

Grade 11 Mathematics of Personal Finance

Inventory of Marks 2001-2004

“An Analytical Reflection on Pedagogy to Improve
Student Performance with Use of the TI-Navigator”

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1.0 Introduction

1.1 Objectives

The objective of this analysis for a specific course (MBF 3C-Mathematics of Personal Finance) examining performance of 198 students over a 3 year period was to explore the degree to which the TI-Navigator, used in a specific pedagogical way, could increase mathematics scores for regular course work.

Questions posed were:

- 1) *By adhering to a specific pedagogy, did the class averages and medians improve with the use of the TI-Navigator at the 5-week-point prior to final evaluations and at the end of the year prior to final evaluations as compared to other years?*
- 2) *Did the percentage of students below 50% decrease by using the TI-Navigator combined with a specific pedagogy at the*
 - i) *5-week-point prior to final evaluations*
 - ii) *end of the course prior to final evaluations*
 - iii) *end of the course after final evaluations**as compared to other years?*
- 3) *Did the percentage of students above 70% increase by using the TI-Navigator combined with a specific pedagogy at the*
 - i) *5-week-point prior to final evaluations*
 - ii) *end of the course prior to final evaluations*
 - iii) *end of the course after final evaluations**as compared to other years?*
- 4) *Did the percentage of students who exhibited an increase in their mark during the last 5 weeks of the course prior to final evaluations increase with use of the TI-Navigator with a specific pedagogy compared to other years?*

It is important to note that the averages of all 198 students were not bumped up at any point during this analysis. For example, a (47-49.9)% earned was not converted to a pass (50%); a mark of 59% was not converted to a 60%. The score for each student was rounded to the nearest tenth and recorded at the 5-week-point prior to final evaluations and at the end of the course prior to final evaluations. It is also important to understand that the results reported are for grade 11 students that are not academically focussed in mathematics.

1.2 Background

This analysis is not being presented as formal research. However, it does represent my best attempt, as an educator, to quantify and gain understanding related to student performance enhancements afforded by a relatively new piece of technology called the TI-Navigator from Texas Instruments.

The TI-Navigator is a wireless classroom communication system that allows a teacher to send/collect information to/from students respectively using the integration of software and hardware (one computer, wireless hubs, TI-calculators). The exact process by which

the TI software and hardware operate can be viewed at many conferences in Canada, the United States of America and abroad. It is not the focus of this report.

I have been a classroom teacher for 11 years and have been using the TI-Navigator for three years. I have used this technology for academic and lower level mathematics learners with various degrees of usage. I have witnessed students become significantly more accountable to process and completion of the task when I am using the TI-Navigator for all levels of learners.

I have used this technology to:

- i) diagnose class and individual understanding of concepts taught during lessons.
- ii) expose students to Internet data and follow-up analysis.
- iii) aggregate data (appending individual data to form a class set of data) for many real-life scenarios (experiments) that force students to contribute different data to class data set.
- iv) de-construct the “four-walled” notion of the classroom; the sense that math learning occurs in one room can be removed by engaging students with students in other cities (Global Learning and Global Learning Communities).

During my exploration of the uses of the TI-Navigator, I experienced lower level math learners becoming significantly more engaged when use of the TI-Navigator was employed than without. In the summer, prior to the 2003-2004 school year, I had surmised that there must be a specific pedagogy that would lead to increases in performance. During the first semester of the 2003-2004 school year I began to identify and develop a specific pedagogy with use of the TI-Navigator in my classroom teaching that I suspected might lead to increases in performance.

As I reflect on my use of the TI-Navigator during this time period, approximately 60% (3 out of 5) of the classes taught made use of the technology in the direction of the developing pedagogy. I dubbed this as a transition semester. In other words, this time afforded better understanding of how to put into practice a specific pedagogy that made sense and affected performance in a positive manner. In this report reference to results from this semester includes the descriptor “Moderate Use” of the specific pedagogy. As the semester unfolded, the pedagogy became more developed and precise. The semester ended with fewer failures than the previous 2 years.

This prompted further testing and the belief that performance results could be improved. I used the TI-Navigator, in the second semester, to a high degree to target the specific pedagogy that emerged from testing in the first (transition) semester of 2003-2004. In this report reference to results from the second semester of 2003-2004 includes the descriptor “High Degree of Use” of the specific pedagogy. This reflected use of the TI-Navigator in about 90% (9 out of every 10 classes) of the classes taught which made use of the specific pedagogy.

1.3 TI-Navigator Technology

The TI-Navigator is a wireless technology that networks a classroom set of TI-calculators to a computer located in the classroom. Integrated software and hardware allows students to connect their calculator to a device called a “hub” and communicate with the teacher (to and from) in a wireless way. This communication can involve any type of calculator

data (Ex. Lists, Real Variables, Learning Check Question File, Learning Check Answer File, Application Variable, Graph Database GDB, Pic, Matrix, etc.). The TI-software allows the teacher to construct and send the type of information that students require for a lesson (Learning Check Question File, Lists, Real Variables, Application Variables, Graph Database GDB, Pic, Matrix, etc.). The teacher can collect information from students and score assessments that were sent to the students in a rather efficient manner. If a student enters an answer to a question on their calculator the teacher can collect, evaluate and save a record of the performance.

1.4 Potential Significance

There is an increasing demand upon teachers to use technology to impact learning. A lack of financial support and resources within the school system make it difficult for teachers to make progress. Pedagogical methods need to be developed and tested that support use of the TI-Navigator to augment learning and ensure that teachers are equipped with skills to affect learning in a positive manner. Evidence needs to be gathered, quantified and presented that highlight the need for technological augmentation in the learning process. It is imperative that educators use tools of technology effectively.

It is my hope that in sharing a pedagogical approach, other educators can reproduce the performance enhancements that I have identified in this report and join the chorus of educators who have found value in using the TI-Navigator to augment student learning in a positive way. It is also important for educational researchers to continue helping educators understand why performance results seem to increase with use of the TI-Navigator used in a specific pedagogical way.

1.5 Pedagogy and Rationale

Following each block of instruction for each class there was a “Diagnostic” delivered wirelessly by TI-Navigator and received on each student’s calculator. A “Diagnostic” was a daily assessment that included various styles of questions (mostly Fill-in-the-Blank). The ‘blank’ for each answer was created to increase the psychometric validity of the assessment. For example, if the answer to a question was 100 (3 characters) the number of characters representing the blank would be set at 10 characters. Each “Diagnostic” contained no more than 5 questions and was completed before the end of class. The “Diagnostics” were worth marks (1 or 2 marks per question).

Students would complete the set of questions before attempting homework for the day. Preceding each block of instruction for each class students were forewarned to pay attention and instructed to ask questions to ensure that they maximize their understanding of the concepts. The questions on the “Diagnostic” resembled questions that were delivered during the lesson.

The assessments were not called ‘tests’ or ‘quizzes’ because of the negative connotation attached to these types of instruments. Students were given their score on the “Diagnostic” before they left class each day. Those students who did not perform well on the “Diagnostic” had time to revise answers and resubmit their solutions for re-evaluation. I was using the technology on a daily basis to diagnose understanding in the room for a concept taught. Those students who needed my help were able to get it. Those students who performed well on the “Diagnostic” were required to work on the homework that was assigned for the day.

