test**: assesses student's level of moral reasoning via a test created by the University of Minnesota.

In the second round (at the end of freshman year), the Wabash National Student Assessment (number 3 above), CAAP (number 4a above) or the Defining Issues test (number 4b above) are completed again. In addition, the students complete another set of items that focus on their first year college experiences. The list of items is as follows:

1. **Wabash National Study Student Experiences Survey**: asks about the students' curricular and co-curricular experiences, experiences with peers and faculty, perceptions relating to "*Good Practices*" and questions from the Student Survey, listed above.

2. **National Survey of Student Engagement (NSSE)**: asks about the activities the students were involved in, how the students spent their time and related to the NSSE benchmarks and Deep Learning Scale.

Wabash College performed their own analysis of the results of the first year (from T1 to T2) WNS in 2006 and recorded their findings as "Outcomes and Performance Measures". They observed that, over the first year, students did not change as much as university faculty expected. The largest change was in the level of Moral Reasoning determined by the Defining Issues Test which showed a 10% increase on average. (Center of Inquiry, 2009).

3.5 WPI in the WNS

The WNS is designed to investigate factors that affect the outcome of liberal arts education (Center of Inquiry, 2009). A liberal arts education is defined as an approach to learning that empowers individuals and prepares them to deal with complexity, diversity, and change. It provides students with broad knowledge of the wider world (e.g., science, culture, and society) as well as in-depth study in a specific area of interest (AACU, 2011). The Center of Inquiry mentions three specific conditions that must exist in an institution to facilitate liberal arts education (C. Blaich, 2004). These are given below:

1. An institutional ethos and tradition that place a greater value on developing a set of intellectual arts than on developing professional or vocational skills.
2. Curricular and environmental structures that work in combination to create coherence and integrity in students' intellectual experiences.
3. An institutional ethos and tradition that place a strong value on student-student and student-faculty interactions both in and out of the classroom.

To clarify, it means that institutions offering a liberal arts education should focus on creating intellectual breadth and enhancing student-student and student-faculty interactions. Now we can explain how WPI meets two of these three general criteria and provides a liberal arts education, thus meriting its place in the WNS.

We compared the Chemical Engineering program at WPI with RPI, a technical institution of similar standing to WPI. It should be noted that Chemical Engineering is one of the strictest majors offered at WPI. As of the academic year 2010-2011, RPI had a Chemical and Biological Engineering program requiring each student to take 39 semester-long courses, of which only 3 were free electives and 3 were area electives in Engineering and Chemistry (RPI Catalog, 2011). The required number of credits for graduation was 135. Only 32 credits could count as a combination of free electives and humanities and arts electives. In contrast, WPI Chemical Engineering had 39 credits in free electives, humanities and arts electives and an Interactive Qualifying Project. By this comparison, WPI allows students to select two more classes outside of their major, allowing students to develop their intellectual breadth, which is one of the three essential conditions that should exist to facilitate a liberal arts education (C. Blaich, 2004).

A liberal arts education strongly hinges on good student-faculty interaction (C. Blaich, 2004). The average class size at WPI is only 15-25 students (WPI, 2011). A smaller class size facilitates student-faculty interactions, thus fulfilling another condition for a liberal arts education.

Results from the following questions were taken from the WNS at T1. This was done to compare WPI students with students from the 7 other universities in the 2008 WNS in terms of how they perceived their faculty.

"My academic experiences (i.e, courses, labs, studying, and discussions with faculty) will be the most enjoyable part of college."

WPI had an average of 3.02/5 for this question, which was higher than the average of 2.91/5 for the 7 other small universities in the WNS in 2008.

For the following question, WPI students had a similar response to the 7 other universities in the WNS in 2008.

"In high school, I frequently talked to my teachers outside of class about ideas presented during class."

WPI had an average of 3.30/5 for this question, which is slightly higher than the average for the 7 other universities, which was 3.27/5.

To conclude, while WPI does offer technical majors, the manner in which the classes at WPI are structured enhances liberal arts education. By offering students opportunities to explore various areas of study and maintaining an excellent student-faculty relationship, WPI enables its students to develop a range of intellectual skills which is the goal of a liberal arts education.

3.6 Usefulness of WNS to WPI

Because WPI offers graduate degrees, it is classified as a university by the WNS. This puts WPI in contrast to most of the participating institutions in the WNS. However, there are various scales in the WNS which can be beneficial to any institution offering undergraduate degrees, including WPI. For this project, data collected from the Academic Motivation Scale for WPI students was analyzed in detail. A brief overview of some WNS scales and the way in which they relate to WPI is provided in this section.

3.6.1 Openness to Diversity and Challenge Scale

This is very similar to the Academic Motivation Scale. It contains 7 questions which ask the students to indicate their level of agreement on a 1 to 5 scale (1=strongly disagree, 5=strongly agree). It includes questions measuring the students' openness to cultural and racial diversity as well as the extent to which they enjoy being challenged by different perspectives, values, and ideas (Center of Inquiry W. C., 2009). This can be a very useful scale for WPI. As of

2011, 9% of WPI students were international students, and 17% of WPI students had multicultural backgrounds (WPI, 2011). This means that there is cultural and racial diversity in WPI, and thus student attitudes about diversity is a key factor to study. Example questions from this scale are provided below.

"Learning about people from different cultures is a very important part of my college education."

"I enjoy having discussions with people whose ideas and values are different from my own."

3.6.2 Contribution to the Sciences Scale

This is a part of the Life Goals Scales in WNS Student Surveys. It contains 2 questions which ask the students to indicate their level of agreement on a 1 to 4 scale (1=low, 4=high). For this scale, the students identify how important it is to them to contribute to the advancement of the sciences (Center of Inquiry W. C., 2009). As of 2011, 81% of WPI students majored in a field of Engineering, Biology, or Computer Science, which makes this scale another important measure of how interested WPI students are in making advancements in their field of study (Collegeboard, 2011). The two questions from this scale are provided below.

"Making a theoretical contribution to science."

"Working to find a cure for a disease or illness."

3.6.3 Need for Cognition Scale

The Need for Cognition Scale measures how much people enjoy engaging in effortful cognitive activities (Center of Inquiry W. C., 2009). This contains 18 questions which require students to indicate their level of agreement on a 1 to 5 scale. Example questions from this scale are provided below.

"I really enjoy a task that involves coming up with new solutions to problems."

"*I would prefer a task that is intellectual, difficult, and important to one that is somewhat important but does not require much thought."*

4 Academic Motivation

The WNS defines academic motivation as

"Students' interest in working hard, getting good grades, and engaging in challenging, intellectual material." (Center of Inquiry W. C., 2009)

This definition does not capture the full concept of academic motivation and the factors that cause it to change in college students. This section encases some of the findings of extensive research done by Edward L. Deci and Richard M. Ryan at the University of Rochester on Self-Determination Theory (SDT).

SDT suggests that conditions supporting an individual's experience of *autonomy*, *competence* and *relatedness* tend to foster the best forms of motivation and engagement for activities, including enhanced performance, persistence and creativity (Self-Determination Theory, 2008). The three essential elements of SDT are (Vansteenkiste & Deci, 2004):

1. Humans are inherently proactive with their potential and mastering their inner forces (such as drives and emotions).
2. Humans have an inherent tendency toward growth development and integrated functioning.
3. Optimal development and actions are inherent in humans but they don't happen automatically.

The underlying work behind this also proceeds to clarify the concept of the different classes of motivation.

4.1 Types of Motivation

Motivation in education can be divided into three classes:

- ***Intrinsic Motivation***

  This stems from a personal enjoyment in completing a coursework. Someone who is intrinsically motivated will do a task for personal satisfaction attained from it and not for external rewards/punishments. Most human activities are driven by external factors for satisfying basic needs. However, we are often moved to act for the fun and challenge presented in the task even if it does not offer any rewards (Ryan & Deci, 2000).

The psychological phenomenon of intrinsic motivation was first identified in experimental studies of animal behavior in 1959 by Robert W. White (White, 1959). White referred to it as *effectance motivation*, concluding from his findings that organisms have an innate need to experience competence and will thus engage in new behaviors to experience joy in the absence of reinforcements or punishments. Reinforcement is defined as a positive response to the completion of a task and a punishment is defined as a negative response.

Cognitive Evaluation Theory (CET), a sub-theory of SDT introduced by Deci and Ryan in 1985, has focused on determining social and environmental factors that facilitate intrinsic motivation and factors that undermine it. CET asserts that events that facilitate an individual's feeling of competence help enhance intrinsic motivation if the individual feels a sense of autonomy. This means that if an individual does something at which he/she excels in absence of external rewards/punishment, the task has a positive effect on his/her intrinsic motivation.

CET asserts that intrinsic motivation is negated by control with external rewards and punishments, as they shift an individual's focus from an internal perceived locus of causality to an external perceived locus of causality (Deci E. , 1971). This means that if an intrinsically motivated person is offered an external reward/punishment for completion of a task, his/her motivation switches from being intrinsic to extrinsic. This inference has been confirmed with a series of meta-analytical reviews of 128 studies in 1999 (Deci, Ryan, & Koestner, 1999). Tangible rewards tend to have a negative effect on intrinsic motivation, even when offered in response to good performance. These rewards typically decrease intrinsic motivation for interesting activities and forestall self-regulation (Deci, Ryan, & Koestner, 1999).

- ***Extrinsic Motivation***

This stems from external factors influencing the individual to complete a task. An extrinsically motivated person will work on a task in which he/she has no inherent interest simply for the anticipated satisfaction received from its reward. In spite of the importance of intrinsic motivation, most activities which people perform are extrinsic-motivation-driven. As a person ages, freedom to be intrinsically motivated is increasingly

curtailed by social demands and roles that require individuals to assume responsibility for non-intrinsically interesting tasks (Ryan & Deci, 2000).

It used to be thought that extrinsic motivation was always non-autonomous. However, research on SDT has proposed that extrinsic motivation can vary greatly in the degree to which it is autonomous, and that extrinsic motivation in individuals can be internalized and integrated to give the individual a better sense of autonomy. Internalization is the process of accepting a value or regulation. Integration is the process by which individuals transform an external regulation into their own so that it will emanate from their sense of self (Ryan & Deci, 2000).

Within SDT a second sub-theory, referred to as Organismic Integration Theory (OIT), has been introduced to describe the different forms of extrinsic motivation and the factors that either promote or hinder the regulation for these behaviors (Ryan & Deci, 1985). Four different classes of extrinsic motivation are defined by OIT with varying degrees of autonomy experienced by the individual.

- ***Amotivation***

This leads to actions that are influenced neither by intrinsic needs or extrinsic factors (Ryan & Deci, 1985). An amotivated person's behavior lacks intentionality and a sense of personal causation. Amotivation results from not valuing an activity, not feeling competent to do it, or not believing that the activity will yield a desired outcome. (Ryan & Deci, 2000) In other words, amotivation is a lack of motivation.

4.2 Intrinsic Motivation

Intrinsic motivation can be subdivided into three sub-classes (Vallerand & Pelletier, 1992):

Intrinsic Motivation to know:

This particular type of intrinsic motivation is important to educational research. This concept explores the individual's intrinsic need to learn for the satisfaction of understanding or exploring something new (Vallerand & Pelletier, 1992). For example, a student who reads more than is required for a class simply to learn something new is intrinsically motivated to know.

Intrinsic Motivation toward accomplishment:

This is defined as engaging in a task for the satisfaction experienced when one attempts to accomplish or create something. People interact with the environment to feel competent, and to create accomplishments. This is also known as "mastery motivation" (Harter, 1981). A person who is intrinsically motivated towards accomplishment would paint in his/her free time so that he/she feels a sense of accomplishment.

Intrinsic Motivation to experience stimulation:

This is closely related to the concept of intrinsic motivation to know. It is the motivation for an individual to engage in activities simply for the stimulation or interest it creates in him/her. An example would be a student who regularly attends philosophy class for the enjoyment he/she derives from stimulating discussions about religion.

4.3 Extrinsic Motivation

Extrinsic motivation can be divided into four sub-classes:

External Regulation:

This is the least autonomous of extrinsic motivation. Activities performed due to external regulation hold no significance to the individual. They are performed in order to obtain external rewards or avoid punishments. This is the type of extrinsic motivation that was typically contrasted with intrinsic motivation in early lab studies and discussions (Ryan & Deci, 2000). An example would be a student being forced to study by his/her parents in order to avoid being grounded.

Introjected Regulation:

With introjected regulation, an individual begins to internalize the reasons behind his/her activity. An individual may act in order to enhance or maintain self-esteem even when he/she has no intrinsic interest in the task. So in spite of the regulation being internal, this is still quite controlling because the person performs the task to avoid consequences of not performing the task. A student who studies because he/she feels that is what good students are supposed to do would exemplify this.

Identified Regulation:

This regulation offers greater autonomy to an individual. Even though the motives behind the individuals actions are still external, the individual has identified those actions as necessary for him/her and accepted the regulation as his/her own (Ryan & Deci, 2000). This is very similar to integrated regulation.

Integrated Regulation:

This, being the most autonomous of extrinsic motivation, occurs when identified regulations are assimilated to an individual. Actions regulated by this are still extrinsic, but they are self-determined and not conflicted. An example of this would be a student studying because getting a good grade is important to him/her.

4.4 Self-Determination Continuum

With the definitions in 3.2 and 3.3, Figure 2 provides a visual representation of the self-determination continuum.

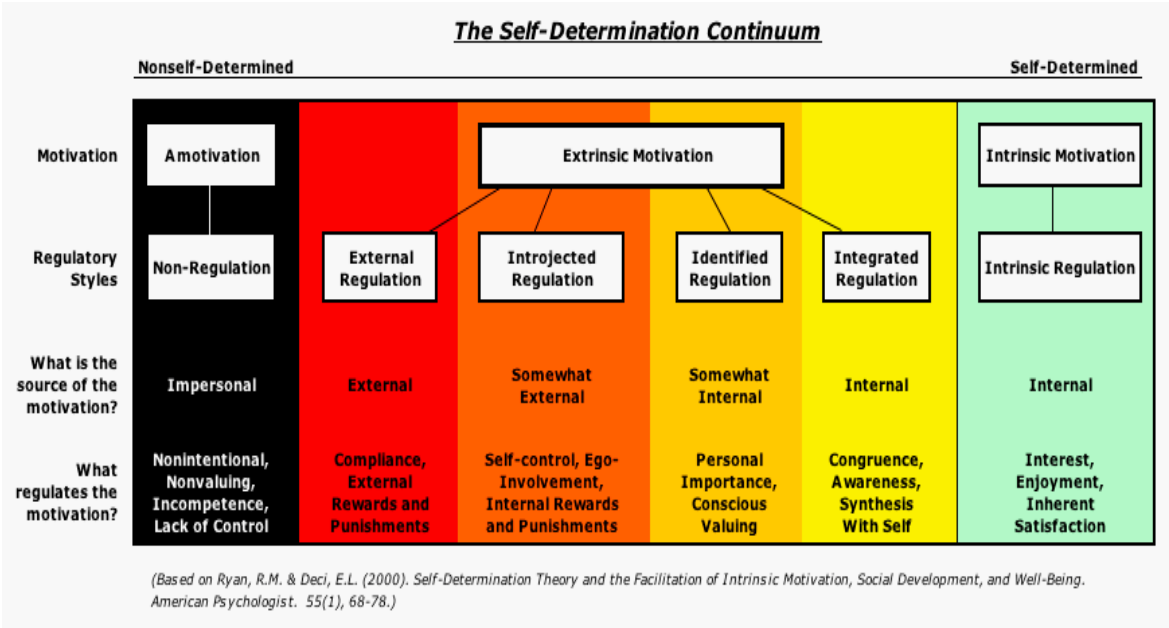

Figure 2: The Self-determination Continuum

Self-determined individuals on average are more likely to be able to think creatively and be driven to succeed. They also require less regulation by external factors and are therefore more autonomous.

To explain the importance of self-determination, a famous social experiment was done in the field of psychology known as the "Candle Problem". This experiment was designed by the German psychologist Karl Duncker and performed for the first time in 1945. The original purpose of the experiment was to show the adverse effects of "functional fixedness" on an individual's problem solving skills. Functional fixedness is when an individual is unable to find a new use for a tool provided to solve a given problem due to its previous use.

In the candle problem, a group of individuals is given the following tools on a table:

- A candle
- A book of matches
- A box of thumbtacks

The goal is to light the candle and successfully attach the candle to the wall next to the table and not let the candle wax drip onto the table. A visual representation of the problem presented to the individuals is provided below. (Pink, 2009)

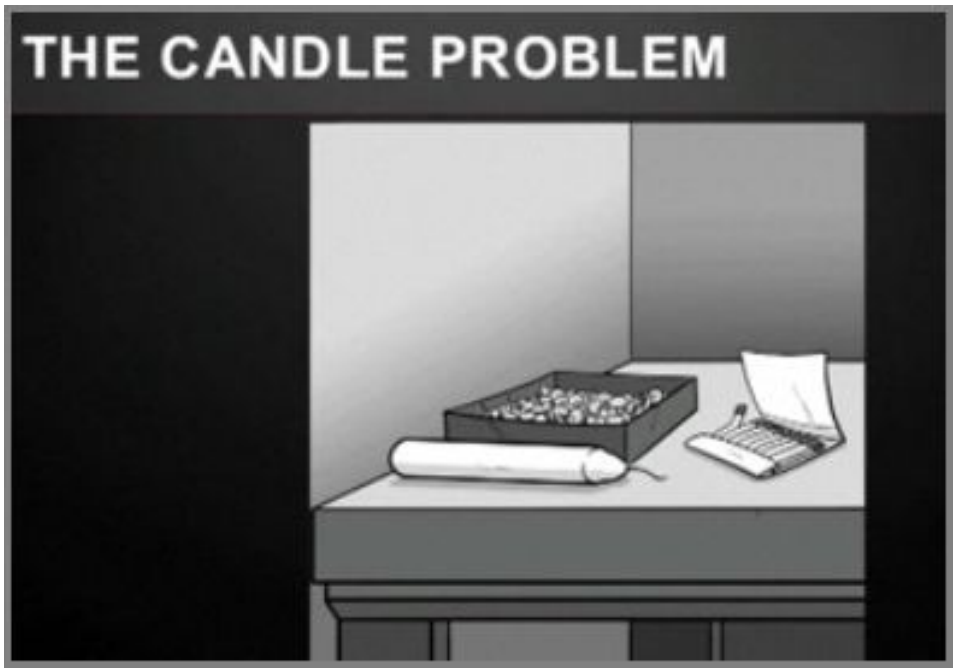

Figure 3: The candle problem

The correct solution to this problem would be to empty the box of thumbtacks, attach the box to the wall and then light the candle and place it on the box. However, this solution is not obvious to most individuals when they are trying to solve this problem. Duncker hypothesized

that this is due to the way the individuals perceive the box. It is seen only as a container for the thumbtacks, and not a potential platform for the candle.

