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### **Creating Academic Community for First-Generation College Students: A Graduate Student Instructor Guidebook**

#### **Title**

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#### **Author**

Lair, Deborah

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## CREATING ACADEMIC COMMUNITY FOR FIRST-GENERATION COLLEGE STUDENTS A Graduate Student Instructor Guidebook

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### Relationship of Time-Management Behaviors to the Effectiveness of Chemistry Pre-Laboratory Assignments

Deborah Lair\*

Chemistry and Physics Program

Center for Research on Teaching Excellence Graduate Teaching Fellow

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During the Fall 2010 semester, a study involving the first semester of general chemistry (Chem 2) investigated the effect of including pre-lab exercises in the normal settings of laboratory work, and in particular, the effect on sections identified by their time-management character. Sections were classified as belonging to one of three groups: procrastinators, average time-managers, or pro-active time-managers. Sixteen sections with a total of 372 students, 141 receiving the intervention, and 231 doing no pre-lab exercises, were involved in the study. Evidence of effectiveness was obtained in the form of improved scores on lab reports. Overall, a modest gain in lab report average scores of 2.2% was observed. Gains were more substantial for both procrastinating sections and their opposites, the pro-active time-managers, while those sections in the middle ground received very little obvious benefit from this particular style of intervention. While demonstrably better than doing no pre-labs for two significant cohorts, this trend and associated literature suggests that other methods of pre-lab preparation may benefit undergraduate student learning and should be further investigated.

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## **Relationship of Time-Management Behaviors to the Effectiveness of Chemistry Pre-Laboratory Assignments**

### **Abstract**

During the Fall 2010 semester, a study involving the first semester of general chemistry (Chem 2) investigated the effect of including pre-lab exercises in the normal settings of laboratory work, and in particular, the effect on sections identified by their time-management character. Sections were classified as belonging to one of three groups: procrastinators, average time-managers, or pro-active time-managers. Sixteen sections with a total of 372 students, 141 receiving the intervention, and 231 doing no pre-lab exercises, were involved in the study. Evidence of effectiveness was obtained in the form of improved scores on lab reports. Overall, a modest gain in lab report average scores of 2.2% was observed. Gains were more substantial for both procrastinating sections and their opposites, the pro-active time-managers, while those sections in the middle ground received very little obvious benefit from this particular style of intervention. While demonstrably better than doing no pre-labs for two significant cohorts, this trend and associated literature suggests that other methods of pre-lab preparation may benefit undergraduate student learning and should be further investigated.

### **Motivation**

It has often been said that research is personal. So I shall indulge in a personal story to allow the reader to understand my motivation in pursuing this particular line of research. During my first semester at UC Merced as a graduate student, I was assigned to be a graduate student teaching assistant (TA) for Chem 2, the first semester of general chemistry. I was responsible for two lab sections, both in the afternoon, but one was on Monday and the other was on Thursday. After the Monday section, I was looking forward to the Thursday section being more 'ready,' but much to my surprise they were even less prepared! Throughout the semester, this initial impression was reinforced. The Thursday group was simply rife with procrastinators. It often seemed to me that the people in the Thursday section were just as capable as those in the Monday group, but simply used their time less efficiently.

Much of the impetus for this study comes from my desire to understand this kind of trend and what can be done to alleviate study habit problem. Under-preparedness isn't a problem solely of the students; this issue impacts laboratory instruction and hence affects the TA's quite deeply. I have seen far too many people enter as TA's only to decide against teaching professionally as a result of frustration. TA's feel that undergraduates are not doing their best or trying as much as they could. Pre-lab exercises give us another avenue to implement a positive feedback loop in students, in which attention leads to success which encourages more attention. The creation of the positive

feedback loop will support both undergraduate success and reduce a portion of the frustration that TA's in service courses<sup>1</sup> often feel.

Why do I label one end of the spectrum procrastinators, a personality trait, and the other end pro-active time-managers, a skill? There are studies which suggest that those people we label as procrastinators really do practice time-management skills. The difference between procrastinators and pro-active time-managers is what each values most. Compared to working towards long-term goals, procrastinators tend to place a higher value on the present day [1]. This tendency to delay is why it is so critical to activate the positive feedback loop and bring the benefits of positive work habits to our students. If in the process we can also teach them the value of being pro-active time-managers, so much the better.

Pre-lab exercises structure student interactions with learning materials. The overall positive effect of adding pre-lab exercises agrees with the findings of other researchers [2, 3] who have found increased student performance in classes with more frequent classes or more time on task. Findings also include favorable results attributed to students being able to exhibit their own preference on course scheduling [2]. Here at UC Merced, laboratory sections are scheduled across a large span of times and days, such that students are able to maximize their own personal choice with scheduling. This level of scheduling choice has enhanced the relationship between course enrollment patterns and time management skills observed in this study. As a result, UC Merced has furnished an excellent testing ground for studying the relationship between student procrastination and the effect of mandatory pre-labs on lab report scores.

## **Background**

So what exactly is a pre-laboratory assignment? In general, it is any activity that orients the student on the upcoming lab experience. Examples include: attendance at a demo, written assignments, computer exercises, or discussion sections. The performance of a laboratory experiment is an enormously rich experience and its very complexity can make it daunting, particularly in introductory-level courses. Pre-lab activities, which familiarize the student with portions of the work they are about to engage in, allow students to focus on new material or techniques.