I utilized the power of TI-Navigator's software to grade incoming "Diagnostic" answers for every student. The technology augmented my classroom instruction. Concepts related to questions exhibiting poor performance were taught again. I was better able to identify and remedy weaknesses.

The technology did not replace pencil and paper calculations. These skills are a fundamental part of learning mathematics. The technology allowed me to get a 'snapshot' of performance every day and 'touch' up the blemishes on the picture. Students were given a mark for the degree of correct communication of mathematical form demonstrated along with a mark produced by the TI-Navigator software for answers submitted.

Students worked together with a high degree of effectiveness. Students worked diligently to understand the calculations and produce correct answers. The sense of 'community' in the classroom increased. Students asked each other to confirm/verify answers before they submitted them for evaluation. If their answers did not agree they tried to figure out which answer was correct/incorrect and why it was correct/incorrect. This is a behaviour that I did not anticipate with this level of learner. The dialogue between students was highly productive. Students who did not submit a pencil and paper copy of solutions did not receive any credit for answers submitted electronically.

Students were required to write out each of the questions given in the "Diagnostic" and provide full solutions. All work was dated and kept in a separate binder (portfolio). This binder remained in the classroom. Students signed out this binder for study purposes.

Each "Diagnostic" could be redone at any point in the course without penalty. This style of learning favours the ability of each student to make appropriate corrections to mathematical understanding due to feedback along a continuum. Consider a basketball player shooting a ball from the free throw line. The more shots the player takes the more likely the player is able to make the shot provided there are conscious corrections in the player's form. Corrections made are based upon the feedback received. This 'coaching' approach worked well for this level of learner. Students who were absent for any reason were scored a zero on each "Diagnostic" missed. Students became accountable for missed work to a higher degree with use of the TI-Navigator than without. Students came in to the classroom to complete missed "Diagnostics" during their own time. Students could also complete or redo "Diagnostics" during class time after completing the "Diagnostic" for the day.

Approximately every two weeks, a class block of time was set aside so that students could redo or complete "Diagnostics" from this time period. This was extremely effective. Each of the "Diagnostics" for the time period were sent to the students. Students completed "Diagnostics" of their choice to target their lowest performances first. This provided a very productive working environment in the classroom because the technology helped cater to individual need. All answers (paper and electronic) to "Diagnostics" were collected at the end of class.

1.6 Marks Management

The need for managing marks and communicating performance to students was extremely important to assist the learning process. Periodically (approx. every 2 weeks)

each student received a print-out of their marks in the course. MarkBook (Asylum Software Inc. - www.markbook.com), a class management software package, was an extremely effective tool. It allowed me to easily blend the TI (Texas Instruments) related “Diagnostic” results with other non-TI assessment instruments for each student. Reporting performance was an efficient process. Students relied on this information. Students were able to easily identify their poorest performance on “Diagnostics” and redo them for evaluation. I relied on MarkBook to identify the poorest performed “Diagnostics” with class average as the tool of comparison. This allowed me to send out multiple “Diagnostics” (5 to 10) on selected days. This ensured that most of my students had “Diagnostics” to complete or redo. MarkBook made it very simple for me to identify other “Diagnostics” required by students whose need was not served from the original list of “Diagnostics” sent. These “Diagnostics” were added to the queue and sent to those students who required them.

2.0 Results and Analysis

2.1 Class Averages and Medians

By adhering to a specific pedagogy, did the class averages and medians improve with the use of the TI-Navigator at the 5-week-point prior to final evaluations and at the end of the year prior to final evaluations as compared to other years?

Referring to figures 1-4, it is difficult to determine trends with exclusive focus on class averages and medians because the performance of an individual is ‘lost’ in the mix. Any statement indicating the degree of use (No Use, Limited Use, Moderate Use, High Degree Use) of the TI-Navigator is making reference to its use with the specific pedagogy outlined in section 1.5.

The averages and medians for two classes in 2003-2004 for which TI-Navigator was used to a high degree seem to indicate measurable improvement over the averages and medians for classes that used TI-Navigator with less focus on the specific pedagogy identified in section 1.5. The average and median for the class representing the transition semester in 2003-2004 indicated by moderate use of the specific pedagogy seem to be indifferent than other years for classes that used TI-Navigator with less focus on the specific pedagogy identified in section 1.5. The changes in averages and medians for each class for 5 weeks prior to course completion and at the end of the course (prior to final evaluations) do not appear significantly different at first glance.

The pedagogy identified seems to be more effective to increase performance with more frequent use of the TI-Navigator. By adhering to specific pedagogy, the class averages and medians seemed to improve with a high degree of use of the TI-Navigator for 5 weeks prior to course completion and at the end of the year prior to final evaluations as compared to other years. Perhaps the reinforcement of learning through timely feedback is a primary reason for measurable improvements in class medians and averages.