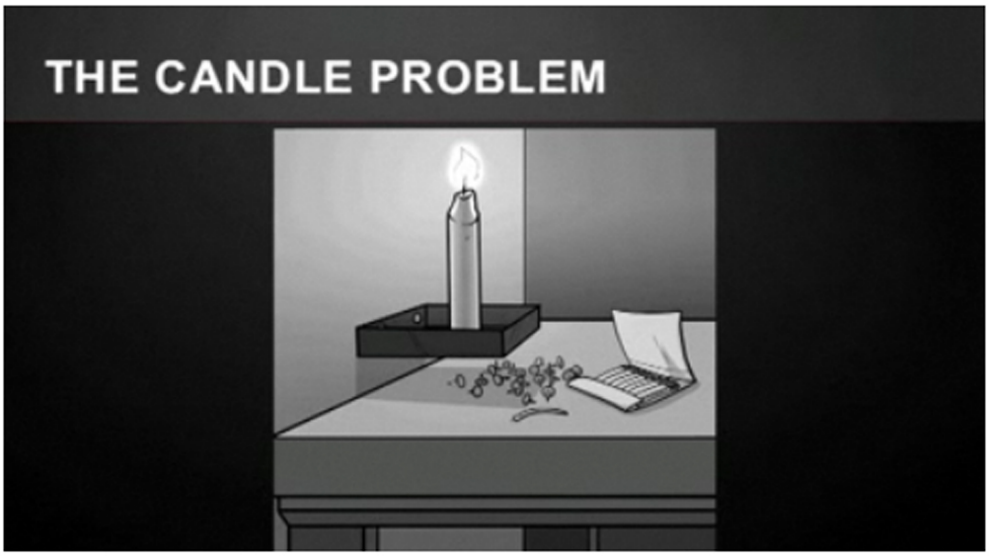

Figure 4: Solution to the candle problem

This experiment was repeated by Deci and Ryan to investigate the effects of extrinsic motivators on an individual's problem solving skills. In their experiment, there were two identical groups of individuals who were presented with the candle problem. The first group was offered a monetary reward for being in the top 25 percent of the fastest to solve the problem. To the second group, Deci and Ryan offered no compensation. The second group was to solve the candle problem simply for the intrinsic joy of solving the problem.

It might be intuitive that the group which was offered a reward for solving the problem as fast as possible would perform better than the other group. Surprisingly, the people in the second group solved the problem about three and a half minutes faster on average. This experiment has been repeated many times since 1973 and has shown similar results. (Pink, 2009)

The reason behind this was that extrinsic rewards such as money reduce an individual's intrinsic motivation to solve a problem; they also narrow the individual's focus on solving the problem. When facing a problem which calls for creativity in reaching a solution, it is important not to narrow the focus on a single solution before exploring other ways to solve the problem.

4.5 The Academic Motivation Scale

The following questionnaire is the Academic Motivation Scale in the WNS. It is a Likert scale, where students are asked to respond to each of the eight statements in the scale with their level of agreement or disagreement to the statement on a scale from 1 to 5 (1= strongly disagree, 5= strongly agree). The academic motivation score for each student was defined as the average of these eight items. All of the responses were weighted equally.

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
A. I am willing to work hard in a course to learn the material even if it won't lead to a higher grade.	1	2	3	4	5
B. When I do well on a test, it is usually because I am well-prepared, not because the test is easy.	1	2	3	4	5
C. I frequently do more reading in a class than is required simply because it interests me.	1	2	3	4	5
D. I frequently talk to faculty outside of class about ideas presented during class.	1	2	3	4	5
E. Getting the best grades I can is very important to me.	1	2	3	4	5
F. I enjoy the challenge of learning complicated new material.	1	2	3	4	5
G. My academic experiences (i.e., courses, labs, studying, discussions with faculty) will be the most <u>important</u> part of college.	1	2	3	4	5
H. My academic experiences (i.e., courses, labs, studying, discussions with faculty) will be the most <u>enjoyable</u> part of college.	1	2	3	4	5

Figure 5: Academic Motivation Scale

From our literature review on SDT, we argued that these items did not all measure a single parameter from the self-determination continuum. Following is a more in-depth examination of each item with a brief description of it.

Item A: I am willing to work hard in a course to learn the material even if it won't lead to a higher grade.

Item A is a measure of a student's *intrinsic motivation toward accomplishment*. A student who agrees with this item is willing to put in extra effort even if it does not lead to a higher grade: an external reward. Working harder than necessary to learn the material is the student's own sense of accomplishment by surpassing themself.

Item B: When I do well on a test, it is usually because I am well-prepared, not because the test is easy.

Item B is a measure of a student's *integrated regulation,* which is the most autonomous of the classes of extrinsic motivation. The act of doing well on a test is a desired outcome and motivating factor for the student. Since doing well in the test is highly important to the student, he/she is willing to spend time and effort in preparing for it. Even though the driving factor is an external reward, the student works hard because it is important to him/her.

Item C: I frequently do more reading in a class than is required simply because it interests me.

Item C is a measure of a student's *intrinsic motivation to experience stimulation*. The student who agrees with this item is genuinely interested in learning the material presented in the class. There are no external rewards present. The student simply studies more than he/she needs to because the course material is enjoyable for him/her.

Item D: I frequently talk to faculty outside of class about ideas presented during class.

Item D is a measure of a student's *intrinsic motivation to know*. The student who has a higher level of agreement to this item attempts to better understand concepts introduced in class by discussing them with the faculty outside of class. There are no direct extrinsic rewards from doing so. The only reward is the student's satisfaction from better understanding the ideas presented during class.

Item E: Getting the best grades I can is very important to me.

Item E is another measure of a student's *integrated regulation*. A good grade is an external reward. The student is not being forced to work hard for the grades. He/she puts in the extra effort because the outcome attained from doing so is important to the student.

Item F: I enjoy the challenge of learning complicated new material.

Item F is a second measure of a student's *intrinsic motivation toward accomplishments*. The student who agrees to this item is driven to experience a greater competence and overcome the challenge of understanding complicated material in order to attain a sense of mastery.

*Item G: My academic experiences (i.e., courses, labs, studying, discussions with faculty) will be the most **important** part of college.*

Item G is a third measure of *integrated regulation* in the scale. It stresses the importance the student places on his/her academic experiences at college. This does not portray how much intrinsic interest the student has in the learning experience at college, but gauges how important he/she thinks the experience will be during and after college. If a student has no observable intrinsic interest to learn, but does so because he/she feels it is important, it can be classified as an autonomous and self-determined form of regulation.

*Item H: My academic experiences (i.e., courses, labs, studying, discussions with faculty) will be the most **enjoyable** part of college.*

Item H is a second measure of a student's *intrinsic motivation to experience stimulation*. A student with a high level of agreement to this item is most likely to have an intrinsic interest in learning something new. He/she also experiences satisfaction from his/her academic experiences regardless of an extrinsic reward.

4.6 Theories Alternate to SDT

Other approaches to motivation in education besides the Self-Determination Theory examined in this analysis provided different insight into practices that affect student academic motivation, as well as the way that motivation should change over a student's college career.

4.6.1 MUSIC model

One such approach is the MUSIC academic motivation model which was presented by Brett Jones, an educational psychologist at Virginia Tech, and published in 2009 in the International Journal of Teaching and Learning in Higher Education (Jones, 2009). This model attributed a student's level of academic motivation to five characteristics. These five attributes, *empowerment*, *usefulness*, *success*, *interest*, and *caring* are expanded upon below.

Empowerment:

"Empowerment refers to the amount of perceived control that students have over their learning" (Jones, 2009, p. 273). According to Jones, if students feel that they have some control over their work, they will become more motivated to not only complete the work but excel in it. The optimal amount of control that they have is dependent on the difficulty of the material and on the individual student, but global standards can be implemented in a classroom to increase motivation in most of the students. This models the benefit of having student-controlled project-based learning, similar to project-based classes at WPI.

Usefulness:

"…students are more motivated when they have more distant goals and have long-range behavioral projects to obtain those goals than when they have only short-term goals" (Jones, 2009, p. 275). If students do not see the use for the material they are learning, they will simply learn the material to pass a test, and reserve their actual motivation for topics that they deem more important for them in the long term. In our project we found this same result, especially when discussing motivation with the interviewed survey participants (Section 5.7).

Success:

"Students need to believe that if they invest effort into the course, they can succeed. This does not mean that a course has to be easy. In fact, students will be bored and unmotivated if the course is too easy" (Jones, 2009, p. 276). According to the MUSIC model, a student will only be motivated if they know that the content they are learning will help them to succeed in that course. If the course is either impossible to pass even with knowledge of the material taught, or if it is easy to pass even without knowledge of the material taught, the academic motivation of students in the course will diminish.

Interest:

"Instructors should think beyond creating interesting classroom activities to thinking about how they might incorporate aspects of instruction that foster in students a more enduring interest in the course content" (Jones, 2009, p. 277). The MUSIC model suggests that there are different types of student interest, and temporary interests such as "gimmicks or flowery pictures" (Jones, 2009) should be exchanged for illustrations and other things that cause a long-term interest in the student. This will increase the personal interest that a student has for material, spurring them to seek out learning the material even outside the classroom and improving academic motivation overall.

Caring:

"Caring does not imply that the instructors are good buddies with the students. Although it is important to be friendly with students and to not show signs of animosity towards them, the key to designing for caring is that students believe that the instructor cares about their learning" (Jones, 2009, p. 279). This pillar of academic motivation in the MUSIC model does not require outside interaction between faculty and students. However this does imply some amount of student -faculty interaction is necessary.

4.6.2 Dweck Model

The Dweck Model is another approach that can be used to understand academic motivation. It was proposed by Carol S. Dweck, the Lewis and Virginia Eaton professor at Stanford University. In her model, Dweck maintains that academic motivation is explained by examining students' theory of intelligence, the academic goals they set, their perceptions of academic ability, and academic behaviors. (Dweck, 2000). Dweck characterizes students in two distinct groups as holding either an *incremental* or *entity* theory of intelligence. Students who are incremental theorists believe that intelligence is malleable and can be increased through effort and new experiences. In contrast, students who are entity theorists believe that intelligence is predetermined and cannot be changed (Miller, 2010). A continuum for Dweck's original model of motivation is provided in Figure 6.

Figure 6: Dweck's model of motivation

The Dweck model suggests that incremental theorists attribute failures to a lack of effort whereas entity theorists attribute failures to a lack of ability. When faced with a challenging task, incremental theorists tend to perform better than entity theorists. Entity theorists tend to withdraw from the task altogether because their goal is to avoid a negative competence judgment rather than increase competence. According to Dweck's theory, highly motivated individuals are incremental theorists who welcome a challenge as opposed to fear it. Thus, in order to attain the best academic success, colleges should encourage practices that move students from being entity theorists to incremental theorists.

5 Results and Discussion

The following sections are statistical analyses done on WPI students' academic motivation scores.

5.1 Terminology

A list of terms and abbreviations used in the analyses is provided below.

- ***Academic Motivation Scale***: a group of 8 questions from the WNS; each student's academic motivation score/value was the average calculated from these 8 questions
- ***AcMo***: academic motivation (score/value)
- ***T1***: fall of 2008, time of the first administration of WNS
- ***T2***: spring of 2009, time of the second administration of WNS
- ***T3***: spring of 2011, time of the focus group interview
- ***AcMo T1***: the academic motivation score/value from T1
- ***AcMo T2***: the academic motivation score/value from T2
- ***Delta AcMo***: the change in academic motivation score/value; unless specified otherwise, the change was always calculated from T1 to T2 (Delta AcMo = AcMo T2- AcMo T1)
- ***200 Students***: the 200 students who completed WNS at both T1 and T2; note these students were a very important group; their data provided the information about the changes from T1 to T2
- ***InAcMo***: Intrinsic Motivation (score/value). This was the average calculated for the questions in the Academic Motivation Scale which measured intrinsic motivation.
- ***ExAcMo***: Extrinsic Motivation (score/value). This was the average calculated for the questions in the Academic Motivation Scale which measured extrinsic motivation.
- ***Fac***: A set of 29 questions in WNS which asked about the WPI faculty at T2.

5.2 WPI and 7 Universities at T1

WPI participated in the WNS in 2008 with 25 other institutions and was classified as 1 of the 7 universities (universities were defined as institutions that offered graduate/Ph.D. programs). Table 2 compares the average for WPI with the average for the 7 universities on each of the questions in the Academic Motivation Scale at T1.

ACADEMIC MOTIVATION SCALE	WPI Mean (SD)	7 other universities Mean (SD)	Mean difference between WPI and 7 universities
A. I am willing to work hard in a course to learn the material even if it won't lead to a higher grade.	4.02 (0.90)	3.75(0.98)	+0.27
B. When I do well on a test, it is usually because I am well-prepared, not because the test is easy.	3.88 (0.98)	3.99(0.88)	-0.11
C. I frequently do more reading in a class than is required simply because it interests me.	2.82(1.21)	2.81(1.18)	+0.01
D. I frequently talk to faculty outside of class about ideas presented during class.	4.02(0.90)	3.75(0.98)	+0.27
E. Getting the best grades I can is very important to me.	**4.12(0.91)**	**4.38(0.79)**	**-0.26**
F. I enjoy the challenge of learning complicated new material.	**4.09 (0.79)**	**3.66(0.92)**	**+0.43**
G. My academic experiences (i.e., courses, labs, studying, discussions with faculty) will be the most important part of college.	3.81(0.93)	3.68(1.00)	+0.13
H. My academic experiences (i.e., courses, labs, studying, discussions with faculty) will be the most enjoyable part of college.	3.02(0.93)	2.91(0.96)	+0.11

Table 2: WPI vs. 7 universities in WNS

It can be seen that WPI students scored higher on average in questions A, C, D, F, G, and H, and lower in questions B and E. The difference that stands out in this table is in question F (*I enjoy the challenge of learning complicated new material*). The average response for this question was 4.09 for WPI students, which is 0.43 higher than the average for the 7 universities. On the contrary, in question E (*Getting the best grades I can is very important to me*) WPI students averaged 0.26 lower than the 7 universities. Question E measured extrinsic motivation and question F measured intrinsic motivation. This result showed that WPI students were more likely to study for the joy of learning new material rather than getting good grades.

5.3 Basic Demographic Information

The first round of the WNS was administered during the new student orientation in August of 2008. Out of more than 900 first-year students, 731 completed this study. The second administration of WNS was in April of 2009. Out of the initial group of 731 students, 200 returned and completed this round of the study.

	Out of 731 Students	Out of 200 Students		Out of 731 Students	Out of 200 Students
Males	**517 (70.7%)**	**111 (55.5%)**	Females	**214 (29.3%)**	**89 (44.5%)**
Engineers	**519 (71.0%)**	**99 (49.5%)**	Non-Engineers	**212 (29.0%)**	**101 (50.5%)**
Athletes	N/A	61 (30.5%)	Non-Athletes	N/A	132 (66.0%)
First Choice	471(64.4%)	127 (63.5%)	Non-First Choice	260 (35.6%)	73 (36.5%)
Greek	N/A	51 (25.5%)	Non-Greek	N/A	149 (74.5%)
Ph.D.	203 (27.8%)	64 (32.0%)	Non-Ph.D.	528 (72.2%)	136 (68.0%)
A's	465 (63.6%)	138 (69.0%)	Non-A's	266 (36.4%)	62 (31.0%)
Honors	N/A	179 (89.5%)	Non-Honors	N/A	21 (10.5%)
Loans	454 (62.1%)	132 (66.0%)	No Loans	277 (37.9%)	68 (34.0%)

Table 3: Comparing Demographics for WPI students

In Table 3:

- *Engineers* - students who planned to major in a field of engineering.
- *Athletes* - students who were on a school-sponsored team.
- *First Choice* - students who had WPI as their first choice of college.
- *Greek* - students who became members of a fraternity or sorority.
- *Ph.D.* - students who planned on pursuing a Ph.D. in their lifetime.
- *A's* - students who received mostly A's in high school.
- *Honors* - students who were on the Dean's List in 2009 at WPI.
- *Loans* - students who received loan financial aid.

Table 3 summarizes the demographics of the students. It also compares the number of students in each demographic between the 731 students who completed the survey at T1 and the 200 students who completed surveys at both T1 and T2. Note that there was no T1 demographic for Athlete, Greek, and Honor's. The percentage in each demographic split was similar between the 731 and 200 students, with the exceptions of Males - Females and Engineers - Non-Engineers.

AcMo T1	731 Students	200 Students
Mean	3.64	3.68
Median	3.62	3.62
Standard Deviation	0.56	0.56

Table 4: Comparison of AcMo T1 between the 731 and 200 students

Table 4 compares the T1 academic motivation between the 731 students and the 200 students. It can be observed that the two groups had very similar scores at T1.

5.4 Basic Information about the 200 Students

Section 4.3, Section 4.4, and Section 4.5 are statistical analyses performed using the data obtained from the 200 students. Unless specified otherwise, the population was defined to be these 200 students.

Academic Motivation at T1 (AcMo T1):

- Mean: 3.675
- Median: 3.630
- Standard Devaition: 0.563

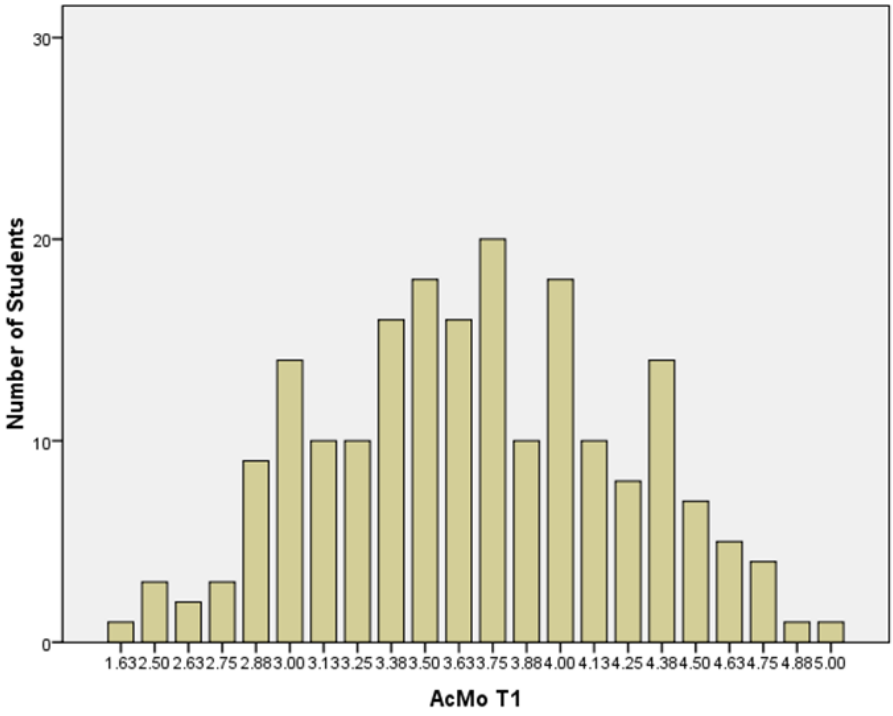

Figure 7: Number of students vs. AcMo T1

In Figure 7, each of the bars represents the number of students who had a particular AcMo T1 value represented on the horizontal axis. The graph shows the 200 students' AcMo T1 distribution resembles a bell shape, thus more students were clustered around the average and fewer were at the two extremes.