5 Weeks Prior to Course Completion

Class Average for Each Class

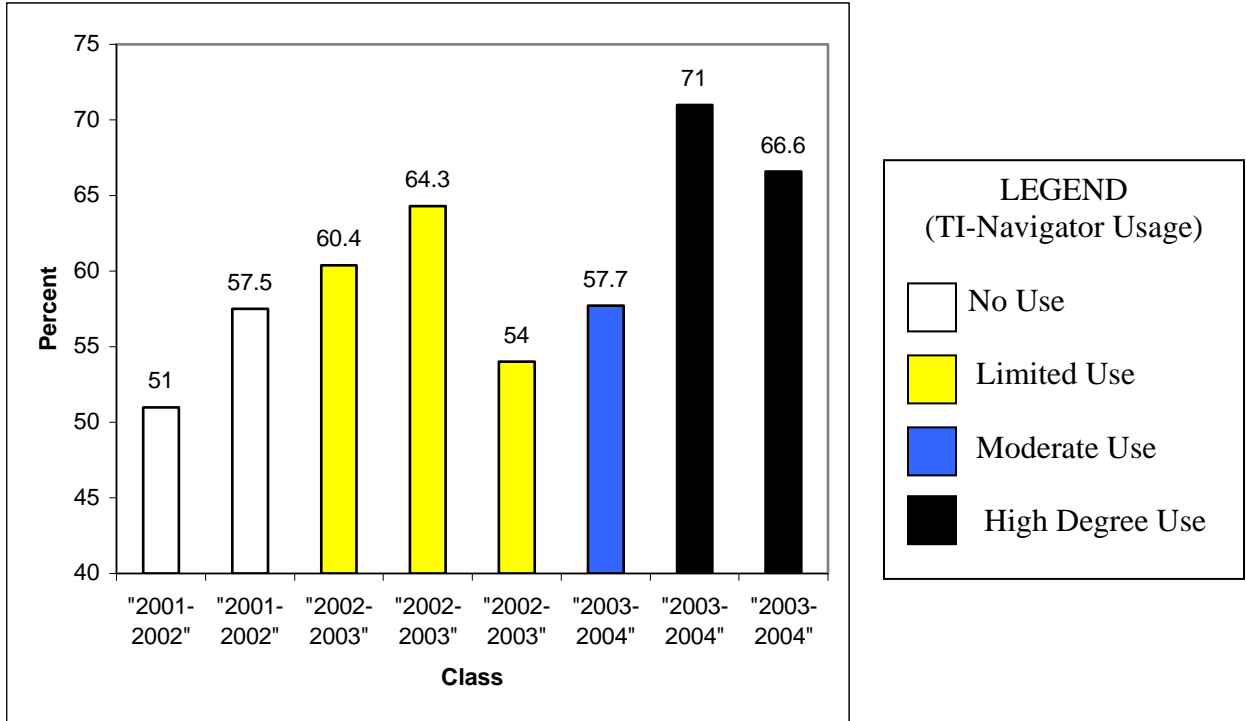


Figure 1

Class Median for Each Class

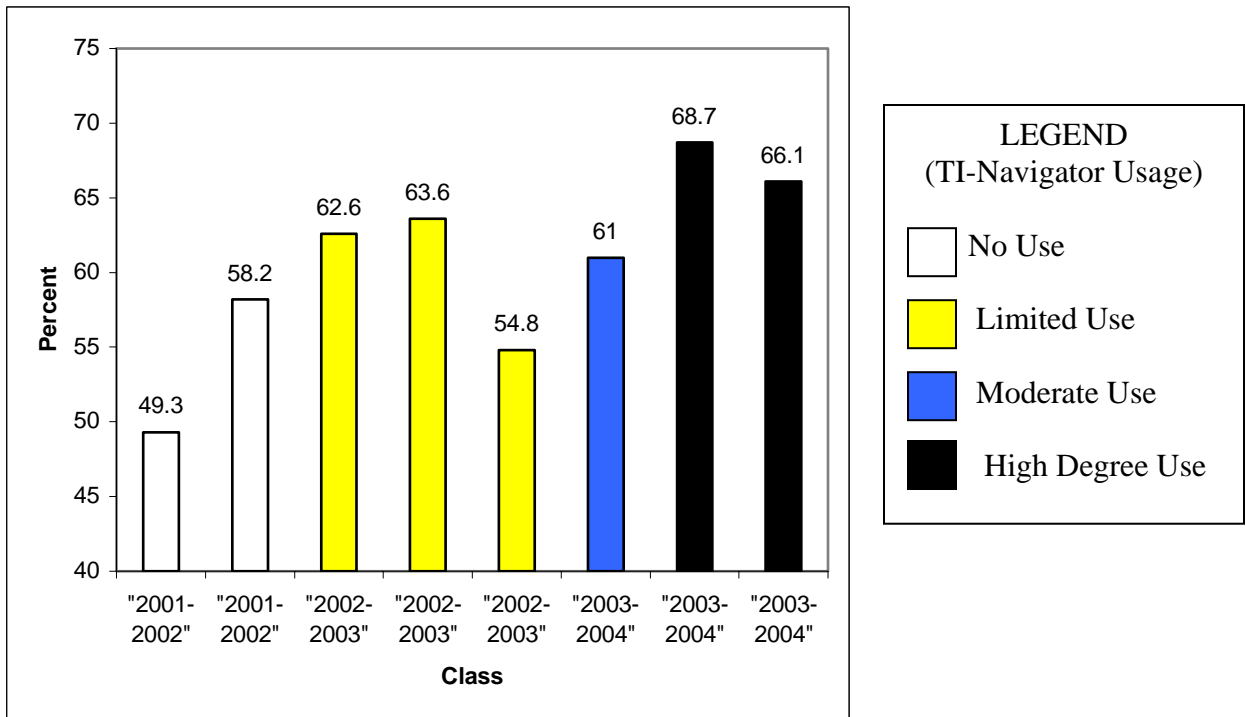


Figure 2

At the End of the Course (Prior to Final Evaluations)

Class Average for Each Class

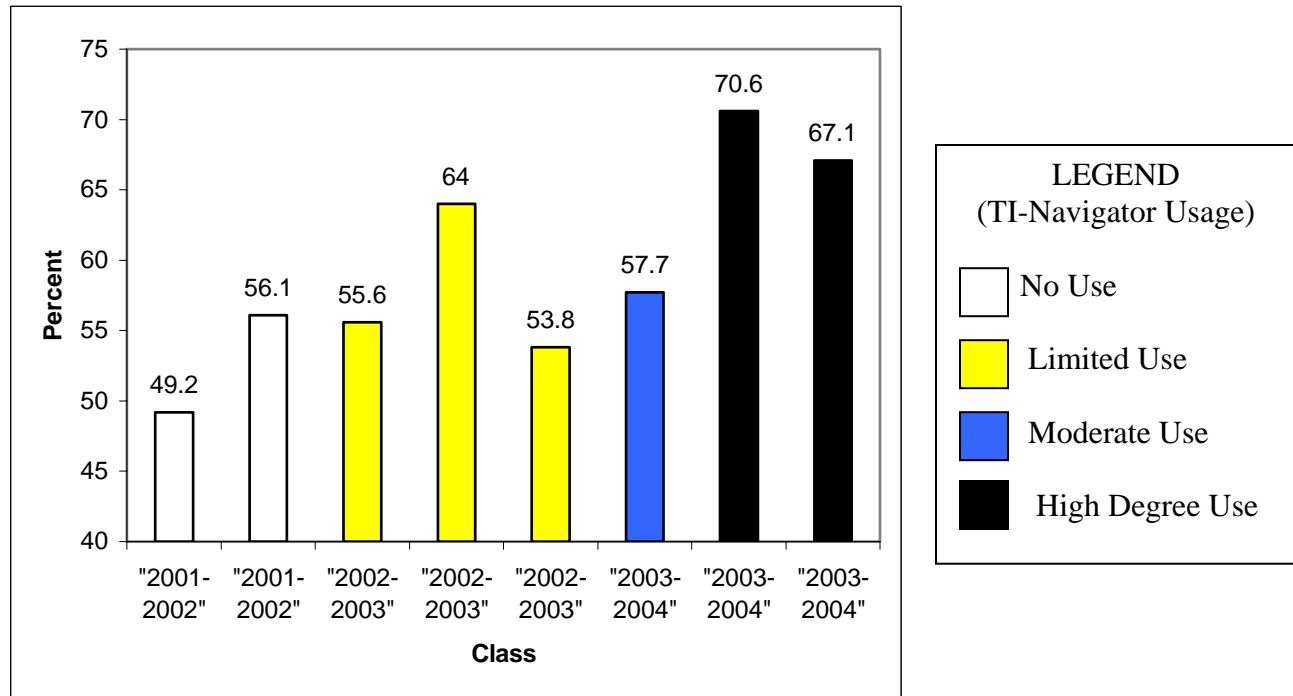


Figure 3

Class Median for Each Class

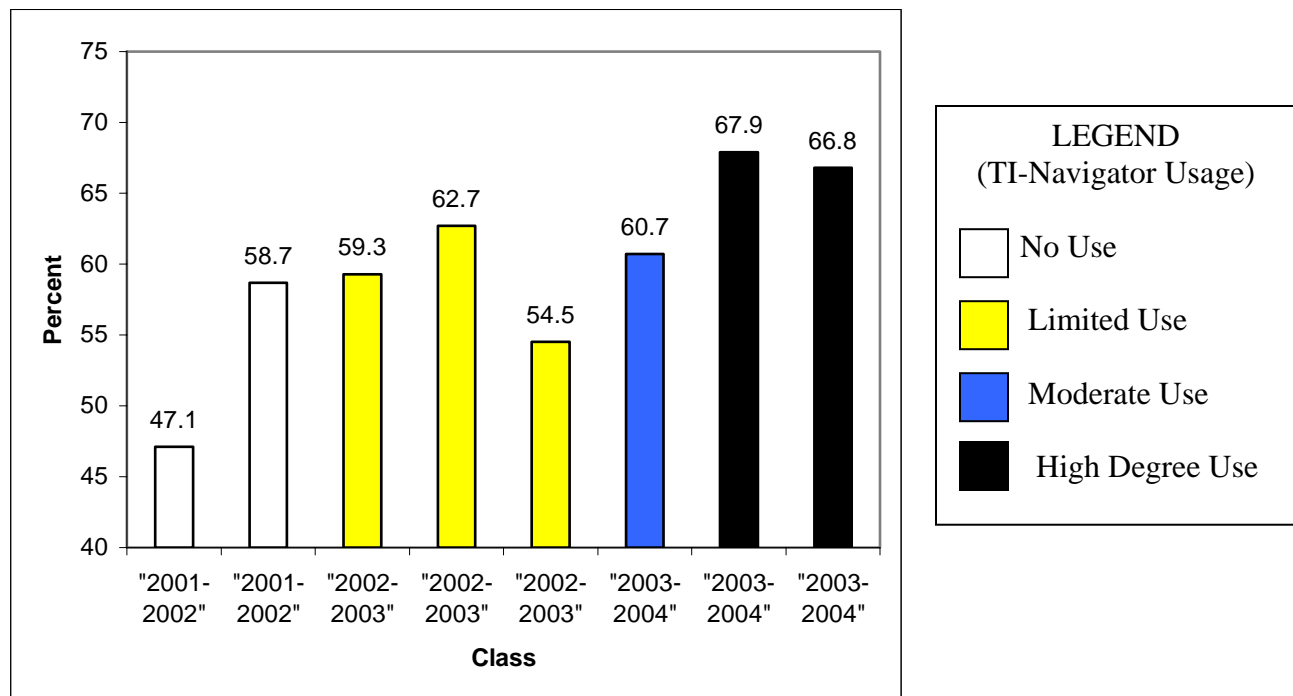


Figure 4

2.2 Students Below 50%

Did the percentage of students below 50% decrease by using the TI-Navigator combined with a specific pedagogy at the

- i) 5-week-point prior to final evaluations*
- ii) end of the course prior to final evaluations*
- iii) end of the course after final evaluations (See 2.3 for Information)*

as compared to other years?

Percentages were calculated by dividing the total number of students with a mark below 50% out of the total number of students enrolled in the course for the given year. Figures 5-8 provide information about the percentage of failing students by year for various times during the course. To gain more insight into performance of the lower performing half of the math students in the inventory, the percentage of students below 50% were analyzed.

Referring to figures 5 and 6, the percentage of failing students was **zero** at the 5-week-point prior to course completion and at the end of the course prior to final evaluations when the TI-Navigator was used to a high degree with a specific pedagogy in semester 2 of 2003-2004. It can be seen that the percentage of failing students when the TI-Navigator was used to a moderate degree with specific pedagogy in semester 1 of 2003-2004, is not significantly different than other years with various degrees of usage of the TI-Navigator with specific pedagogy. Referring to figures 7 and 8, the percentage of failures increased from the 5-week-point prior to course completion to the end of the course prior to final evaluations for years that utilized the TI-Navigator with specific pedagogy with a limited degree or not at all. Referring to figures 9 and 10, failure rates did not increase for the last 5 weeks of the course when the TI-Navigator was used to a moderate or high degree with a specific pedagogy.

Percentage of Students Below 50%

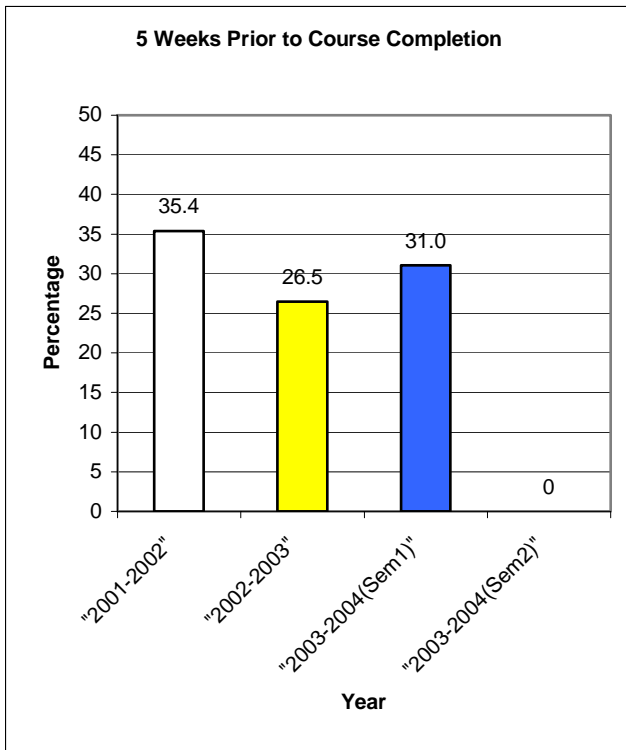


Figure 5

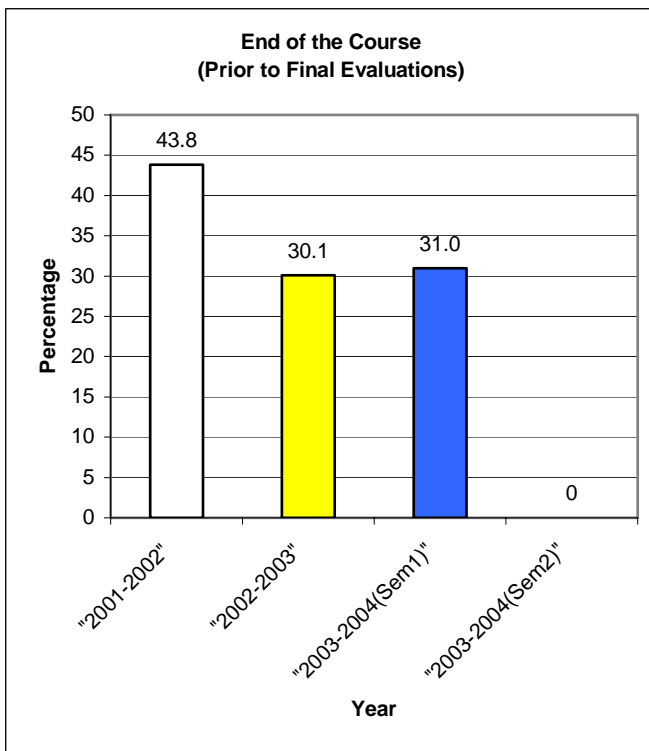
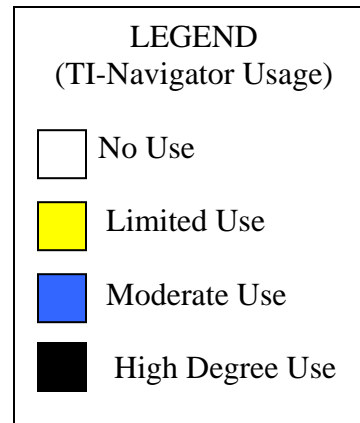