Academic Motivation at T2 (AcMo T2):

- Mean: 3.447
- Median: 3.380
- Standard Deviation: 0.636

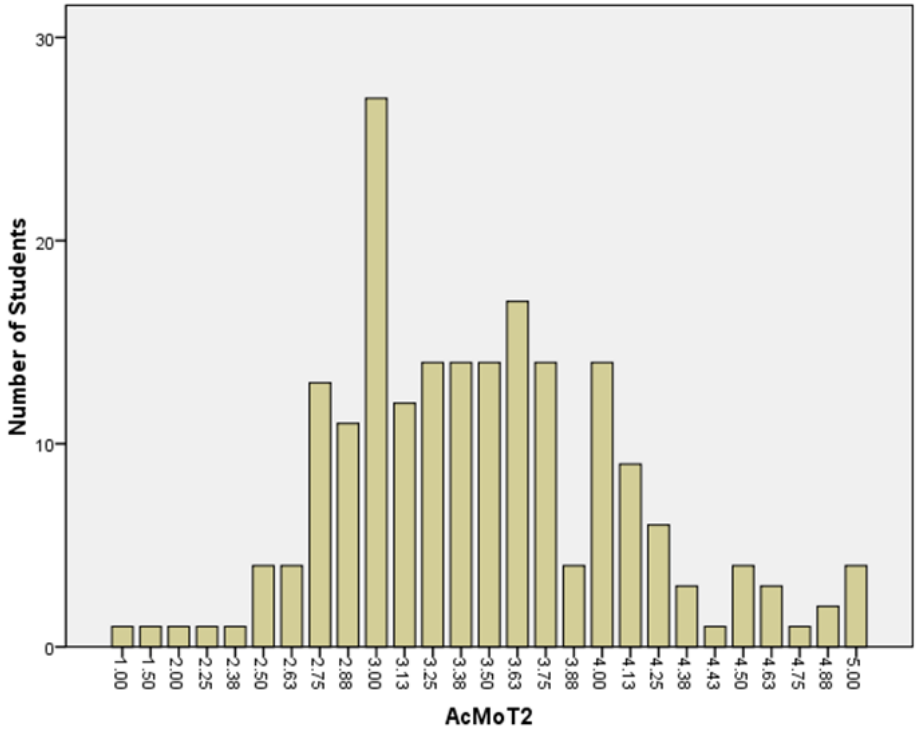

Figure 8: Number of Students vs. AcMo T2

In Figure 8, the axes are set up similar to the first histogram. There were more students on the left side of the histogram than in Figure 7. This was because more students had a relatively lower academic motivation score at T2.

Change in Academic Motivation (Delta AcMo):

- Mean: -0.228
- Median: -0.250
- Standard Deviation: 0.547

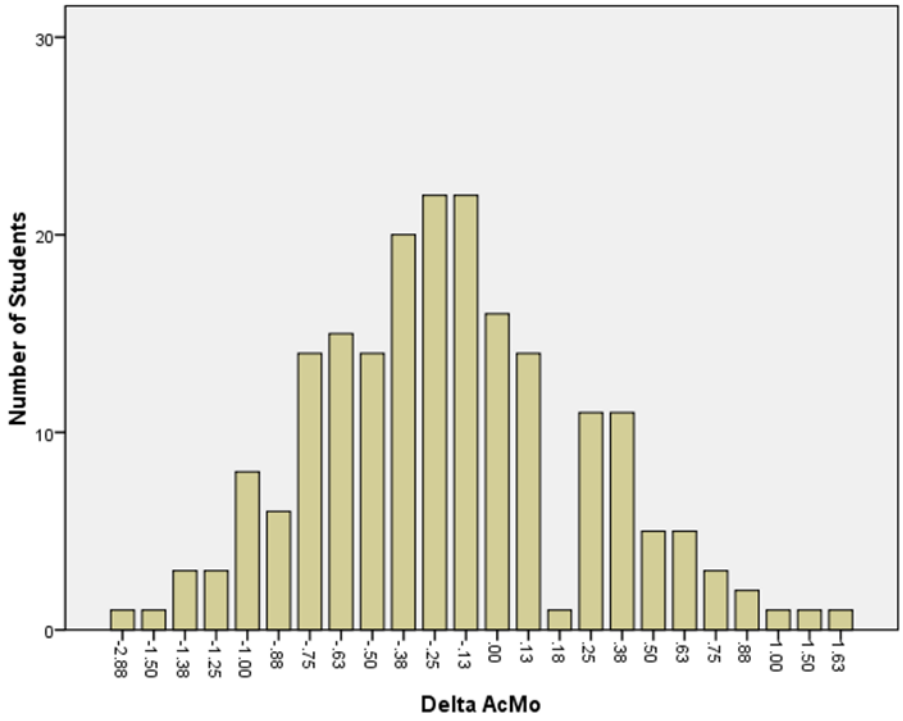

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Figure 9: Number of Students vs. Delta AcMo

In Figure 9, the horizontal axis is the different values of the change in academic motivation from T1 to T2. More students were clustered to the left of 0, thus more students had a decrease in academic motivation score from T1 to T2. The histogram resembles a bell shape. It can be observed that there were only 10 students who had a relatively large increase or decrease (an increase or decrease in academic motivation greater than one in magnitude).

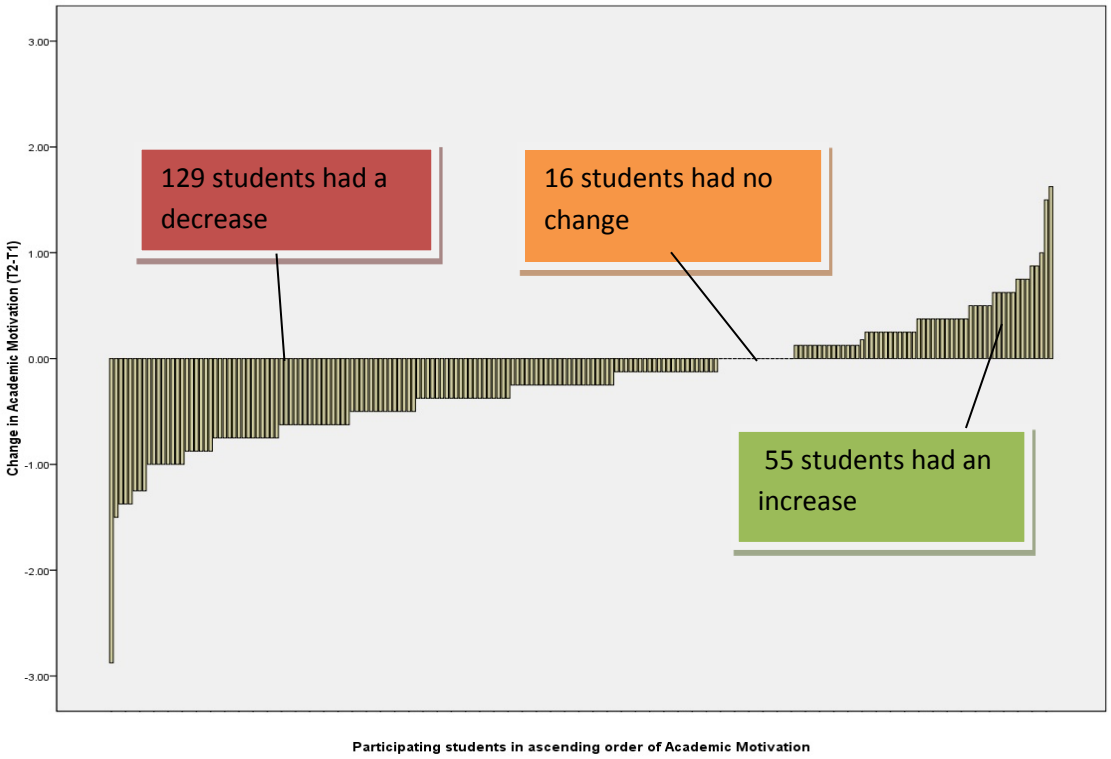

Figure 10: Change in academic motivation in ascending order

Figure 10 shows the change in academic motivation of the 200 students in ascending order. A total of 129 students had a decrease in motivation from T1 to T2, 16 had no change, and 55 had an increase in motivation.

5.5 Correlation

Correlation measures the strength of linear association between two variables. (Lund Research, 2011) More information about correlation can be found in Appendix 9.1.3.

5.5.1 AcMo T1, AcMo T2, Delta AcMo

		AcMo T2
AcMo T1	Pearson Correlation	0.589

Table 5: Corr AcMo T1 vs. AcMo T2

As shown in Table 5, the correlation index for AcMo T1 and AcMo T2 was 0.589. This indicated that there was a positive relationship between the two variables. It meant that if a student's AcMo T1 value was above average, then his/her AcMo T2 value was likely to be above average as well.

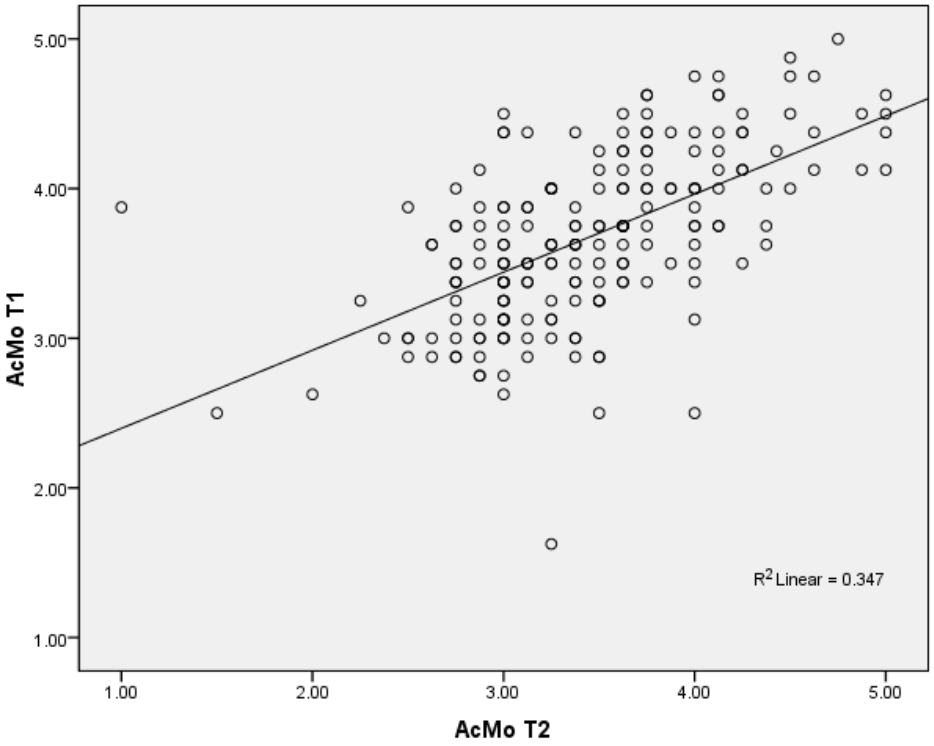

Figure 11: AcMo T1 vs. AcMo T2

The line in Figure 11 is the best fit line of the scatter plot, which minimizes the square errors of the vertical deviations. This is also known as the R^2Linear, or the square of the correlation. The positive y-intercept and positive slope implies that students scored higher at T1 than at T2.

		Delta AcMo
AcMoT1	Pearson Correlation	-0.346

Table 6: Corr AcMo T1 vs. Delta AcMo

From Table 6, the correlation index for AcMo T1 and Delta AcMo was -0.346. This indicated that there was a negative relationship between the two variables. It meant that if a student had a high score at T1, his/her score was more likely to decrease at T2.

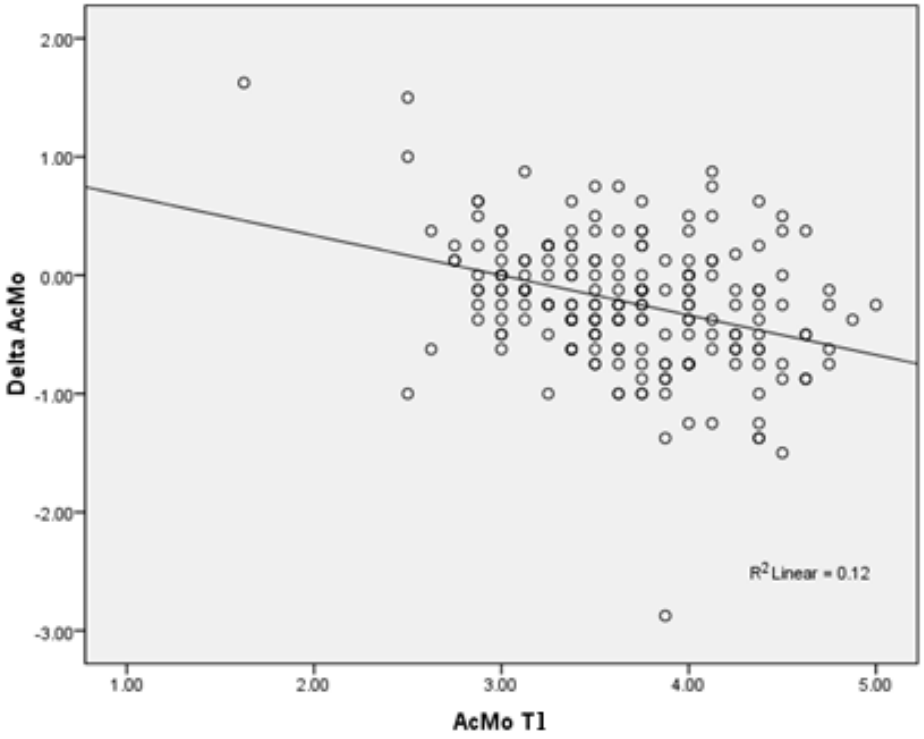

Figure 12: AcMo T1 vs. Delta AcMo

Figure 12 is a scatter plot of AcMo T1 and Delta AcMo. The best fit line has a negative slope, showing there was a negative correlation between them.

		Delta AcMo
AcMoT2	Pearson Correlation	0.555

Table 7: Corr AcMoT2 vs. Delta AcMo

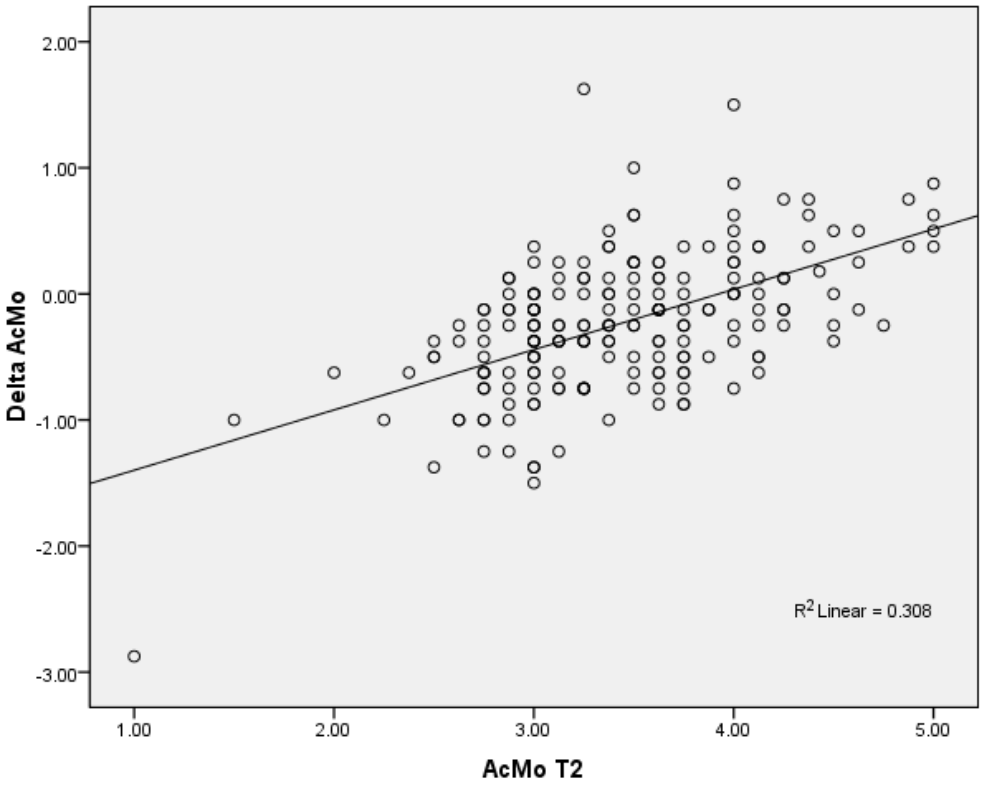

Figure 13: Delta AcMo vs. AcMo T2

From Figure 13 and Table 7, it can be observed that there was a positive relationship between AcMo T2 and Delta AcMo. Once again, the line in the graph is the best fit line, which has a positive slope.

From the above three correlation analyses, we can conclude that students with high AcMo T1 values were likely to have high AcMo T2 values. However, their academic motivation values were more likely to decrease since there was more room for them to decrease than to increase.

5.5.2 AcMo vs. 8 questions in the Academic Motivation Scale

The correlations were calculated between AcMo T1 and each of the individual questions at T1, and between AcMoT2 and each of the individual questions at T2. Note that there were 16 correlations done. The range of the correlation indices is given in Table 8.

	Correlation Range
AcMoT1 vs. 8 questions(T1)	[0.514, 0.650]
AcMoT2 vs. 8 questions(T2)	[0.557, 0.699]

Table 8: Corr range of the 8 questions

We observed that all the correlation indices fell within a narrow range, thus meaning no individual question stood out.

5.5.3 Faculty

There were 29 questions in the WNS Student Experiences Survey which asked about the faculty at T2. Each of these questions was also based on a 1-5 scale, similar to the Academic Motivation Scale. By using correlation tests, the result showed that all 29 of them were more positively correlated with respect to AcMo T2 than to AcMo T1. This led to the hypothesis that the students' academic motivation was influenced by the faculty at WPI.

In order to test this hypothesis, 11 of the 29 questions were chosen grouped into two sets:

- Questions that had the most positive correlations with respect to AcMoT2 and Delta AcMo. This set of questions is defined as **Fac1**.
- Questions that had nearly no correlation with AcMoT1 but had a high correlation with AcMoT2 and Delta AcMo. This set of questions is defined as **Fac2**.

		AcMoT1	AcMoT2	Delta AcMo
1. The frequency that the faculty asked the student to show how a particular course concept could be applied to an actual problem or situation	Pearson Correlation	.219	.384	.221
	Number of Students	199	199	199
2. The extent to which the student agrees that non-classroom interactions with faculty have had a positive influence on career goals and aspirations	Pearson Correlation	.276	.418	.203
	Number of Students	196	196	196
3. The extent to which the student agrees that non-classroom interactions with faculty have had a positive influence on intellectual growth and interest in ideas	Pearson Correlation	.342	.459	.182
	Number of Students	196	196	196
4. The extent to which the student agrees that non-classroom interactions with faculty have had a positive influence on personal growth, values, and attitudes	Pearson Correlation	.232	.368	.190
	Number of Students	198	198	198

Table 9: Corr AcMo vs. Fac1

Table 9 contains the correlations between AcMo and Fac1. Focusing on the last three questions about the student-faculty contact in Table 9, there were two ways to explain the positive correlation:

1. Good non-classroom interactions with the faculty had a positive impact on students' academic motivation.
2. The students interacted with the faculty because they were more motivated. Therefore, only motivated students would have non-classroom interactions with faculty and would agree that the interactions are beneficial.

A new set of data, AcMo* T1, AcMo*T2 and Delta AcMo*, was calculated by excluding the question that asked about how frequently students talked to teachers outside of class (Question D in the Academic Motivation Scale). This was done in order to determine how these three questions correlate with academic motivation without taking the frequency of student-faculty contact into account. Table 10 provides the information about AcMo*.

	AcMo*T1	AcMo*T2	Delta AcMo*
Mean	3.7150	3.5564	-.1565
Median	3.7143	3.5714	-.1429
Std. Deviation	.54882	.63926	.58084

Table 10: AcMo*

The correlation test was repeated with respect to Fac1. The table below shows the questions that have a high correlation with AcMo*T2 and Delta AcMo*:

		AcMo*T1	AcMo*T2	Delta AcMo*
1. The extent to which the student agrees that non-classroom interactions with faculty have had a positive influence on career goals and aspirations	Pearson Correlation	0.251	0.414	0.215
	Number of Students	196	195	195
2. The extent to which the student agrees that non-classroom interactions with faculty have had a positive influence on intellectual growth and interest in ideas	Pearson Correlation	0.295	0.439	0.202
	Number of Students	196	195	195
3. The extent to which the student agrees that non-classroom interactions with faculty have had a positive influence on personal growth, values, and attitudes	Pearson Correlation	0.2	0.352	0.198
	Number of Students	198	197	197

Table 11: Corr AcMo* vs. Fac1

These three questions had a high correlation with AcMo*T2 and Delta AcMo*. This showed that interpretation one was valid, and we concluded that the quality of non-classroom interactions between the students and the faculty had an impact on the students' academic motivation.

		AcMo T1	AcMo T2	Delta AcMo
1. Frequency that faculty gave assignments that helped in learning the course material	Pearson Correlation Number of Students	.070 198	.251 198	.219 198
2. Most faculty with whom the student had contact are genuinely interested in teaching	Pearson Correlation Number of Students	.075 199	.250 199	.213 199
3. Frequency that faculty had a good command of what they were teaching	Pearson Correlation Number of Students	.001 195	.249 195	.286 195
4. Frequency that the presentation of material was well organized	Pearson Correlation Number of Students	.032 199	.222 199	.225 199
5. Most faculty with whom the student had contact are outstanding teachers	Pearson Correlation Number of Students	.097 199	.276 199	.220 199
6. Frequency that faculty were well prepared for class	Pearson Correlation Number of Students	.061 198	.205 198	.174 198
7. Frequency that faculty effectively reviewed and summarized the material	Pearson Correlation Number of Students	.098 199	.291 199	.236 199

Table 12: Corr AcMo vs. Fac2

Table 12 shows the correlations between AcMo and Fac2. The students were split into 5 groups according to their response to question 5, “Most faculty with whom the student had contact are outstanding teachers”. In order to determine whether there were any significant differences between these groups, their academic motivation values were compared and a “one-way analysis of variance” was done.

	Students' response to Question 5	Number of students	Mean	Std. Deviation	Minimum	Maximum
AcMo T1	Strongly Disagree	8	3.5000	.47716	2.88	4.38
	Disagree	20	3.5625	.50735	2.50	4.50
	Neutral	72	3.6806	.56446	2.50	4.88
	Agree	75	3.6933	.59250	1.63	5.00
	Strongly Agree	24	3.7604	.56496	2.50	4.75
	Total	199	3.6759	.56464	1.63	5.00
AcMo T2	Strongly Disagree	8	2.6875	.70394	1.00	3.00
	Disagree	20	3.3063	.59531	2.50	5.00
	Neutral	72	3.3792	.54039	2.00	5.00
	Agree	75	3.5733	.62130	2.38	5.00
	Strongly Agree	24	3.6406	.76107	1.50	5.00
	Total	199	3.4488	.63668	1.00	5.00
Delta AcMo	Strongly Disagree	8	-.8125	.92099	-2.88	-.13
	Disagree	20	-.2563	.64313	-1.38	1.50
	Neutral	72	-.3013	.46879	-1.50	1.00
	Agree	75	-.1200	.52490	-1.38	1.63
	Strongly Agree	24	-.1198	.49106	-1.00	.75
	Total	199	-.2271	.54877	-2.88	1.63

	Sig.
AcMo T1	.703
AcMo T2	.001
Delta AcMo	.006

Table 13: OutstandingTeachersT2 One Way Analysis of Variance

Table 13 shows that the significance level of AcMo T1 was 0.703, which was much larger than the common threshold of 0.05, thus there was no significant difference in the means of academic motivation between students who agreed and disagreed with this question. This was intuitive because at T1, no one could have known how they were going to answer this question at T2. On the other hand, looking at the significance level of AcMo T2 and Delta AcMo, 0.01 and 0.06, these values were less than and close to the common threshold of 0.05. Thus there was a difference between the groups who answered this question differently in terms of their average academic motivation. A correlation test was done on this as tabulated below:

		Most faculty with whom student had contact are outstanding teachers
AcMo T1	Pearson Correlation	.097
	Number of Students	199
AcMo T2	Pearson Correlation	.276
	Number of Students	199
Delta AcMo	Pearson Correlation	.220
	Number of Students	199

Table 14: Corr FacOutstandingTeachers

It can be observed from Table 14 that there was very low correlation between this question and AcMo T1. However, there was a positive correlation with AcMo T2 and Delta AcMo. From this, we concluded that the students' academic motivation was affected by the faculty throughout the year.

5.5.4 AcMo, GPA 08-09

The following section analyzes the relationship between the changes in the 200 students' GPAs over freshman year and their changes in academic motivation.

		GPA
Delta AcMo	Pearson Correlation	.131
	Number of Students	200

Table 15: Delta AcMo vs. GPA

Table 15 shows the result of the correlation test between Delta AcMo and the students' GPAs at T2. The correlation index was 0.13, which was close to zero and thus concluded that there was no linear relationship between the two variables.

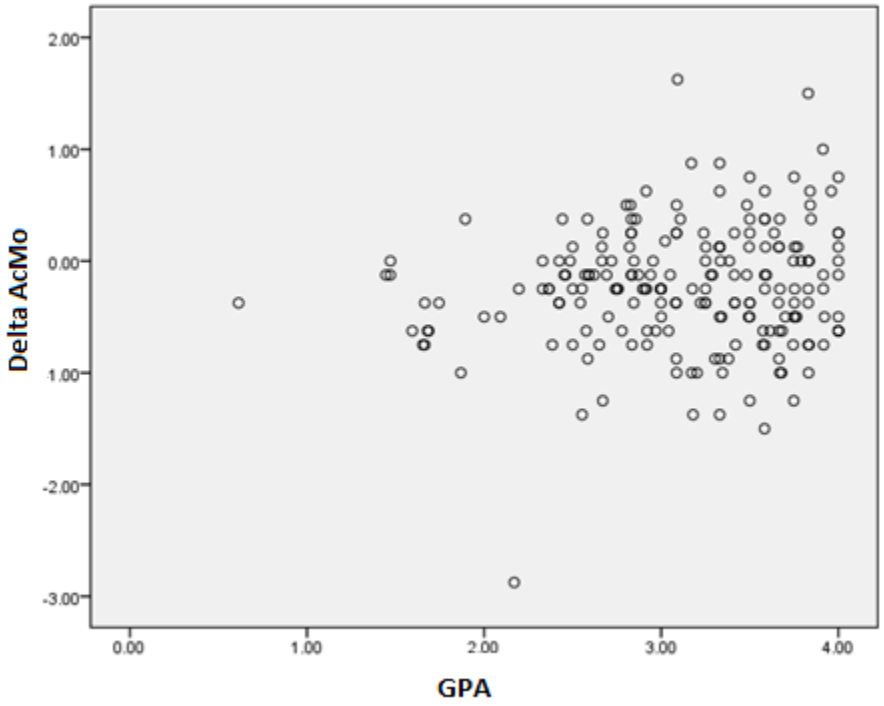

Figure 14: Delta AcMo vs. GPA

Figure 14 is a scatter plot of the student's 08-09 GPA against the change in academic motivation. There was no relationship observed between Delta AcMo and GPA from this figure.

5.6 Chi-square test

In order to investigate possible relationships between change in academic motivation and student background, the students were separated into four groups for each background factor. A 2x2 Chi-square test was used to determine the probability that the distribution occurred by random chance. A Fisher's Test was also used to verify the Chi-square test result. For each test, the null hypothesis stated that there was no relationship between the split and change in academic motivation. The common threshold of significance (p-value) of 0.05 was used. This meant that if the Chi-square tests returned a p-value lower than 0.05, the null hypothesis could be rejected, and we could conclude that there was a significant relationship between the split and change in academic motivation.

5.6.1 Male vs. Female

The first factor we examined to determine whether it had a significant relationship with change in academic motivation was gender. The basic question we were trying to answer in this test was: Was there a relationship between a student's gender and his or her change in academic motivation?

	Observed	Expected	Residual
Male Increase	25	30.49	-5.49
Male Decrease	77	71.51	+5.49
Female Increase	30	24.51	-5.49
Female Decrease	52	57.49	+5.49

Table 16: Delta AcMo by Gender

From Table 16 one important thing to notice was that there were 5 more males who decreased than expected and 5 more females who increased than expected.

	Delta AcMo
Chi-square	3.164
Degrees of freedom	1
P-value	0.075
Fisher's P-value	0.107

Table 17: Significance for Gender

From Table 17, the Chi-square test gave a p-value of 0.075, meaning there was a 7.5% chance that this distribution occurred by random chance. This p-value was above the typical rejection threshold of 0.05. However, we argued that there could be a connection between gender and change in academic motivation: a higher number of males than expected showed a decrease in academic motivation than females.

5.6.2 Would Choose WPI Again vs. Would Not Choose WPI Again

	Observed	Expected	Residual
Choose WPI Increase	53	50.4	+2.6
Choose WPI Decrease	115	117.6	-2.6
Wouldn't Choose WPI Increase	1	3.6	-2.6
Wouldn't Choose WPI Decrease	11	8.4	+2.6

Table 18: Delta AcMo by Choose WPI again

	Delta AcMo
Chi-square	2.874
Degrees of freedom	1
P-value	0.09
Fisher's P-value	0.111

Table 19: Significance for Choose WPI again

Table 19 shows that even though the p-value was above the common rejection threshold of 0.05, it is arguable that there was a weak relationship between whether or not students would choose WPI again and their change in academic motivation. Although the residual is small, the low p-value was attributed to the fact that only one student out of the 12 who would not choose WPI again increased in academic motivation.

5.6.3 Engineer vs. Non-Engineer

The next factor that was studied to see if it had a significant relationship with change in academic motivation was a student's choice of major.

	Observed	Expected	Residual
Engineer Increase	23	25.85	-2.85
Engineer Decrease	63	60.15	+2.85
Non-Engineer Increase	32	29.15	+2.85
Non-Engineer Decrease	65	67.85	-2.85

Table 20: Delta AcMo by Major

	Delta AcMo
Chi-square	0.848
Degree of freedom	1
P-value	0.358
Fisher's P-value	0.420

Table 21: Significance for Major

The Chi-square test for Engineers vs. Non-engineers returned a p-value much greater than the common rejection threshold of 0.05. Thus we concluded that there was no significant relationship between the split and the change in academic motivation.

5.6.4 Athlete vs. Non-Athlete

Next, we sought to determine if there was a relationship between participation in varsity athletics and change in academic motivation.

	Observed	Expected	Residual
Athlete Increase	19	17.04	+1.96
Athlete Decrease	38	39.96	-1.96
Non-Athlete Increase	36	37.96	-1.96
Non-Athlete Decrease	91	89.04	+1.96

Table 22: Delta AcMo in Varsity Athletics

	Delta AcMo
Chi-square	0.466
Degree of freedom	1
P-value	0.494
Fisher's P-value	0.492

Table 23: Significance for Participation in Varsity Athletics

The Chi-square test returned a p-value much greater than the threshold of 0.05 for Athletes vs. Non-athletes. Thus we concluded that there was no significant relationship between this split and the change in academic motivation.

5.6.5 Greek vs. Non-Greek

Here we were testing if being part of a Greek organization had a relationship with change in academic motivation in students.

	Observed	Expected	Residual
Greek Increase	18	14.95	+3.05
Greek Decrease	32	35.05	-3.05
Non-Greek Increase	37	40.05	-3.05
Non-Greek Decrease	97	93.95	+3.05

Table 24: Delta AcMo by Greek

	Delta AcMo
Chi-square	1.223
Degrees of freedom	1
P-value	0.269
Fisher's P-value	0.282

Table 25: Significance for Greek

The Chi-square test for Greek vs. Non-Greek returned a p-value much greater than the threshold of 0.05. Thus we concluded that there was no significant relationship between the split and the change in academic motivation.

5.6.6 A's in High School vs. Non-A's in High School

Here we were testing if high school grades had a relationship with change in academic motivation in students.

	Observed	Expected	Residual
A's Increase	38	38.26	-0.26
A's Decrease	90	89.74	+0.26
Non-A's Increase	17	16.74	+0.26
Non-A's Decrease	39	39.26	+0.26

Table 26: Delta AcMo by A's in HS

	Delta AcMo
Chi-square	0.008
Degrees of freedom	1
P-value	0.927
Fisher's P-value	1.000

Table 27: Significance for A's in HS

The Chi-square test returned a p-value much greater than the threshold of 0.05. Thus we concluded that there was no relationship between the split and the change in academic motivation.

5.6.7 Ph.D. vs. Non-Ph.D.

Here we were testing if plans to earn a doctorate had a relationship with change in academic motivation in students.

	Observed	Expected	Residual
Ph.D. Increase	19	18.83	+0.17
Ph.D. Decrease	44	44.17	-0.17
Non-Ph.D. Increase	36	36.17	-0.17
Non-Ph.D. Decrease	85	84.83	+0.17

Table 28: Delta AcMo by Ph.D.

	Delta AcMo
Chi-square	0.003
Degrees of freedom	1
P-value	0.954
Fisher's P-value	1.000

Table 29: Significance for Ph.D.

The Chi-square test returned a p-value close to 1. We concluded that there was no significant relationship between the split and the change in academic motivation.

5.6.8 Dean's List 2009 vs. Non-Dean's List 2009

Here we were testing if academic achievements in college (inclusion to the Dean's list at WPI) had a relationship with change in academic motivation in students.

	Observed	Expected	Residual
Honors. Increase	7	5.38	+1.62
Honors Decrease	11	12.62	-1.62
Non-Honors Increase	48	49.62	-1.62
Non-Honors Decrease	118	116.38	+1.62

Table 30: Delta AcMo by Dean's List

	Delta AcMo
Chi-square	0.771
Degrees of freedom	1
P-value	0.380
Fisher's P-value	0.420

Table 31: Significance for Dean's List

The Chi-square test returned a p-value greater than the threshold of 0.05. We concluded that there was no significant relationship between the split and the change in academic motivation.

5.6.9 First Choice vs. Non First Choice

Finally, the difference in change in academic motivation between students who had WPI as their first choice of college and those who did not was examined. This time, instead of testing simply whether the academic motivation increased or decreased, the amount of change was taken into consideration.

	Observed	Expected	Residual
F : ΔT∈[0.5,4.0]	9	11.5	-2.5
F : ΔT∈[0.3,0.5)	6	7.0	-1.0
F : ΔT∈ [0.2,0.3)	8	7.0	+1.0
F : ΔT∈[0.1,0.2)	10	9.6	+0.4
F : ΔT∈[-0.1,0.1]	11	10.2	+0.8
F : ΔT∈[-0.2,-0.1]	12	14.0	-2.0
F : ΔT∈[-0.3,-0.2)	11	14.0	-3.0
F : ΔT∈ [-0.5, -0.3)	15	2.0	+0.2
F : ΔT∈[-4.0,-0.5)	4	41.5	+3.5
NF : ΔT∈[0.5,4.0]	9	6.6	+2.4
NF : ΔT∈[0.3,0.5)	5	4.0	+1.0
NF : ΔT∈ [0.2,0.3)	3	4.0	-1.0
NF : ΔT∈[0.1,0.2)	5	5.5	-0.5
NF : ΔT∈[-0.1,0.1]	5	4.9	+0.1
NF : ΔT∈[-0.2,-0.1]	10	8.1	+1.9
NF : ΔT∈[-0.3,-0.2)	11	8.1	+0.9
NF : ΔT∈ [-0.5,-0.3)	5	7.0	-2.3
NF : ΔT∈[-4.0,-0.5)	20	23.8	-3.0

Table 32: Delta AcMo by College Choice

In Table 32, "F: ΔT∈ [0.5, 4]" would denote students who had WPI as their first choice and had a change in motivation between 0.5 and 4.0. "NF: ΔT∈ [-0.5,-0.3)" would denote students who did not have WPI as their first choice and had a change in motivation between -0.5 and -0.3.

Similar to the previous sections, a Chi-square test was run to determine the significance of these results. This is given in Table 33.

	Delta AcMo
Chi-square	6.850
Degrees of freedom	8
P-value	0.558

Table 33: Significance for College Choice

The Chi-square test returned a p-value of 0.558, which means there was more than a 50% chance that this distribution occurred by random chance. Thus there was no statistical significance between the students' choice of college and their change in academic motivation.

5.6.10 Summary of Chi-square tests

Table 34 summarizes the results of the Chi-square tests done on the splits:

Split	p-value	Relationship with Delta AcMo
Male vs. Female	0.075	Weak
Choose WPI Again vs. not	0.09	Weak
Engineer vs. non-Engineers	0.358	No
Athlete vs. non-Athletes	0.494	No
Greek vs. non-Greek	0.269	No
High School A's vs. not	0.927	No
Ph.D. vs. non-Ph.D.	0.954	No
Dean's List vs. not	0.380	No
First Choice WPI vs. not	0.558	No

Table 34: Summary of Chi-square tests

5.7 Interviews at Time T3

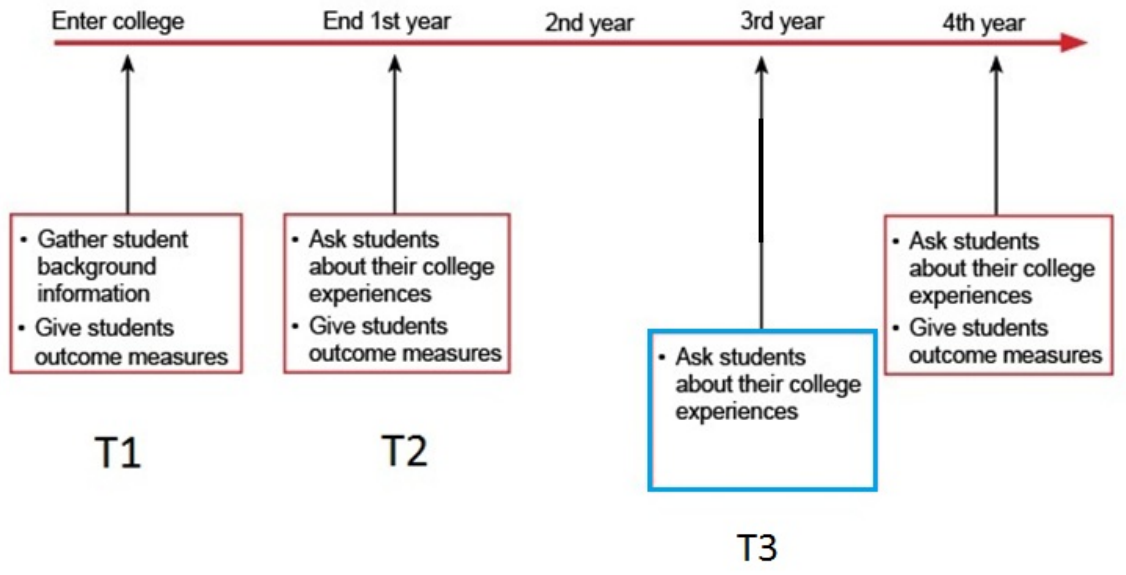

Figure 15: Wabash Interviews

To analyze how academic motivation changed further in their college careers, our group held interviews in the spring of 2011 with students who completed surveys at both T1 and T2. These interviews were independent of the WNS. This time was denoted as T3 to be consistent with the timeline given previously. Out of the 200 students who completed both the T1 and T2 survey, 17 returned for the T3 interview, where they were given the Academic Motivation Scale to complete once more. This was done to provide a third set of data and gather insight about any change that occurred between a student's freshman and junior year.