Figure 6

Percentage of Students Below 50%

(A Different Perspective)

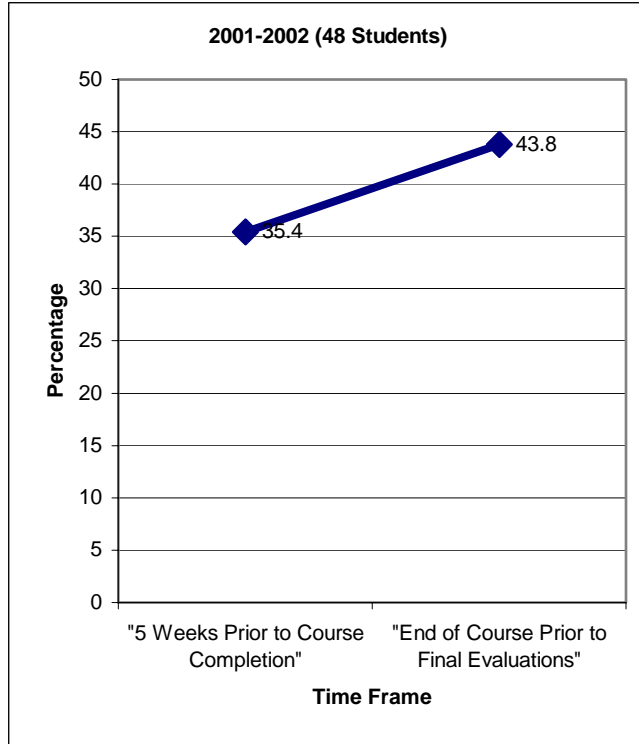


Figure 7

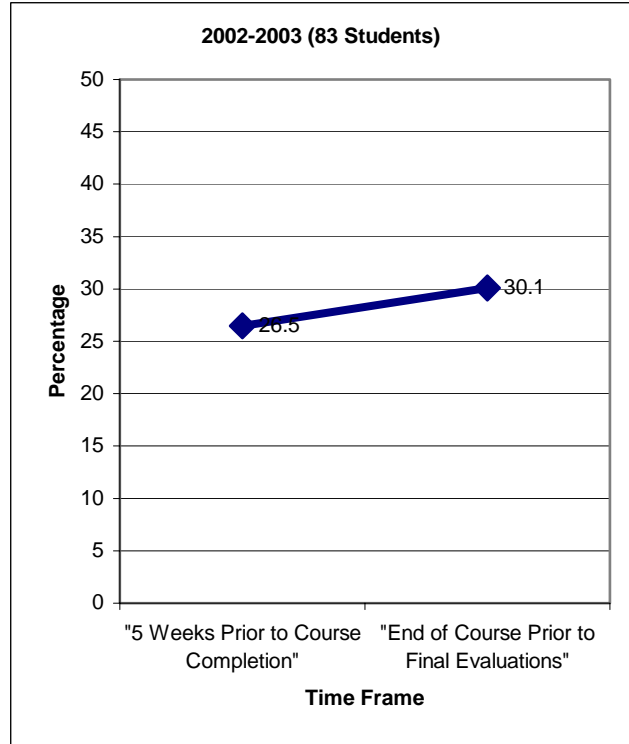


Figure 8

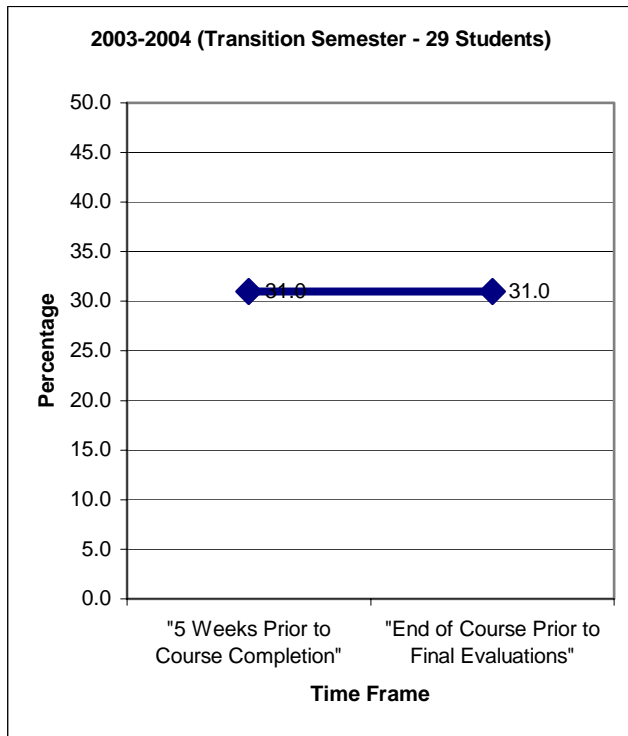


Figure 9

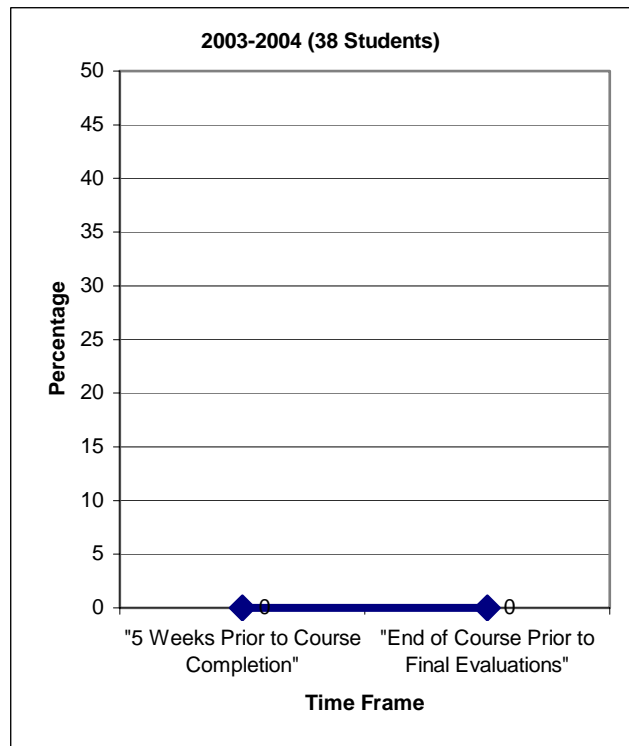


Figure 10

2.3 Failures After Final Evaluations

Referring to figure 11, it can be seen that the percentage of failures at the end of the course after final evaluations shows a decrease with a moderate and a high degree of use of the TI-Navigator with use of a specific pedagogy. The percentage of failures between semester 1 and 2 of 2003-2004 are not significantly different. It is important to note that the exam for semester 2 of 2003-2004 was significantly different than the exam delivered in previous years and in semester 1 of 2003-2004. Recall that there were no failures in semester 2 prior to final evaluations (See Figure 6). All failures occurred due to poor performance on final evaluations. The TI-Navigator was **not** used in any way to help students prepare for the final evaluations. Perhaps if it had been used there may have been a significant reduction in failures in semester 2 versus semester 1 of 2003-2004. This requires further testing to see if the percentage of failures can be reduced with intervention from use of the TI-Navigator. Learners at this level have difficulty performing on large scale evaluations such as a final exam. This fact is confirmed in Figure 11.