The students were also given a short survey in which more specific questions were asked, such as questions pertaining to changing majors, involvement in major projects, and most importantly the student's own view of the ways that their motivation had changed since freshman year. This was followed by a short focus group session in which the students were asked to speak openly about their responses to the survey. Some majority opinions emerged as a result of this session. The students felt that their motivation in a class was significantly affected by the level of interest the professors had in the class. They explained that professors who seemed to teach directly out of the book demotivated them because they felt that if the professor did not make the

effort to compose his/her own lesson plan, then he/she must not be interested in the class nor the students.

Students also appreciated professors who embraced those who took time out of class to discuss material pertaining to the class. Students felt that the basic math and science courses they took in their freshman year demotivated them as well. They felt the material they were learning was neither interesting nor useful for their careers. They did not like the fact that it was all theory-based and that they could not apply what they learned. Another opinion was that their motivation had shifted as they neared the end of their college career from being driven by classes and learning to being driven by graduation and the prospect of jobs.

There was an overall interest in some type of post-sufficiency humanities courses to be offered to upperclassmen to provide them with a greater variety of classes their junior and senior year, which they felt would increase academic motivation. Finally, most of the students felt that WPI's project-based curriculum provided a very unique and beneficial learning atmosphere, preparing students very well by giving them "hands on" experience while they were still in college. Some of the responses from individual students are given below.

About their professors:

"I found it empowering that professors will take their free time to talk with you."

About introductory math courses:

"Each problem was the same, they just had different numbers."

About WPI's project-based curriculum:

"I'm glad WPI offers many classes where you get to actually apply what you learn because my friends from other engineering schools tell me that most of what they learn is only theory-based."

"Projects here show you that what you are learning actually works."

About beginning to take major-related courses:

"This is serious now; I have to really know what I'm doing."

"I became more motivated because I realized what I want to do in life."

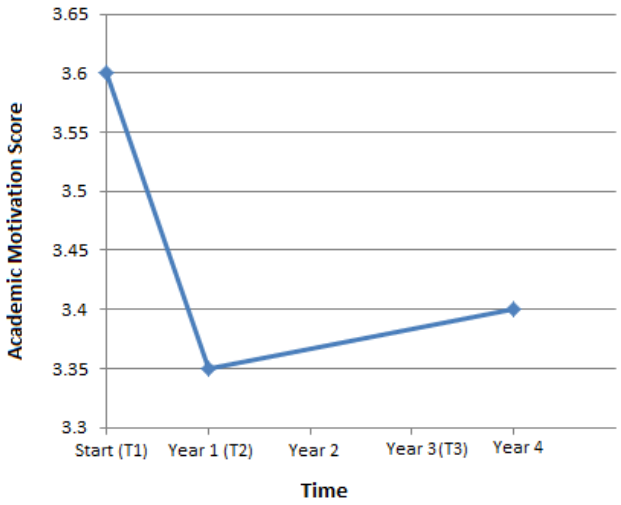

Figure 16: Four-year Trend in 2006 WNS Institutions

Figure 16 was created using data collected by the WNS over four years from the 19 institutions that participated in the study in 2006 (Center of Inquiry, 2008). To compare the change in motivation modeled here with the 17 students interviewed at T3, Table 35 shows the academic motivation scores for these students at T1, T2 and T3.

17 Students	AcMo T1	AcMo T2	AcMo T3	Delta AcMo T1,T2	Delta AcMo T2,T3
1	4.50	4.50	4.63	0.00	0.13
2	4.00	3.88	4.38	-0.13	0.50
3	4.25	3.75	4.25	-0.50	0.50
4	4.50	4.88	4.25	0.38	-0.63
5	4.75	4.13	4.13	-0.63	0.00
6	4.50	4.25	4.00	-0.25	-0.25
7	4.25	3.50	4.00	-0.75	0.50
8	3.50	4.00	3.50	0.50	-0.50
9	3.63	4.38	3.38	0.75	**-1.00**
10	4.13	4.25	3.38	0.13	-0.88
11	3.63	3.00	3.38	-0.63	0.38
12	3.50	3.00	3.38	-0.50	0.38
13	3.00	2.88	3.38	-0.13	0.50
14	3.50	3.13	3.13	-0.38	0.00
15	4.63	3.75	3.00	-0.88	-0.75
16	3.63	2.63	3.00	**-1.00**	0.38
17	2.50	4.00	2.75	**1.50**	**-1.25**
Average	3.91	3.71	3.64	-0.15	-0.12

Table 35: Interviewed Students at T3

On average, the academic motivation score of the 17 students decreased from T1 to T2 and again from T2 to T3. The individual changes in motivation from T1 to T2 had two extreme values (magnitude of change greater than or equal to 1.00), but since one was positive and one was negative, they did not distort the average change from T1 to T2. However, in the individual changes from T2 to T3, the two extreme values were both negative. These two students were disregarded and the remaining 15 were considered to calculate a new set of scores for T1, T2 and T3 as shown in Table 36.

15 Students	AcMo T1	AcMo T2	AcMo T3	Delta AcMo T1,T2	Delta AcMo T2,T3
Average	4.02	3.70	3.72	-0.32	0.02

Table 36: Remaining 15 Students at T3

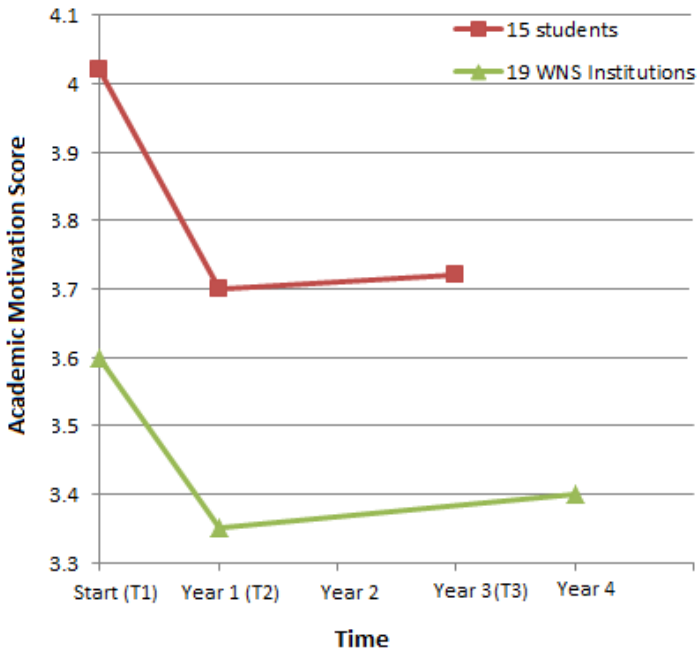

Figure 17: Relating 15 Students to 19 WNS Institutions

Figure 17 shows the change in academic motivation for the remaining 15 students at T3 and for the students from the 19 institutions in the 2006 WNS. Although the absolute scores were higher for the 15 students, the relative changes in scores were very similar in the two groups. By

this, we predict that these 15 students will follow the trend set by the students from these 19 institutions and increase in motivation from Year 3 (T3) to the Year 4.

		Delta AcMo T2, T3
Delta AcMo T1, T2	Pearson Correlation	-.697
	Number of students	17

Table 37: Corr Delta AcMo T2, T3 vs. Delta AcMo T1, T2

Table 37 shows that the Pearson correlation index was -0.697. Thus if a student's motivation had a positive change from T1 to T2, then his/her motivation was likely to decrease from T2 to T3. Conversely, if a student's motivation decreased from T1 to T2, then his/her motivation was more likely to increase from T2 to T3. Based on this result, we hypothesize that there will be an increase in the 200 students' academic motivation score from end of first year (T2) to fourth year.

5.8 Extrinsic and Intrinsic Motivation at WPI

By our analysis, the Wabash Academic Motivation scale has 3 questions which measure extrinsic motivation and 5 questions that measure intrinsic motivation. In order to find any significant difference between the two, we calculated the mean, median and standard deviation for the intrinsic and extrinsic motivation at T1 and T2 and evaluated the change in intrinsic and extrinsic motivation.

	ExAcMo T1	InAcMo T1	ExAcMo T2	InAcMo T2	Delta ExAcMo	Delta InAcMo
Mean	3.968	3.499	3.883	3.180	**-0.085**	**-0.316**
Median	4.000	3.500	4.000	3.200	0.000	-0.200
Std. Deviation	0.704	0.618	0.735	0.720	0.766	0.616

Table 38: Basic Statistics for InAcMo and ExAcMo

We can observe in Table 38 that the extrinsic motivation remained significantly higher than the intrinsic motivation for T1 and T2. Moreover, while extrinsic motivation only reduced by 0.085 on average over freshman year, intrinsic motivation went down by a staggering 0.316 on average. This tells us two things.

- The items in the Wabash scale that measure extrinsic motivation are worded to gauge how important it is for students to get the best grades, and how important the student feels his/her academic experiences are. We can see that on average, these factors remained nearly the same for WPI students over their freshman year. On the other hand, their intrinsic motivation dropped significantly.

- WPI students scored higher on items measuring extrinsic motivation than they did for those measuring intrinsic motivation. This is in accordance with Self-Determination Theory, which suggests that as an individual grows, their intrinsic desire to act reduces and is largely replaced by extrinsic motivators such as grades, or a prospective career.

6 Conclusions

WNS defines academic motivation as a raw number obtained from responses to the eight questions in the Academic Motivation Scale. On average, academic motivation decreased for students from time T1 to T2 and then again to T3. The population of 200 students had a mean academic motivation score of 3.68 at T1, which reduced to 3.45 in T2. This trend is not surprising because research suggests that academic motivation had a similar decrease in other participating institutions in the WNS.

Academic motivation in freshman year was affected by faculty contact. There was a strong positive linear relationship between how highly students rated their interactions with faculty and their change in academic motivation. Students who had contact with faculty were more likely to have an increase in academic motivation in freshman year.

We hypothesized that a decrease in GPA would be related to a decrease in academic motivation as defined by the study. This was disproved, as it was found that there was no correlation that existed between change in GPA and change in academic motivation.

Male students showed a higher frequency of decrease than expected and females showed a higher frequency of increase than expected in academic motivation over freshman year. Even though this result was not considered to be statistically significant, it was very near the threshold of significance and it was the most defining split that was found in this analysis. The other splits, such as change in academic motivation versus varsity athletics or change in academic motivation versus participation in Greek life did not yield results that were near the threshold of statistical significance.

In the interviews at T3, students explained they had a lack of motivation in basic math and science courses in their freshman year. Their motivation increased as they encountered courses that were more pertinent to their major. The majority of upperclassmen was in favor of pass/fail humanities courses being offered after they have completed their sufficiency to provide a variety to their course load. The average academic motivation score of the 15 students considered from the interviews followed the trend set by the 19 institutions from the 2006 WNS. From this, it can be expected that these 15 students would also follow the trend and increase in academic motivation from T3 to the end of college.

This report classified the eight questions in the Academic Motivation Scale into two groups: three measuring extrinsic motivation and five measuring intrinsic motivation. Among the

200 WPI students, while intrinsic motivation changed by -0.32 from T1 to T2, extrinsic motivation only changed by -0.09. This result, along with other findings of this project indicated that a better way to measure academic motivation would be to measure intrinsic and extrinsic motivations separately.

7 Recommendations for Future Studies

Our analysis revealed a difference between change in intrinsic motivation and change in extrinsic motivation among WPI students. While the WNS merged both types of motivation into one single scale, we observed that students had a large decrease in intrinsic motivation and a much smaller decrease in extrinsic motivation. A possible future study should define individual scales measuring intrinsic motivation and extrinsic motivation and analyze the change in each of them in a similar longitudinal study like the WNS.

When we performed a chi square test to determine the relationship between change in academic motivation and gender, we observed that a higher number of male students had a decrease in academic motivation that what was expected. This can be attributed to female students being more intrinsically motivated in comparison to male students. Thus a future study should investigate the change in intrinsic motivation by gender.

Most of our analysis was done using the data obtained from the academic motivation scale in the WNS. There are other scales in the WNS which we were not able to analyze in detail in a similar manner. Thus future IQP groups should utilize the WNS data for these scales (such as the Social Responsibility Leadership Scale, Miville-Guzman Universality Diversity Scale, etc.).

One important factor that we were unable to study was the impact of a student's income on his/her academic motivation. Future IQP groups should analyze students' personal incomes or their parents' incomes play a role in their motivation.

Future studies can be done on other scales that aim to measure motivation, such as the Academic Motivation Scale (Vallerand & Pelletier, 1992), which is a 28-item scale translated to English from the French Echelle de Motivation en Education and is one of the well-known scales for measuring motivation. As was done in our research, the results from this survey can be compared with responses from the interviewed subjects to determine its accuracy. Also, research done for this project was primarily based on Self-determination Theory. Future projects could focus their background research on other motivation model such as MUSIC and Dweck models.

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9 Appendices

9.1 Appendix A: Glossary of statistical terms and Tests

Below is a list of useful statistical terms and tests. Some of the examples provided below are a bit extreme in order to illustrate the concept in a clearer manner.

- **Population**: All of the objects (people) in the data (survey).
- **Sample**: A specific subset of the population.

Example:

Population: The 200 WPI students who had done surveys both at the beginning and the end of the year.

Samples: Female students, Male students, International students, etc.

9.1.1 Measure of Central Tendency:

- **Mean** is the average value of a set of numbers. The mean of a population is represented by the symbol μ, and the mean of a sample is represented by the symbol $\bar{x}$.
- **Median** is calculated by rearranging the numbers from lowest to highest and taking the value in the middle of this new sequence; if the set has an even number of values, the average of the middle two is taken to be the median.

What does it imply when the mean of a set of numbers is higher/lower than its median?

The cause of this occurrence is the "extreme values" in a set of data.

If the mean is higher than the median, there will be some unusually high values. If the mean is lower than the median, there will be some unusually low values.

9.1.2 Measure of Dispersion:

Variance measures how far are each of the values away from their mean.

Variance of a population is denoted by σ^2 and variance of a sample is denoted by s^2.

$$\sigma^2 = \frac{\sum_{i=1}^{N}(x_i - \mu)^2}{N}$$

$$s^2 = \frac{\sum_{i=1}^{n}(x_i - \bar{x})^2}{n-1}$$

x_i denotes each of the values in a data set,

N (n) is the total number of values in a population (sample)

If the values in a data set are really different or far away from their mean, the σ^2 will be relatively large and vice versa. For now we will not be looking at the difference between "N" and "n-1". This is because sample variance tends to be lower than the population variance when calculated the same way.

Example:

Set: {-2, -1, 1, 2}
Mean = 0 $\sigma^2 = (4+1+1+4)/4 = 2.5$
Set: {-20, -10, 10, 20}
Mean = 0 $\sigma^2 = (400+100+100+400)/4 = 250$

The above two groups of data have the same mean, but the values are distributed around its mean differently (disregard that they are both symmetrical in this example).

Standard Deviation is the square root of the variance. It is a measure of the average distance of the data points from the mean of the distribution.

9.1.3 Measure of Relationship:

Covariance is a measure of the linear relationship between two sets of data,

$$Cov(x,y) = \sum_{i=1}^{n} \frac{(x_i - \bar{x})(y_i - \bar{y})}{n}$$

If x is above its average when y is above its average and x is below its average when y is below its average as well, the covariance will be positive, which means x and y change in the same direction. On the other hand, a negative covariance is when x goes up, y goes down and vice versa.

Example:

x	11	22	64	66	22
y	44	11	55	11	44

Table 39: Example Covariance

Mean of x = (1+2+4+6+2)/5 = 3
Mean of y = (4+1+5+1+4)/5 = 3
Cov(x,y) = [(1-3)(4-3) + (2-3)(1-3) + (4-3)(5-3) + (6-3)(1-3) + (2-3)(4-3)] / 5
= -1
Thus x goes up when y goes down, and x goes down when y goes up.

Correlation is calculated as $Cov(x,y)/\sigma_x\sigma_y$, the covariance of two sets of data divided by their standard deviation. It is unitless and always valued between -1 and 1.

9.1.4 Chi-square Test:

The Chi-square Test is used in two similar but distinct circumstances:

- To test how closely the observed data matches expected data values, also known as the Goodness-of-Fit test.
- To determine whether two variables are independent.

Example for the Goodness-of-Fit test:

The following table shows the number of students came to class during a week. If we want to see how good the expectation fits the actual data, we will use the χ^2 test.

	Monday	Tuesday	Wednesday	Thursday	Friday
Expected	14	10	19	23	18
Observed	13	19	16	16	13

Table 40 : Example Goodness-of-fit

To calculate the χ^2 value, we will use the following formula:

$$\chi^2 = \sum_{i=1}^{n} \frac{(x_{observed} - x_{expected})^2}{x_{expected}}$$

And referring to the χ^2 table, if the calculated χ^2 value is smaller than the one in the table with the corresponding degree of freedom (Degree of freedom = n-1), it is a good expectation for the data set.

Looking at the numerator $(x_{observed} - x_{expected})^2$, we see that when the number of the observed values is close to what we expected, this number will be small and the sum of all fractions with small numerator will be a relatively small χ^2 –value as well, thus a smaller χ^2 value means a better expectation.

Example to determine if two values are independent:

In the following table, we want to see if there is a relationship between gender and grade.

	Male	Female	Row Sum
A	12	7	19
B	25	12	37
C	14	5	19
NR	3	1	4
Col. Sum	54	25	79

Table 41: Example Independence

First assume the null hypothesis:

H_0: Gender has no effect on what grade the students get.

If gender has no effect:
The number of male students got A should be (19/79)*54 = 12.987
The number of male students got A should be (19/79)*25 = 6.012
The number of male students got B should be (37/79)*54 = 25.251
The number of male students got B should be (37/79)*25 = 11.709
The number of male students got C should be (19/79)*54 = 12.987
The number of male students got C should be (19/79)*25 = 6.012
The number of male students got NR should be (4/79)*54 = 2.7341
The number of male students got NR should be (4/79)*25 = 1.266

Expected	male	female
A	12.987	6.012
B	25.251	11.709
C	12.987	6.012
NR	2.7341	1.266

Table 42: Example Independence (2)

$\chi^2 = 0.578$

It is lower than the number in the χ^2 value table, thus it is a good expectation and the null hypothesis is true. As a result, it can be said that there is no statistically significant between gender and grades.

9.1.5 Fisher's test:

Another widely-used test for determining the independence between two groups is Fisher's exact test. Invented by R. A. Fisher, it is generally applied to analyze 2x2 contingency tables. It is sometimes preferred over the Chi-square test when considering smaller sample sizes because Fisher's exact test is less dependent on the equality of distribution. The procedure for Fisher's test is as follows:

	Group 1	**Group 2**	
Outcome 1	a	b	a+b
Outcome 2	c	d	c+d
	a+c	b+d	n

Table 43: Example Fisher's Test

First, we calculate the "cutoff p-value".

$$p_{cutoff} = \frac{(a+b)!\,(c+d)!\,(a+c)!\,(b+d)!}{a!\,b!\,c!\,d!\,n!}$$

Next, all permutations of positive integers (and zero) for a, b, c, and d which satisfy the sums of the rows and columns of the original table, also known as the marginal sums (a+b, c+d, a+c, and b+d), are considered. The number of permutations will be equal to one more than the value of the smallest marginal sum. A separate p-value is calculated for each of these tables as well (using the same expression as above). Once this is done, each p-value which is less than or equal to the p_{cutoff} (including the cutoff value itself) are summed up to find the p-value of the distribution. This number expresses the probability that the null hypothesis is correct. Generally, a p-value less than .05 signifies that the null hypothesis can be rejected and that there is a fundamental difference between the two groups under consideration.

An example of a situation in which Fisher's exact test can be used would be if a class of 20 kindergarteners was asked which color they liked more, blue or pink. Out of the 12 males, 9 chose blue and 2 chose pink, and of the females, 1 chose blue and 8 chose pink. These results are represented in the 2x2 contingency table below.

	Male	Female	
Blue	9	1	10
Pink	2	8	10
	11	9	20

Table 44: Example Fisher's Test (2)

This distribution will have 10 possible permutations which satisfy the marginal sums, which are listed below along with the associated p-values.

10	0	9	1	8	2	7	3	6	4
1	9	2	8	3	7	4	6	5	5
p-value=0.00006		p-value=0.00268		p-value=0.03215		p-value=0.15006		p-value=0.31507	

5	5	4	6	3	7	2	8	1	9
6	4	7	3	8	2	9	1	10	0
p-value=0.31507		p-value=0.15006		p-value=0.03215		p-value=0.00268		p-value=0.00006	

Table 45: Example Fisher's Test (3)

Note that not every distribution will follow a pattern of p-values such as this.

Each p-value less than or equal to the p_{cutoff} (.00268) is summed to find the p-value for the distribution.

$$p = .00006 + .00268 + .00268 + .00006 = .00548$$

This p-value of .00548 signifies that there is a .548 % probability that there is no correlation between the boys and girls in this kindergarten class, so the null hypothesis can be rejected and it can be said that there is a fundamental difference between these two groups.

9.2 Appendix B: How to use SPSS

All of the data analysis presented was done using the statistical analysis software package SPSS (Statistical Package for the Social Sciences). The data obtained from the Wabash National Study comes in a standard SPSS-readable format. This appendix is a brief tutorial in the use of SPSS for analyzing the Wabash National Study data.

Begin with opening the file entitled "Wpi200studentswithGPA.sav" in SPSS.

9.2.1 Data Editor Window

One of the windows after opening the Wabash Survey data is the **Data Editor window**; it has two views: **Data view** and **Variable View**. You can switch between them using the two buttons located at the left hand side corner.

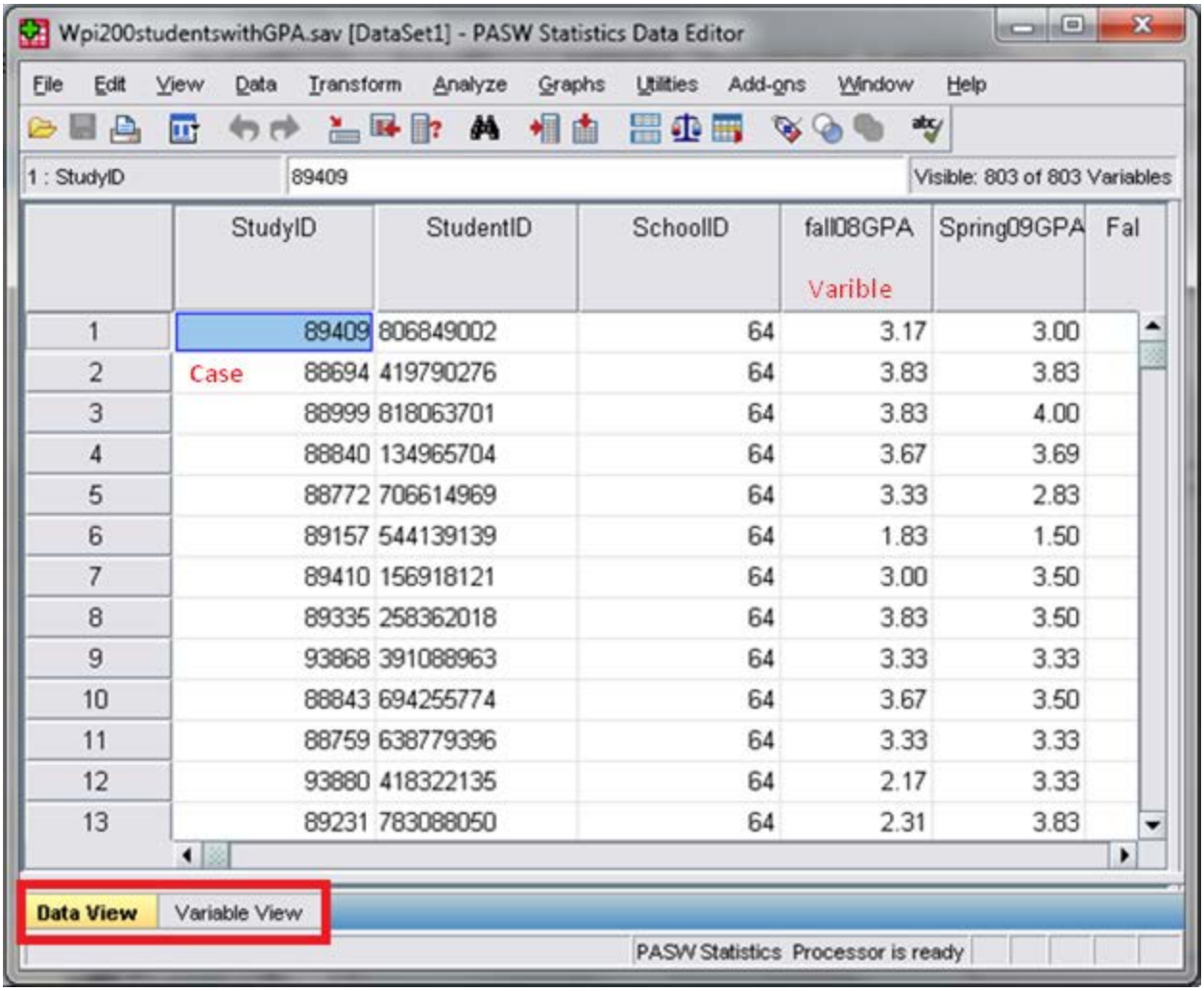

Figure 18: Data View

In Figure 18, the window is in **Data View** and it's used to input and edit data just like in Excel. Each row is called a **Case** and it represents an individual student. Each column is called a **Variable**, and a variable may be the answers to a Wabash survey question, the students' GPA, etc.

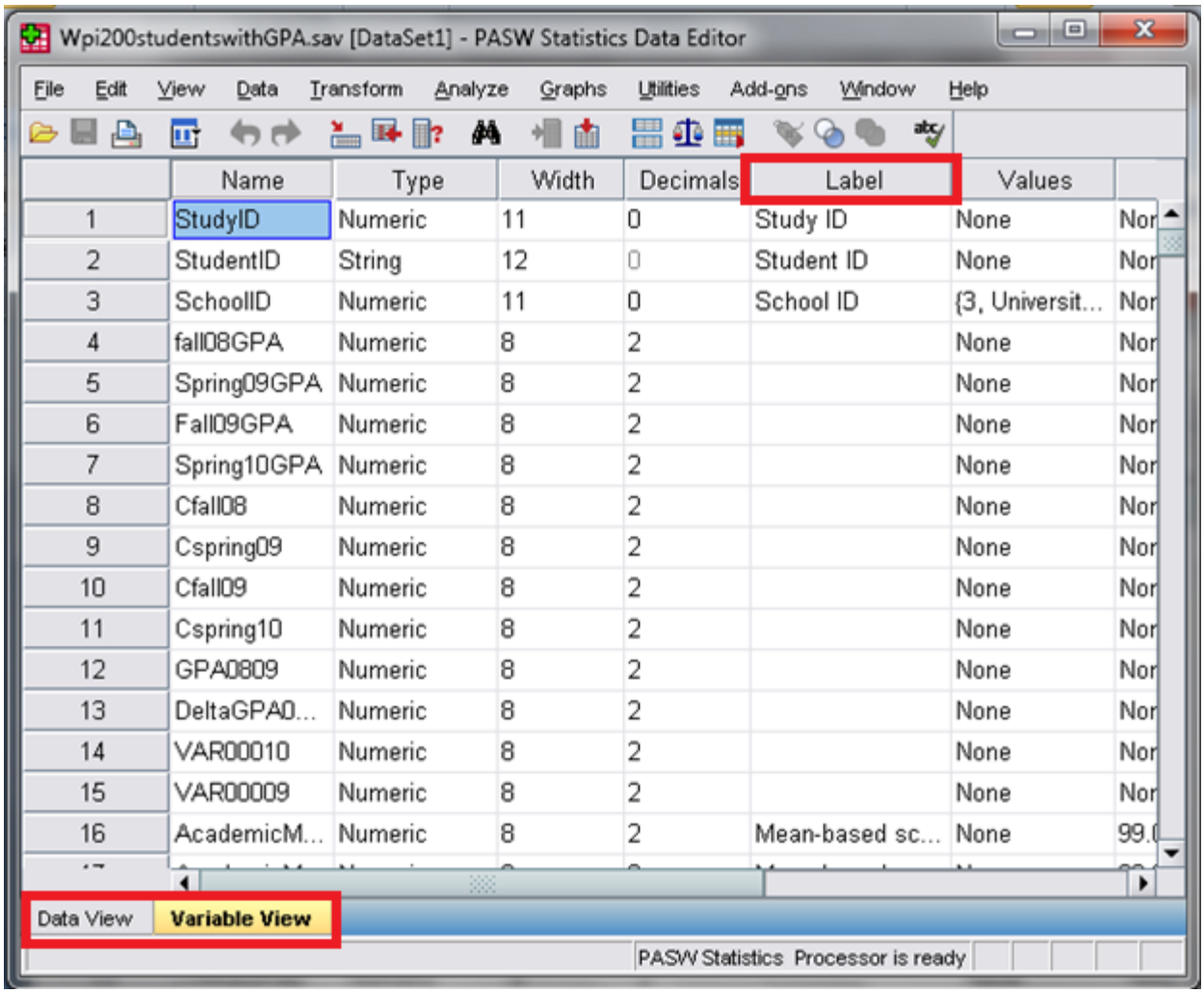

Figure 19: Variable View

This is the window in **Variable View**; we can use it to define new variables or change the existing variables. Under **Label** we can find a full detailed description of the variable, and you can find the original Wabash survey question under here.

The other window that you see after opening SPSS is the **Output Window**, the graph and calculations that SPSS generates will be shown in this window.

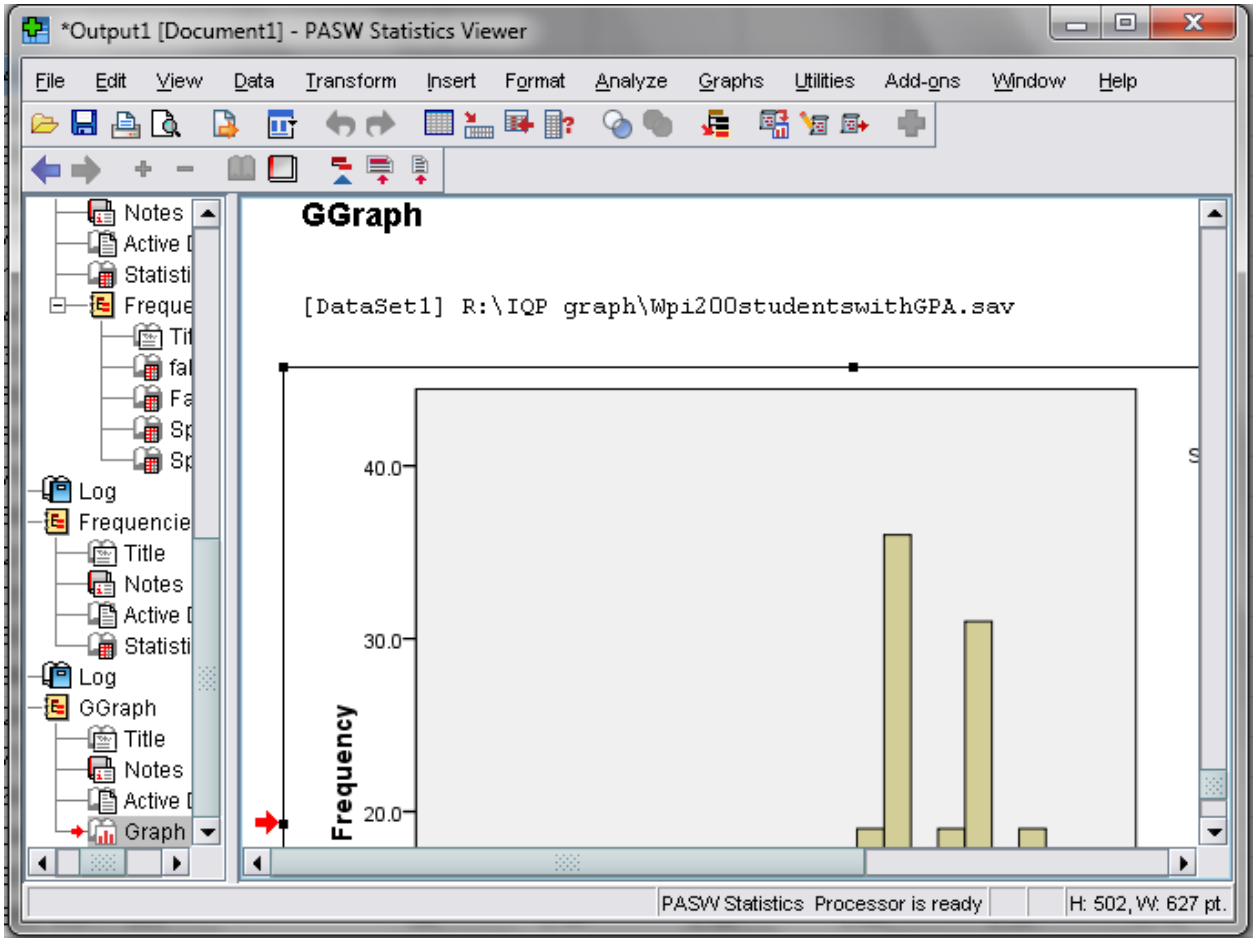

Figure 20: Out Put Window

9.2.2 Working with variables

To define a new variable, click on **[Insert Variable]**, it is located on the top of the window. Then edit the new variable's **Name**, **Type**, **Label**, etc. in **Variable View**.

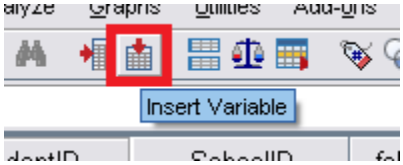

Figure 21: Insert Variable

To find a variable, click on **[Go to Variable]** and type in the name or part of the name of the variable that we are trying to find.

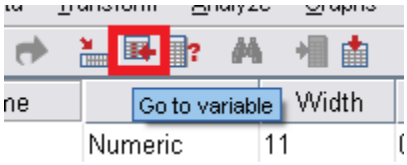

Figure 22: Go to Variable

To sorting the results of a variable, right click on a variable in data view and there are **[Sort Ascending]** and **[Sort Descending]**.

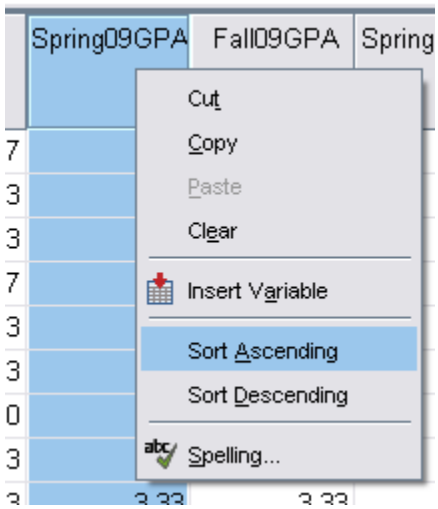

Figure 23: Sort Variable

To do calculations between variables, click on **[Transform]** then **[Compute Variable...]**. Drag the variables that you are computing into the window on the right, see below Figure 24 for an example. The outcome of this calculation will be shown as a new variable.

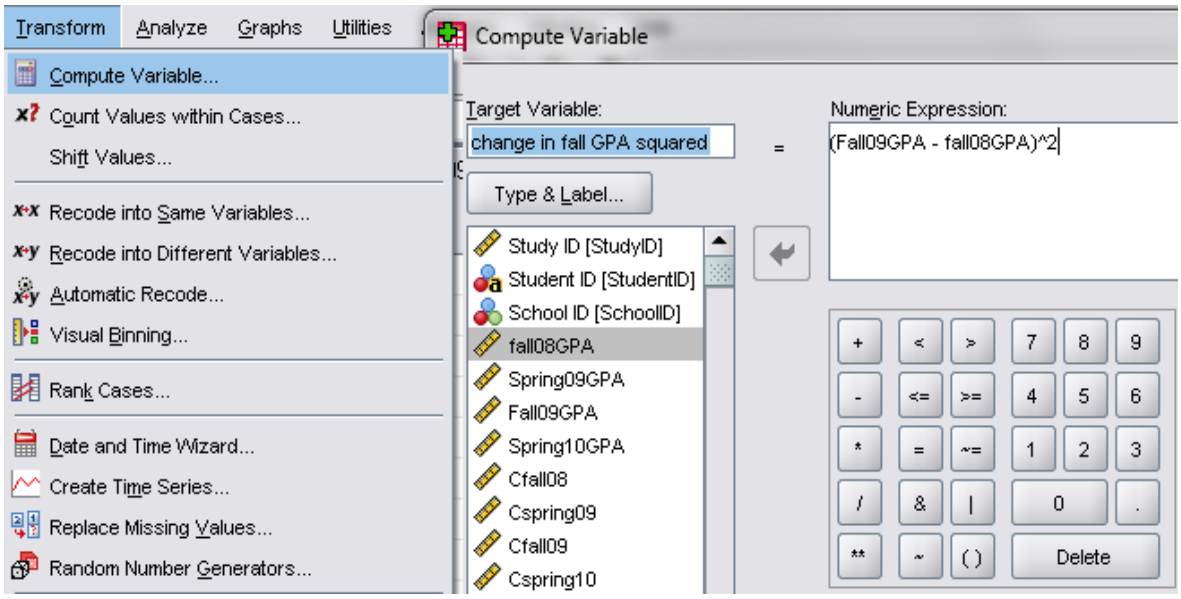

Figure 24: Calculations between Variables

9.2.3 Statically Values Tests and Graphs

To calculate the mean median and standard deviation, go to **[Analyze] → [Descriptive Statistics] → [Frequencies]**

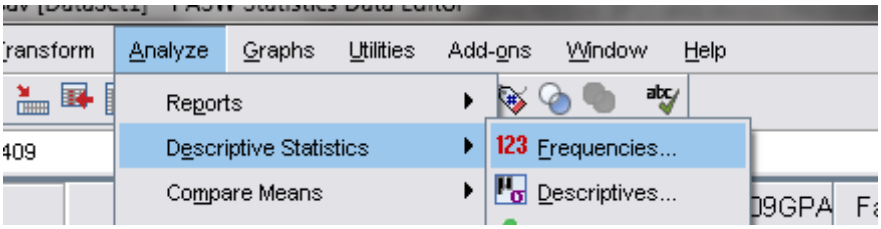

Figure 25: Calculating mean etc. 1

Then this window below will appear, click on **[statistics…]**, and check the boxes for **Mean Median** and **Std. deviation**.