Percentage of Students Below 50%

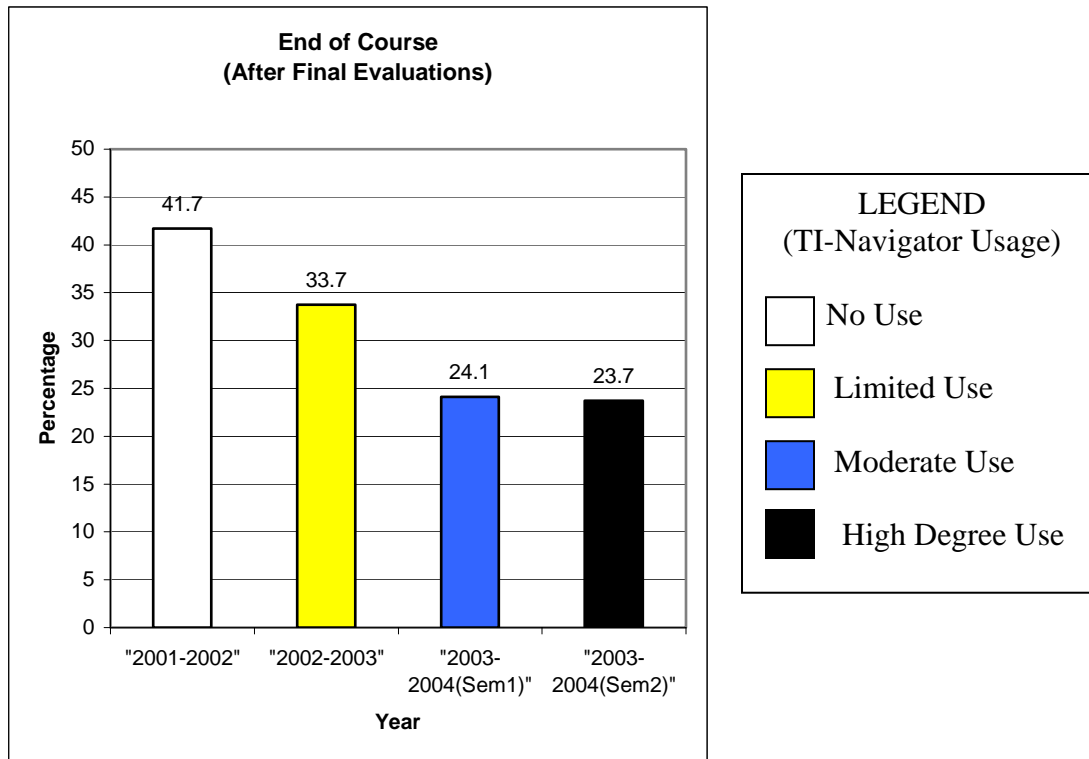


Figure 11

2.4 Students Above 70%

Did the percentage of students above 70% increase by using the TI-Navigator combined with a specific pedagogy at the

- iv) 5-week-point prior to final evaluations*
- v) end of the course prior to final evaluations*
- vi) end of the course after final evaluations*

as compared to other years?

Referring to Figures 12-14, the percentage of students above 70% are significantly higher for the 3 time periods specified with a high degree of use of the TI-Navigator targeting a specific pedagogy in 2003-2004 than in other years. Note that in the transition semester of 2003-2004 there was not a significant difference in the percentage of students above 70% than in other years when the TI-Navigator was used to a moderate degree with a specific pedagogy. This may suggest that benefits for students performing at the upper portion of a class perform better with more use of the TI-Navigator with a specific pedagogy. Even though the TI-Navigator was not used to prepare students for the final evaluations it can be seen that the percentage of students performing at this level was significantly higher at the end of the course after final evaluation (See Figure 14). This may suggest that a high degree of use of the TI-Navigator with a specific pedagogy throughout the semester (course work) did have a positive impact on performance. It appears as though use of the TI-Navigator to a high degree with a specific pedagogy is helping students to achieve better at the lower and upper end of performance. This is especially true for students above 70% at the 3 points of time (5-week-point prior to final evaluations, end of the course prior to final evaluations, end of the course after final evaluations) as compared to other years with varied levels of usage of the TI-Navigator with specific pedagogy.

Percentage of Students, by Year, Above 70%

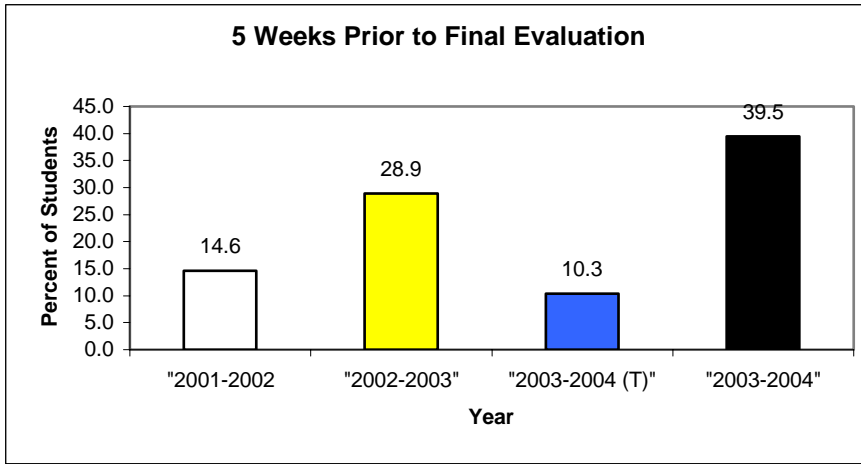


Figure 12

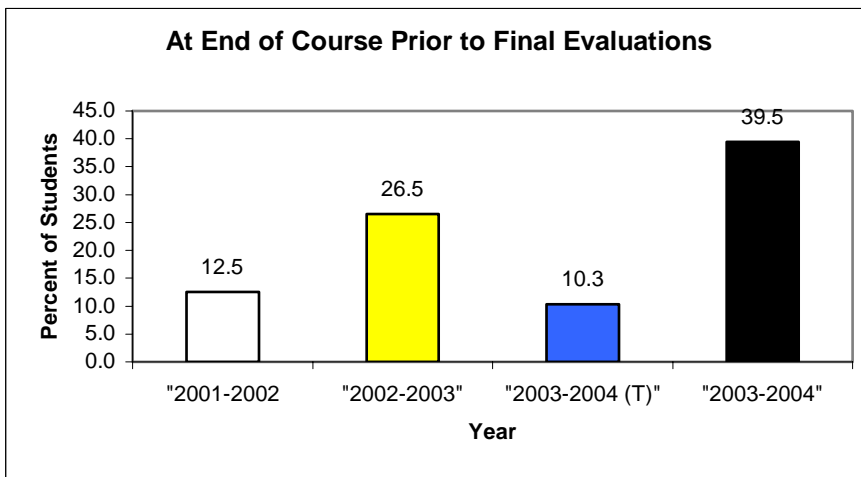


Figure 13

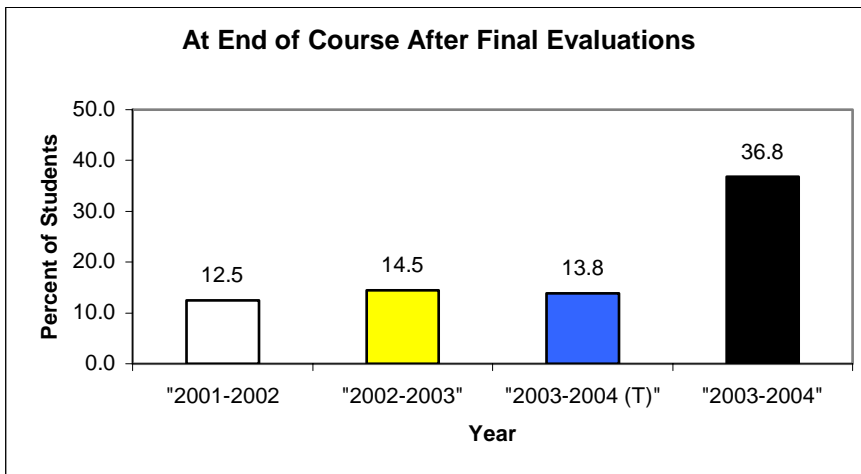


Figure 14

LEGEND
(TI-Navigator Usage)