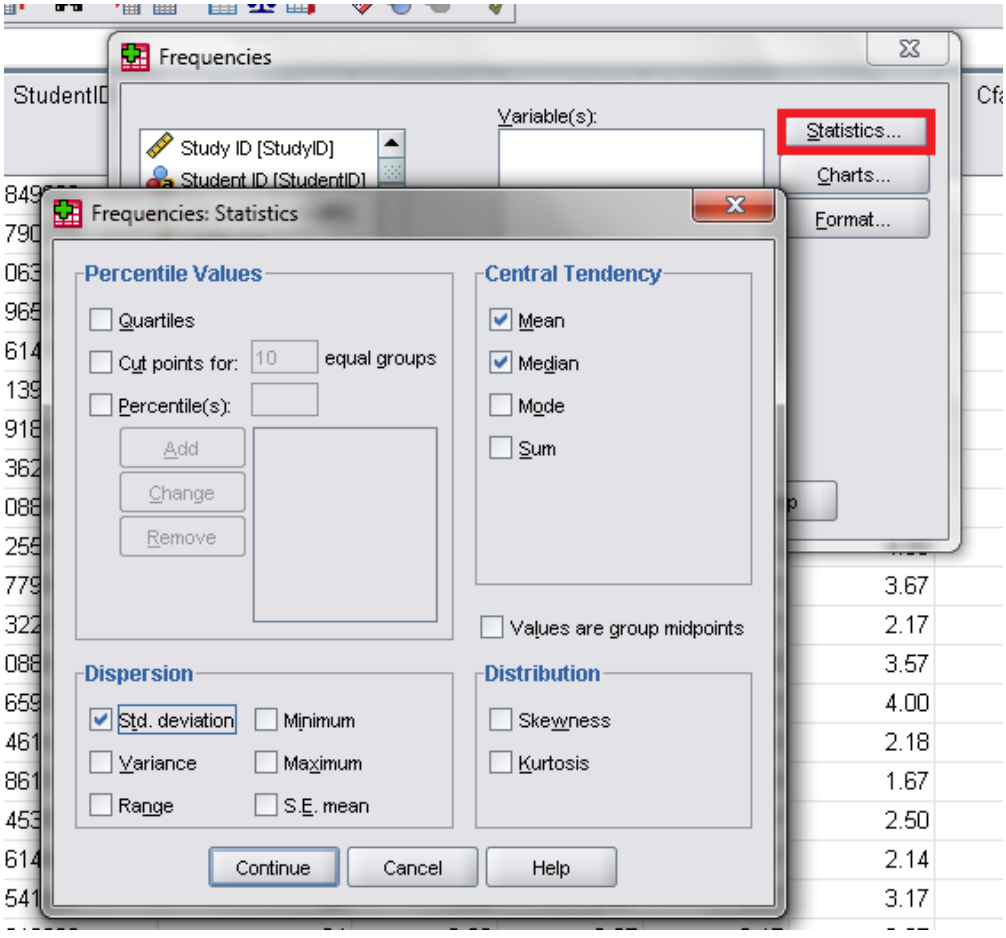

Figure 26: Calculating mean etc. 2

Now drag the variables that you need to calculate into the window.

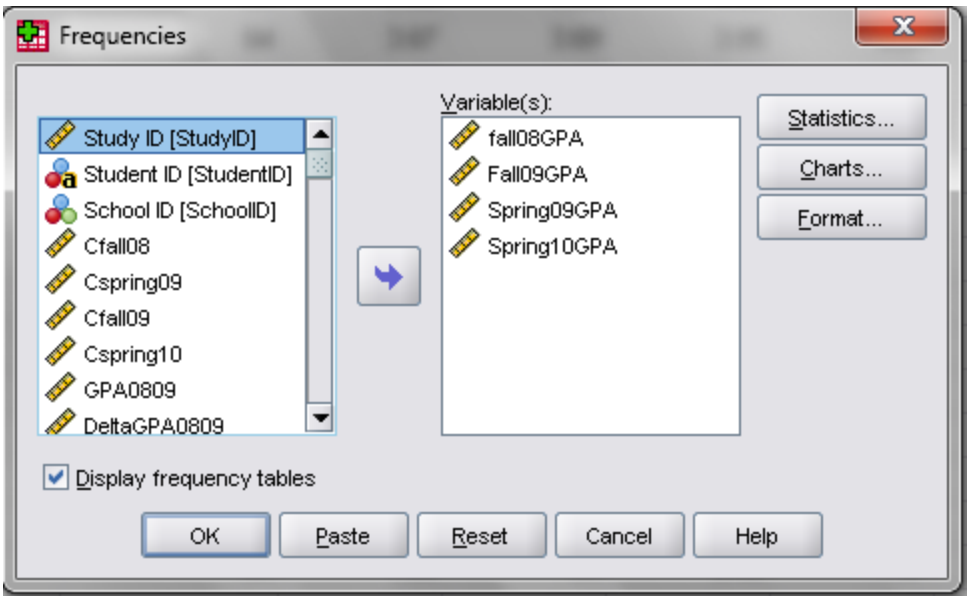

Figure 27: Calculating mean etc. 3

After hitting ok, the results will appear on your **output window**.

Frequencies

```
[DataSet1] R:\IQP graph\Wpi200studentswithGPA.sav
```

Statistics

		fall08GPA	Fall09GPA	Spring09GPA	Spring10GPA
N	Valid	200	196	200	193
	Missing	0	4	0	7
Mean		3.0903	3.1190	3.1208	3.0882
Median		3.3100	3.1700	3.2000	3.1700
Std. Deviation		.71333	.67932	.70370	.69089

Figure 28: Calculating mean etc. 4

To calculate the correlations between two variables, go to **[Analyze] → [Correlate] → [Bivariate].**

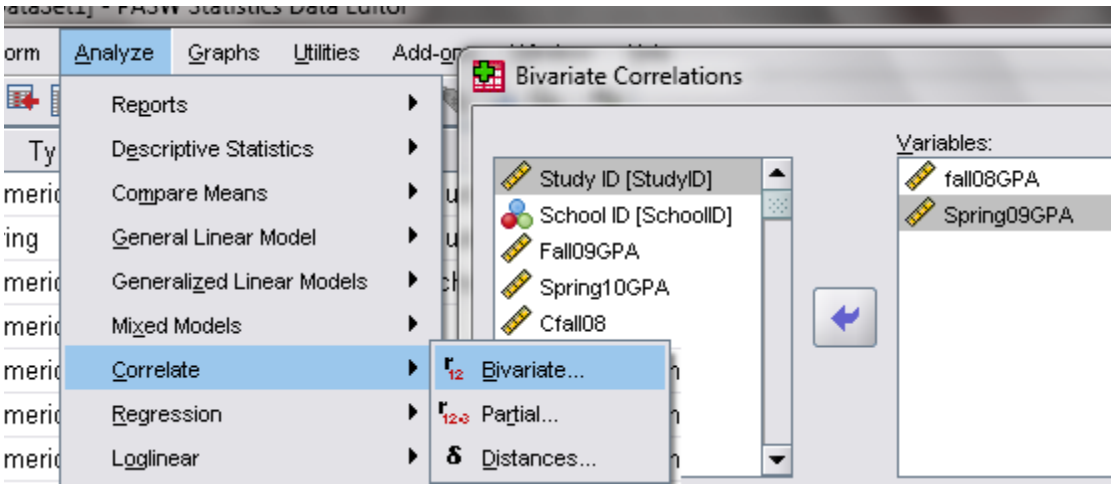

Figure 29: Calculate Correlation 1

Then drag the two variables into the window on the right and click on ok, the result will show up in the **Output Window**.

Correlations

[DataSet1] R:\IQP graph\Wpi200studentswithGPA.sav

Correlations

		fall08GPA	Spring09GPA
fall08GPA	Pearson Correlation	1	.729**
	Sig. (2-tailed)		.000
	N	200	200
Spring09GPA	Pearson Correlation	.729**	1
	Sig. (2-tailed)	.000	
	N	200	200

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

Figure 30: Calculate Correlation 2

The values with **or * behind them, they indicate statistical significance. If the number is close to 1, it means that there is a positive relationship. If the number is close to 0, it means that there is no relationship most times. If the number is close to -1, it means that there is a negative relation between the two variables.

To generate a graph, go to **[Graph] → [Legacy Dialogs] → [(Choose your graph)].**

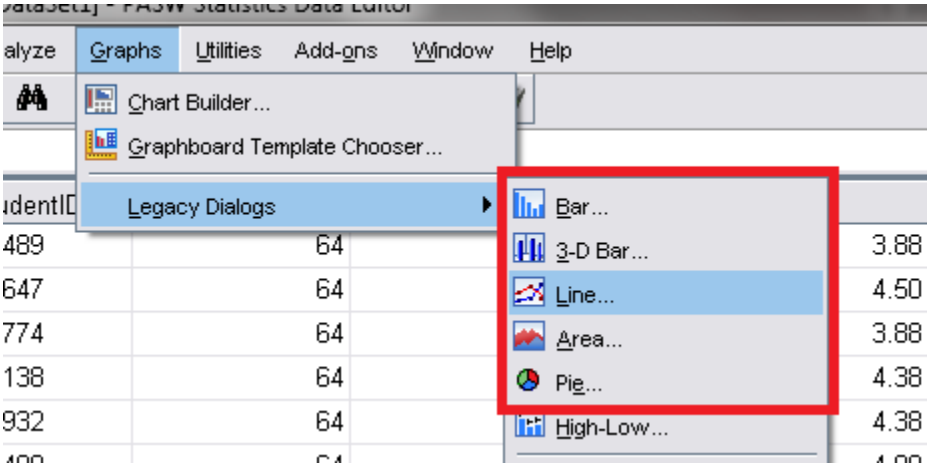

Figure 31: Generate Graph

For more information, refer to *SPSS Statistics: How to Use SPSS* (Services, 2010).

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9.3 Appendix C: T3 Interview questionnaire

Name: _____

Student ID: _____

Email Address: _____

ACADEMIC MOTIVATION SCALE

General Instructions: Circle the number that indicates the extent to which you agree/disagree with each of the following statements about your views or perspectives in general.

There is neither a right nor wrong answer to any question. Please do your best to provide complete information. However, if you do not want to respond to an item, feel free to leave the response blank. Your identity and responses will be held in strict confidence.

	Strongly Disagre	**Disagree**	**Neutral**	**Agree**	**Strongly Agree**
A. I am willing to work hard in a course to learn the material even if it won't lead to a higher grade.	1	2	3	4	5
B. When I do well on a test, it is usually because I am well-prepared, not because the test is easy.	1	2	3	4	5
C. I frequently do more reading in a class than is required simply because it interests me.	1	2	3	4	5
D. I frequently talk to faculty outside of class about ideas presented during class.	1	2	3	4	5
E. Getting the best grades I can is very important to me.	1	2	3	4	5
F. I enjoy the challenge of learning complicated new material.	1	2	3	4	5
G. My academic experiences (i.e., courses, labs, studying, discussions with faculty) will be the most <u>important</u> part of college.	1	2	3	4	5
H. My academic experiences (i.e., courses, labs, studying, discussions with faculty) will be the most <u>enjoyable</u> part of college.	1	2	3	4	5

Further Assessment:

Please circle the appropriate answers.

1. Did you participate in the Great Problems Seminar in your freshman year? Yes No

If yes, please list the GPS name _____

2. Did you complete your Humanities and Arts Requirement? Yes No

If yes, please list the area of depth _____

3. Have you begun or completed your Interactive Qualifying Project? Yes No

If yes, please list the location of the IQP _____

4. Please list your current major(s)

_____

_____

5. Have you changed your major since freshman year Yes No

If yes, please list your previous major(s) _____

_____

_____

6. Are you a member of a Greek organization? Yes No

If yes, please list the organization(s) _____

_____

_____

7. If you could start over again, would you go to the SAME institution you are now attending? Yes No

Please briefly explain your response.

_____

_____

8. Do you consider your Academic Motivation to have increased or decreased since freshman year? Increase Decrease

Please briefly explain your response.

_____

_____

9.4 Appendix D: Script for open session T3 Interviews

6:30 PM:

Serve pizza to be consumed during interview and introduce our project to interviewees.

6:40 PM:

Hand out the questionnaire (2 pages). While students are completing the questionnaire, we will be standing in the back as to not draw attention and distract.

6:50 PM:

Take up questionnaire then begin the discussion with the students about their interpretation of the Wabash academic motivation questions and ask them to tell us about their academic college experiences.

Guide Questions:

1. On question number eight, “Do you consider your Academic Motivation to have increased or decreased since freshman year??” can you attribute your answer to a specific experience or event?

2. Do you believe that WPI’s project-based curriculum has had a positive effect on your motivation as a student? How so?

3. Do you think that when you prepare well for an exam, you do better even if the exam is not easy?

4. Do you enjoy talking to your professors about course materials? If yes, please briefly explain why.

5. Do you believe you study harder than usual if you aren’t doing well in a class?

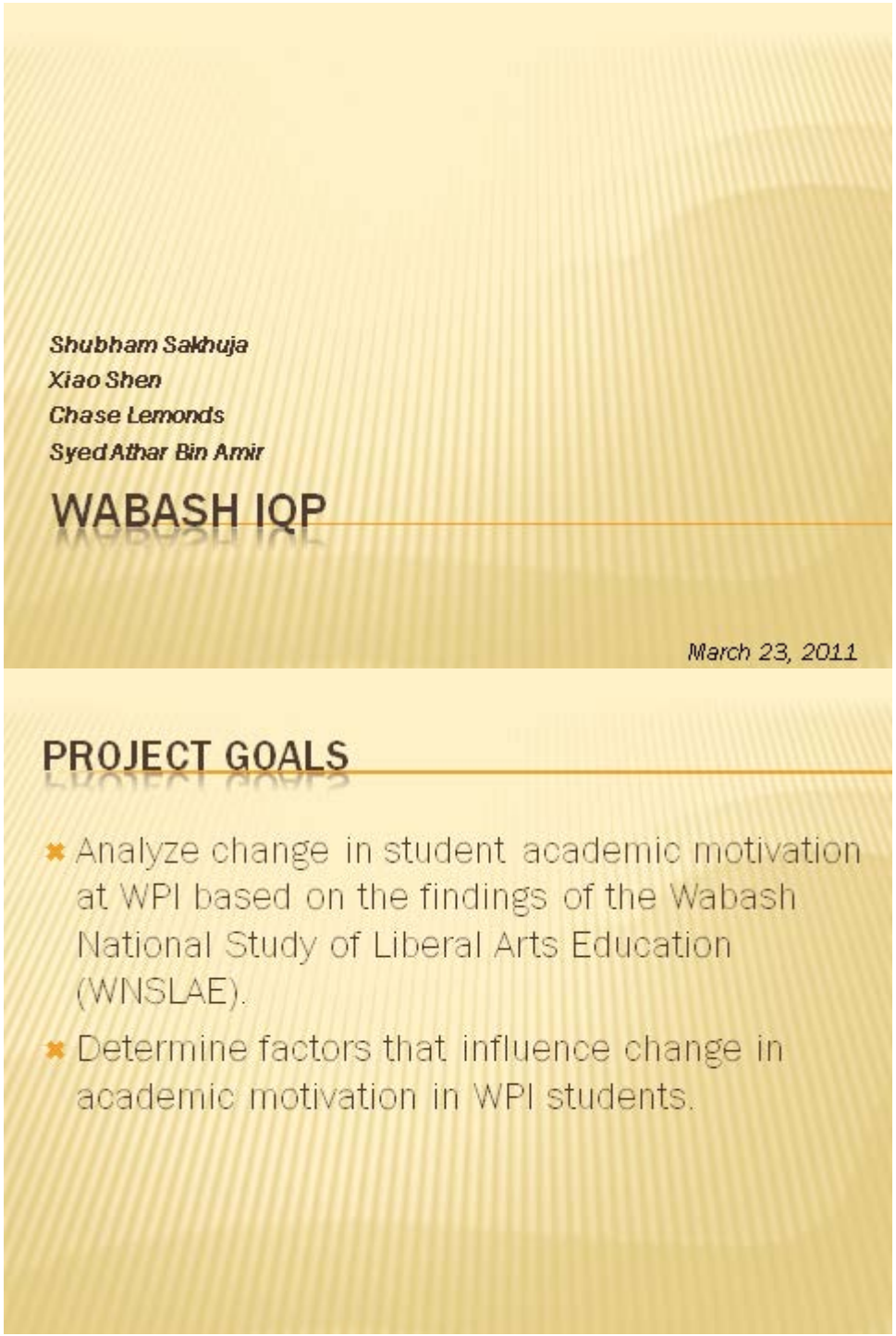
6. Do you believe you study harder than usual if you enjoy learning the content covered in a class?

7. How would you describe your overall academic experience your freshman year at WPI?

7:30 PM:

We thank them for their time and send them on their way.