- No Use
- Limited Use
- Moderate Use
- High Degree Use

T - TRANSITION SEMESTER TOWARDS A HIGH DEGREE OF USE OF THE TI-NAVIGATOR WITH INTEGRATED PEDAGOGICAL PROCESS

2.5 Changes in Individual Marks

It was important to analyze changes within individual student averages to address the following question.

Did the percentage of students who exhibited an increase in their mark during the last 5 weeks of the course prior to final evaluations increase with use of the TI-Navigator with a specific pedagogy compared to other years?

To address this question each student's mark at the 5-week-point prior to course completion was compared with the mark earned at the end of the course prior to the final evaluations and organized into charts (See Figures 15 & 16 for sample charts). The intent of this analysis was to measure performance increases, if any, during the last 5 weeks of the course. It was decided that 1% changes in mark would best exemplify performance changes in the last 5 weeks. Naturally, students' marks can go down, up or stay the same. The mark earned at the 5-week-point prior to course completion was the baseline of comparison and the mark earned at the end of the course prior to final evaluations was the end-point of the comparison. For example, if a student's mark increased by 1.2% then the tally within the interval representing the change in mark for (1 to 2)% would be increased by 1. For example, if a student's mark decreased by 2.5% then the tally within the interval representing the change in mark for (-2 to -3) would be increased by 1.

Upon examining figures 15 and 16 it can be said that a higher proportion of students increased their mark in the last 5 weeks of the course with a high degree of use of the TI-Navigator in 2003-2004 than with no use of the TI-Navigator in 2001-2002 with specific pedagogy. In figures 17-20 it becomes clear that with either moderate use or a high degree of use of the TI-Navigator with specific pedagogy a larger proportion of students increase their marks in the last 5 weeks of course work than with no use or limited use of the TI-Navigator with specific pedagogy. It becomes quite clear that in 2001-2002 and 2002-2003 that the proportion of students increasing their grade in the last 5 weeks of the course is significantly lower than in the transition semester of 2003-2004 and the other data from 2003-2004.

Although the class averages and medians in 2003-2004 (Transition Semester) with moderate use of the TI-Navigator and specific pedagogy were not significantly different than the class averages and medians in prior years, there is evidence to support moderate use of the TI-Navigator to enhance performance. We see that in figure 21 the proportion of students in 2003-2004 whether moderate or high level of use of the TI-Navigator was employed with specific pedagogy, performance increases in the last 5 weeks were measurable. There is evidence to suggest that performance increases did occur with the use of TI-Navigator with a specific pedagogy for moderate and high degree of usage for the last 5 weeks of the course.

Change in Marks from 5 Weeks Prior to Course Completion to the End of the Course Prior to Final Evaluations

2001-2002

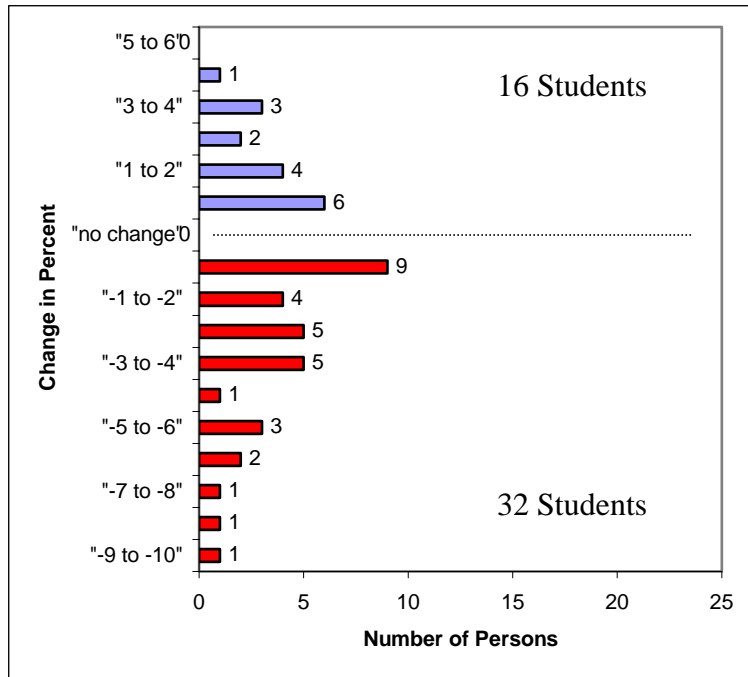


Figure 15

2003-2004

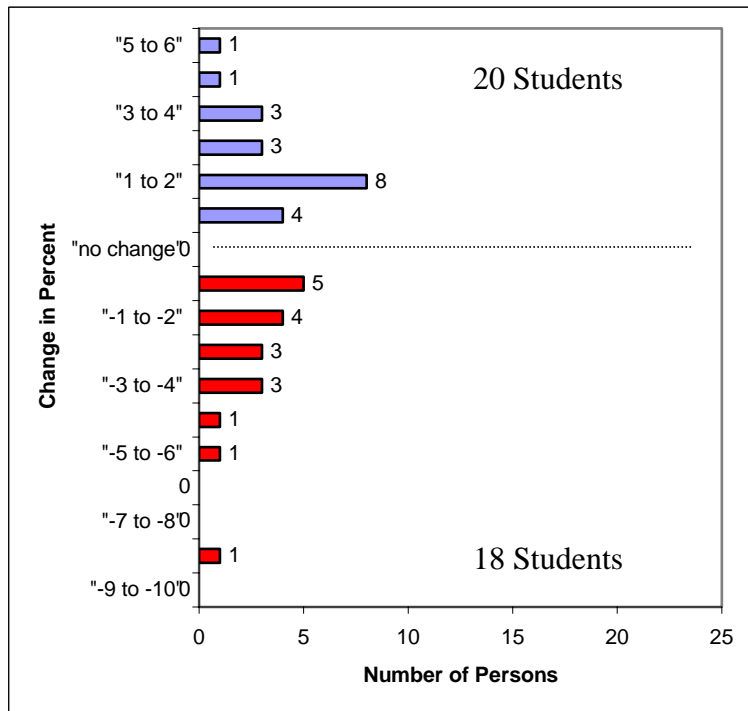


Figure 16

Percentage Of Students that Increased, Decreased or had No Change in their Average in the Last 5 Weeks of the Course