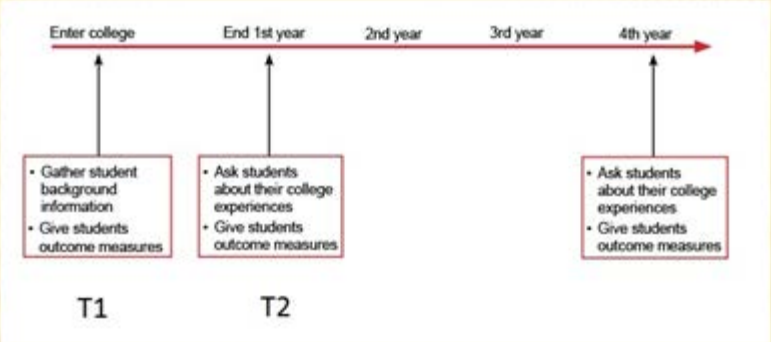
9.5 Appendix E: Presentation

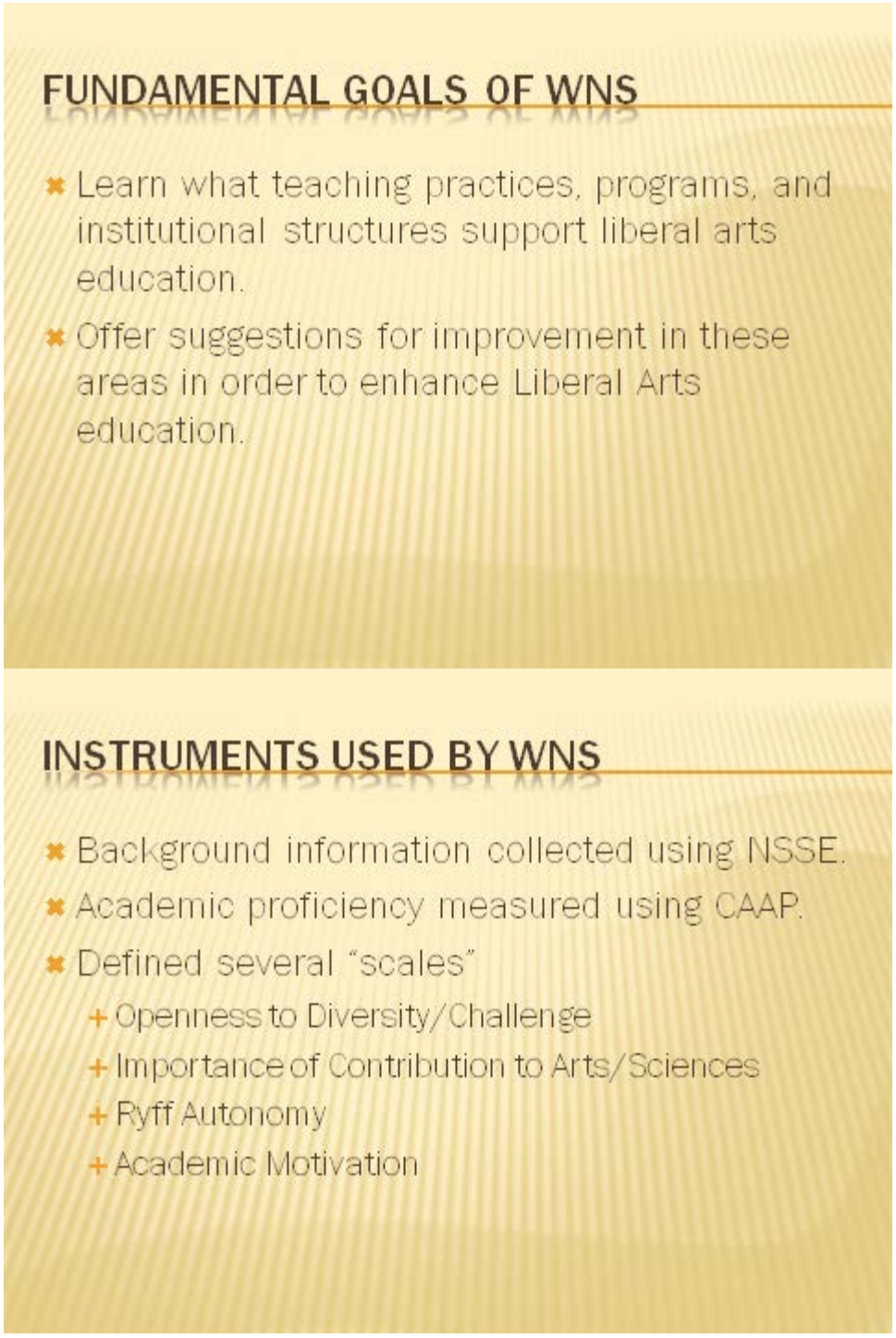


WABASH NATIONAL STUDY (WNS)

- A longitudinal study conducted by the Center of Inquiry at Wabash College, Indiana.
- As of 2010, there have been 49 participating institutions including Worcester Polytechnic Institute.
- More than 17,000 students nationwide have participated in the study from 2006-2010.

WABASH NATIONAL STUDY TIMELINE




FUNDAMENTAL GOALS OF WNS
Learn what teaching practices, programs, and institutional structures support liberal arts education.
Offer suggestions for improvement in these areas in order to enhance Liberal Arts education.
INSTRUMENTS USED BY WNS
Background information collected using NSSE.
Academic proficiency measured using CAAP.
Defined several "scales"
Openness to Diversity/Challenge
Importance of Contribution to Arts/Sciences
Ryff Autonomy
Academic Motivation

ACADEMIC MOTIVATION

- WNS defines it as "the student's level of interest regarding academic subjects when competence is judged against a standard of performance or excellence".
- We interpreted this as the student's drive to succeed in their academics regardless of the level of intrinsic interest they have in each specific subject.

ACADEMIC MOTIVATION IN WNS

- In the WNS, eight-questions are used to define a student's level of academic motivation.
- Students were asked to record their level of agreement with each question using a 1-5 scale.

ACADEMIC MOTIVATION QUESTIONS

QUESTIONS	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
A. I am willing to work hard in a course to learn the material even if it won't lead to a higher grade.	1	2	3	4	5
B. When I do well on a test, it is usually because I am well-prepared, not because the test is easy.	1	2	3	4	5
C. I frequently do more reading in a class than is required simply because it interests me.	1	2	3	4	5
D. I frequently talk to faculty outside of class about ideas presented during class.	1	2	3	4	5
E. Getting the best grades I can is very important to me.	1	2	3	4	5
F. I enjoy the challenge of learning complicated new material.	1	2	3	4	5
G. My academic experiences (i.e., courses, labs, studying, discussions with faculty) will be the most important part of college.	1	2	3	4	5
H. My academic experiences (i.e., courses, labs, studying, discussions with faculty) will be the most enjoyable part of college.	1	2	3	4	5

T1 AND T2 AT WPI

- *731 Students in August '08*
- *200 students in April '09*

T1	731 WPI Students	The 200 Students
Mean	3.64	3.68
Median	3.62	3.62
Std. Deviation	0.56	0.56

Decrease in Academic Motivation for the 200 Students

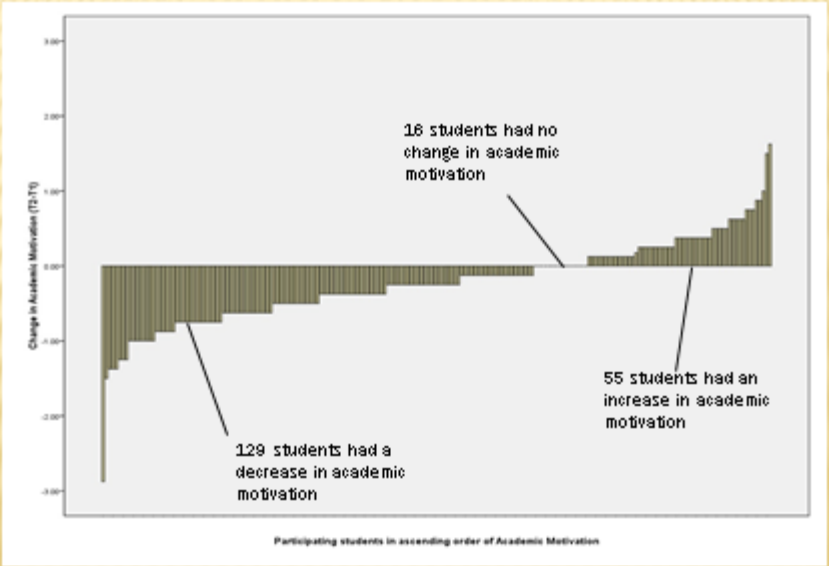
Survey	Mean (200 Students)	Median (200 Students)	Standard Deviation (200 Students)
Fall '08 (T1)	3.68	3.63	0.56
Spring '09 (T2)	3.45	3.38	0.64

CHANGE IN MEAN ACADEMIC MOTIVATION

- A student's academic motivation is the average of his/her responses to the 8 questions.

Mean Change in Academic Motivation (T2-T1)	Standard Deviation in Change in Academic Motivation (T2-T1)
-0.229	0.549

GRAPHICAL REPRESENTATION OF THE CHANGE



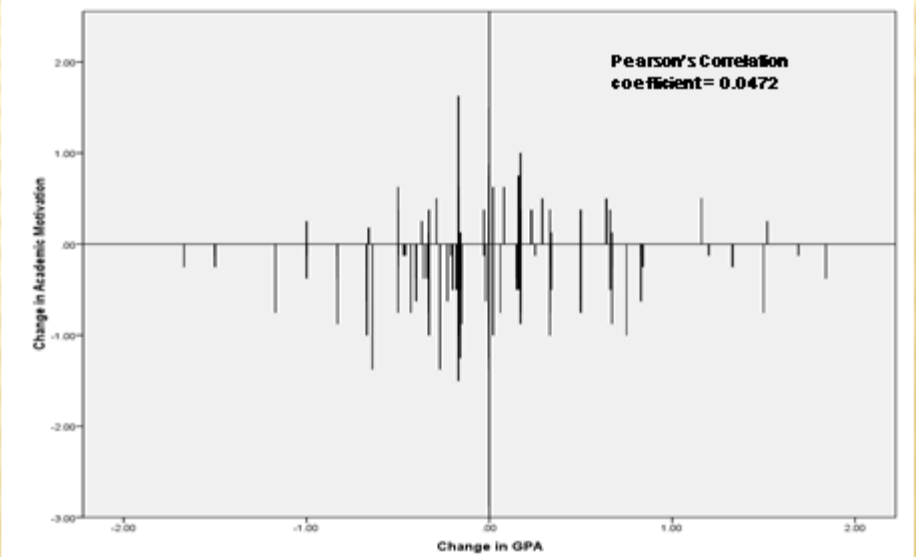
CHANGE FROM T1 TO T2: FREQUENCIES

Academic Motivation Scale Survey Questions	Decrease	Increase	No Change
A. I am willing to work hard in a course to learn the material even if it won't lead to a higher grade.	75 (37.5%)	44 (22%)	81 (40.5%)
B. When I do well on a test, it is usually because I am well-prepared, not because the test is easy.	53 (26.5%)	69 (34.5%)	78 (39%)
C. I frequently do more reading in a class than is required simply because it interests me.	65 (32.5%)	56 (28%)	79 (39.5%)
D. I frequently talk to faculty outside of class about ideas presented during class.	109 (54.5%)	29 (14.5%)	62 (31%)
E. Getting the best grades I can is very important to me.	58 (29%)	31 (15.5%)	111 (55.5%)
F. I enjoy the challenge of learning complicated new material.	83 (41.5%)	25 (12.5%)	92 (46%)
G. My academic experiences (i.e., courses, labs, studying, discussions with faculty) will be the most important part of college.	74 (37%)	50 (25%)	76 (38%)
H. My academic experiences (i.e., courses, labs, studying, discussions with faculty) will be the most enjoyable part of college.	69 (34.5%)	45 (22.5%)	86 (43%)

WPI STUDENTS VS. "7 LARGE UNIVERSITIES"

Academic Motivation Scale Survey Questions	T1 for WPI Mean (SD)	T1 for 7 large Mean (SD)	Difference in mean
A. I am willing to work hard in a course to learn the material even if it won't lead to a higher grade.	4.02 (0.90)	3.75 (0.98)	+0.27
B. When I do well on a test, it is usually because I am well-prepared, not because the test is easy.	3.88 (0.98)	3.99 (0.88)	-0.11
C. I frequently do more reading in a class than is required simply because it interests me.	2.82 (1.21)	2.81 (1.18)	+0.01
D. I frequently talk to faculty outside of class about ideas presented during class.	4.02 (0.90)	3.75 (0.98)	+0.27
E. Getting the best grades I can is very important to me.	4.12 (0.91)	4.38 (0.79)	-0.26
F. I enjoy the challenge of learning complicated new material.	4.09 (0.79)	3.66 (0.92)	+0.43
G. My academic experiences (i.e., courses, labs, studying, discussions with faculty) will be the most important part of college.	3.81 (0.93)	3.68 (1.00)	+0.13
H. My academic experiences (i.e., courses, labs, studying, discussions with faculty) will be the most enjoyable part of college.	3.02 (0.93)	2.91 (0.96)	+0.11

CHANGE IN ACADEMIC MOTIVATION VS. CHANGE IN GPA



FIRST CHOICE OF COLLEGE

- *Was WPI the student's first choice of college?*

WPI was the first choice (127 Students)				
	T1	T2	Delta T	GPA
Mean	3.66	3.38	-0.28	3.06
Median	3.62	3.38	-0.25	3.17
Std. Deviation	0.50	0.65	0.54	0.65

WPI was not the first choice (73 Students)				
	T1	T2	Delta T	GPA
Mean	3.70	3.56	-0.13	3.23
Median	3.75	3.50	-0.12	3.33
Std. Deviation	0.66	0.58	0.56	0.59

FIRST CHOICE OF COLLEGE: COMPARING WITH 731 WPI STUDENTS

	731 WPI Students	The 200 Students
First Choice	471 (64.5%)	127 (63.5%)
Not First Choice	260 (35.5%)	73 (36.5%)

First Choice (T1)	731 WPI Students	The 200 Students
Mean	3.59	3.66
Median	3.62	3.62
Std. Deviation	0.55	0.50
Not First Choice (T1)	**731 WPI Students**	**The 200 Students**
Mean	3.72	3.70
Median	3.75	3.75
Std. Deviation	0.59	0.66

FIRST CHOICE OF COLLEGE: CHI SQUARE TEST

H_0: There is no relationship between students' first choice of college and the change in their academic motivation.

Test Statistics	
	Delta T
Chi-Square	6.850[a]
Degree of freedom	8
Significance level	0.553

Result:

H_0: Not rejected. There is no relationship between the split and the change in academic motivation.

	Delta T		
	Observed	Expected	Residual
F: ΔI∈[0.5,+]	9	11.5	-2.5
F: ΔI∈[0.3,0.5)	6	7.0	-1.0
F: ΔI∈ [0.2,0.3	8	7.0	1.0
F: ΔI∈[0.1,0.2)	10	9.6	.4
F: ΔI∈[-0.1,0.1]	11	10.2	.8
F: ΔI∈[-0.2,-0.1]	12	14.0	-2.0
F: ΔI∈[-0.3,-0.2)	11	14.0	-3.0
F: ΔI∈ [-0.5,-0.3)	15	12.	.2
F: ΔI∈[-+,-0.5)	45	41.5	3.5
NF: ΔI∈[0.5,+]	9	6.6	2.4
NF: ΔI∈[0.3,0.5)	5	4.0	1.0
NF: ΔI∈ [0.2,0.3)	3	4.0	-1.0
NF: ΔI∈[0.1,0.2)	5	5.5	-.5
NF: ΔI∈[-0.1,0.1]	5	4.9	1
NF: ΔI∈[-0.2,-0.1]	10	8.1	1.9
NF: ΔI∈[-0.3,-0.2)	11	8.1	.9
NF: ΔI∈ [-0.5,-0.3)	5	7.3	-2.3
NF: ΔI∈[-+,-0.5)	20	23.8	-3.8

MALE VS. FEMALE

Question:
Did female subjects have a different change in academic motivation when compared against the male subjects?

H_0:
There is no relationship between students' gender and the change in their academic motivation.

Result:
H_0: Rejected. It is arguable that there is a relationship between the split and the change in academic motivation.

	Observed	Expected	Residual
Male Increase	25	30.49	+5.49
Male Decrease	77	71.51	-5.49
Female Increase	30	24.51	+5.49
Female Decrease	52	57.49	-5.49

Test Statistics	
Chi-Square	3.164
P-Value	0.075
Fisher's	0.107

ENGINEER VS. NON-ENGINEER

Question:
Did engineering students have a different change in academic motivation when compared to non-engineering students?

H_0:
There is no relationship between students' choice of major and the change in their academic motivation.

Result:
H_0: Not rejected. There is no relationship between the split and the change in academic motivation.

	Observed	Expected	Residual
Engineer Increase	23	25.85	-2.85
Engineer Decrease	63	60.15	+2.85
Non-Engineer Increase	32	29.15	+2.85
Non-Engineer Decrease	65	67.85	-2.85

Test Statistics	
Chi-Square	0.848
P-Value	0.358
Fisher's	0.420

ATHLETE VS. NON-ATHLETE

Question:
Did varsity athletes experience a different change in academic motivation when compared to those who did not compete in varsity athletics?

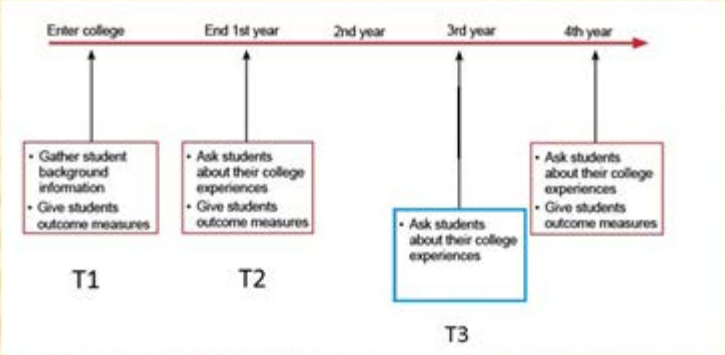
H_0:
There is no relationship between students' participation in varsity athletics and the change in their academic motivation.

Result:
H_0: Not rejected. There is no relationship between the split and the change in academic motivation.

	Observed	Expected	Residual
Athlete Increase	19	17.04	+1.96
Athlete Decrease	38	39.96	-1.96
Non-Athlete Increase	36	37.96	+1.96
Non-Athlete Decrease	91	89.04	-1.96

Test Statistics	
Chi-Square	0.466
P-Value	0.494
Fisher's	0.492

EXPLANATION OF T3 INTERVIEWS



In the Spring of '11, 17 students of the 200 who participated in T2 answered the Academic Motivation questions again.

INTERVIEW RESULTS (FACTS)

Survey	Mean (17 Students)	Median (17 Students)	Standard Deviation (17 Students)
Fall '08 (T1)	3.90	4.00	0.62
Spring '09 (T2)	3.76	3.88	0.64
Spring '11 (T3)	3.64	3.38	0.56

The mean academic motivation for this sample group has been higher than the original sample group of 200 students from T2, so we can infer that the larger population of students will have a much lower mean academic motivation at T3.

INTERVIEW RESPONSES (MAJORITY OPINIONS)

- Positive effects of project-based learning
- Interest in pass/fail humanities classes
- Lower interest in basic math/science courses
- Higher interest in major-related courses
- Shift from academic to professional drive

CONCLUSIONS

- Students' academic motivation decreased over freshman year
- Academic motivation is heavily based on personal goals of the student
- The most distinctive factor in change in academic motivation is gender
- Student's change in GPA is not correlated to change in academic motivation

FUTURE STUDIES

- Change in academic motivation based on gender.
- Role played by student's choice of courses on student academic motivation.
- Difference in motivation for project-based classes and theory-based classes.

9.6 Appendix F: Wabash Data CD

The CD contains all the data that were used and created in this IQP Report, below is a list of the files:

- **WaBashWPIRawData**
  This is the file from Wabash National Study; it contains all the data for the 731 WPI students. The responses for T2 questions were left blank for students who did not participate in the survey at T2.

- **DataOn200Students**
  This file was made by separating the 200 students who participated in the survey at T2. The following variables were added:
  - Change of academic motivation (AcMoT2-AcMoT1)
  - Students' GPA from fall '08, spring '09 and the change (GPASpring09 – GPAFall08)
  - Students' calculated Intrinsic Motivation at T1, T2 and the change
  - Students' calculated Extrinsic Academic Motivation at T1, T2 and the change

- **71 Students AcMo Not Decreased**
  The 71 students out of 200 that had an increase in academic motivation or stayed the same.

- **129 Students AcMo Decreased**
  The 129 students out of 200 that had a decrease in academic motivation.

- **17 Students at T3 interview**
  The data information from of the 17 students from the interview.

- **5 Questions for In AcMo**
  The 5 questions that are used to calculate the Intrinsic Motivation of the 200 student.

- **3 Questions for Ex AcMo**
  The 5 questions that are used to calculate the Intrinsic Motivation of the 200 student.