2001-2002

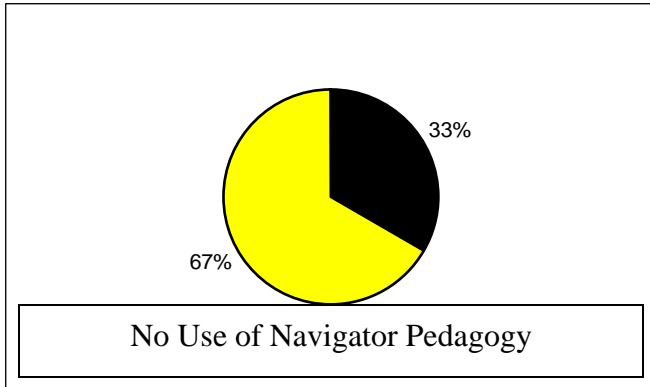


Figure 17

2002-2003

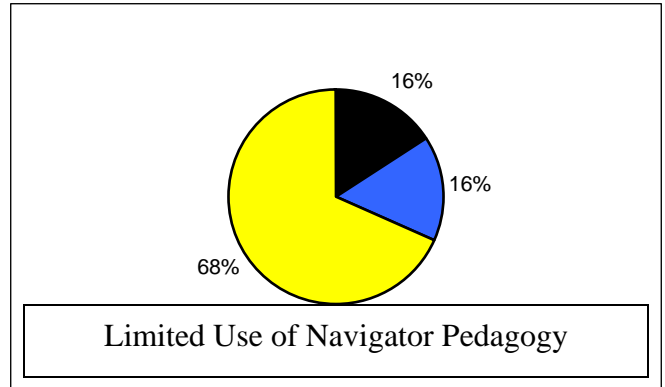


Figure 18

2003-2004 (Transition Semester)

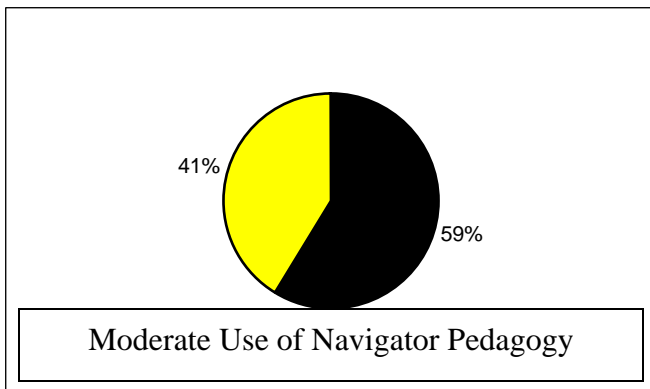


Figure 19

2003-2004

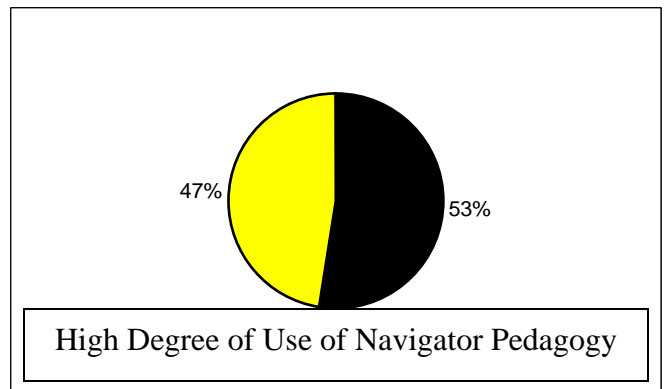
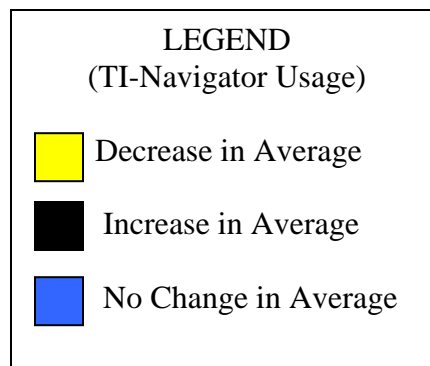


Figure 20



Percent of Students that Increased Performance from 5 Weeks Prior to Course Completion to the End of the Year Prior to Course Completion

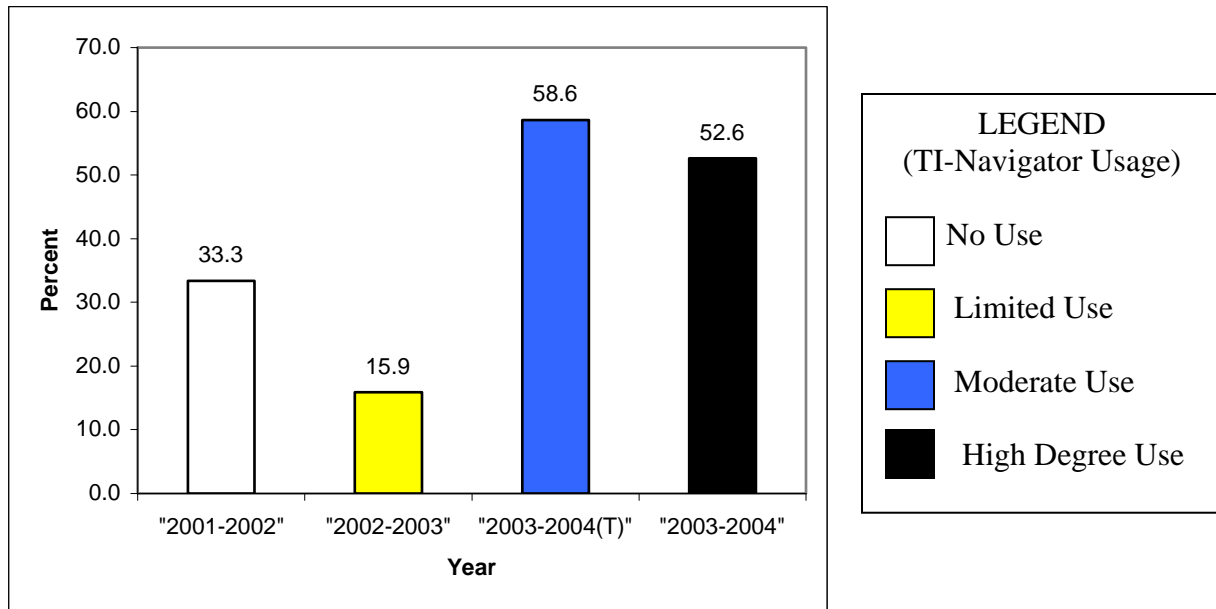


Figure 21

3.0 Conclusions

3.1 Performance Enhancements

This analysis attempted to quantify, if any, performance enhancements as a result of using the TI-Navigator in a specific pedagogical way. There is evidence that moderate and high degree use of the TI-Navigator with specific pedagogy (outlined in 1.5) supports performance enhancements of student grades in a positive fashion as seen with data for 2003-2004 year versus prior years with less degree of usage of the TI-Navigator with specific pedagogy. Enhancements were well noted at the 5-week-point prior to course completion and at the end of the course prior to final evaluations. These included a lower proportion of students failing the course, a higher proportion of student achieving higher than 70% and higher proportion of students increasing their grades in the last 5 weeks of the course.