Researchers in chemical education have found that various types of pre-lab interventions have increased student comprehension [4, 5, 6]. Psychology researchers have reported that procrastinating students receive grades on par with their non-procrastinating peers [1]. The question, then, is this: Given that research has shown that both time on task activities and time allowances for reflection increase student

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<sup>1</sup> A service course is an introductory course in a discipline which is not the student's major, but which is required by the student's major. Thus, many of the students in the course are not majoring in that discipline.

comprehension [3, 6], to what extent should we expect a related, required assignment to affect procrastinating students as compared to average students?

This investigation asks whether an intervention, in the form of a pre-lab assignment, aided time-management challenged students more, less, or roughly the same as it did more organized students. In particular, the pre-lab was due the day of the lab section, as is the norm in the next course in the sequence of general chemistry here at UC Merced. As such, the current research focuses on a situation with enforced time on task. The goal was to determine how effective our current method of utilizing pre-labs is, and whether there is a difference in effect related to the time-management habits of the sections.<sup>2</sup>

There are two steps to evaluating results. The first is to determine its statistical significance, via standard deviation. In this study results were analyzed using the formula for standard deviation given below. Standard deviations for individual lab sections were usually on the order of 2 points, out of the 25 points for a perfect laboratory report.

$$\sigma = \sqrt{\frac{1}{N} \sum_{i=1}^N (x_i - \mu)^2}, \quad \text{where} \quad \mu = \frac{1}{N} \sum_{i=1}^N x_i.$$

The second step involves determining the meaningfulness of the results. Typically, a full standard deviation is considered from the standpoint of the student, as receiving 2 more points on a lab report is approaching a full letter grade difference in score. Additionally, those of us who grade these reports are quite certain that the score we assigned to the student is, in fact, the grade he or she earned given the rubric parameters and demonstrated effort. The interested reader may wish to consider the debate on the issues of statistical significance and meaningfulness which has raged in psychology circles [7].

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<sup>2</sup> The idea of using section scores rather than individual scores arose from my previous experiences as a TA. Since I had observed distinct ‘personalities’ in different lab sections, with the most striking feature being the difference in their capacities for procrastination, I conceived that it would be possible to collect the data needed on an aggregate basis. The design of this study then relies on an underlying tendency of students with similar time-management identities to bunch together in lab sections. The study involved human subjects, so a paramount concern was maintaining privacy, yet it needed to be accomplished in a single semester and used a personal metric. The use of aggregate data vastly simplified obtaining IRB approval for the project.

## Methodology

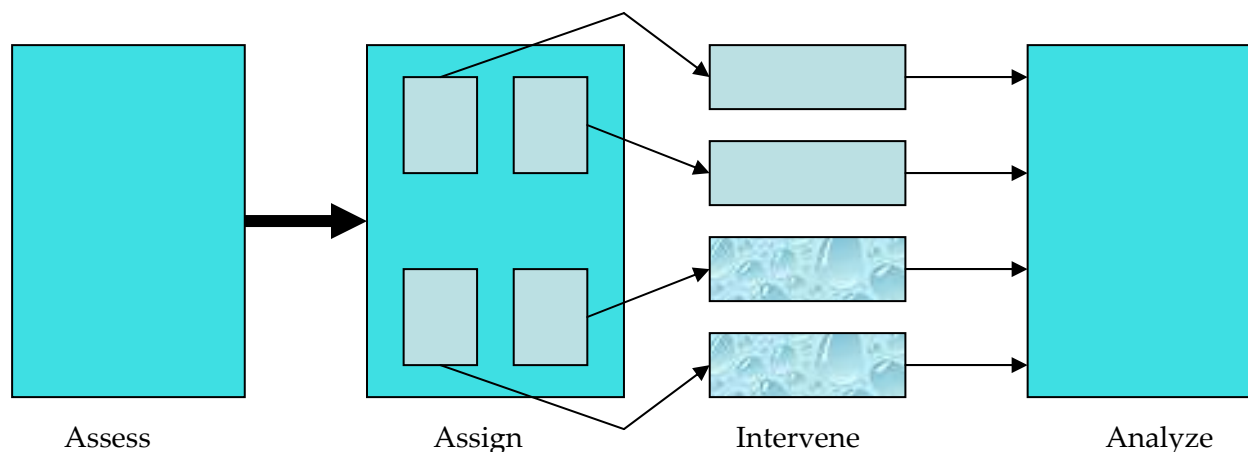


Figure 1. Methodology Graphic

The first step was to assess the time-management behaviors of the lab sections. Two methods were used to accomplish this task: (1) TA observation of behaviors using a simple tally, and (2) a student survey that used self-identification to allow calculation of a numerical value for the average 'procrastination' score of the section. Neither method associated individuals with specific behaviors, thus maintaining the respect of individual privacy. The tally sheet behaviors counted by the TA's appear in Table 1.

Table 1. TA Tally Sheet Questions

How many students:

Came in more than 5 minutes late	
Needed to borrow goggles	
Did not have an official lab notebook	
Wore open-toed shoes to lab	

After classification of the 16 lab sections, six of the sections were assigned to receive the pre-lab assignments. Choice of those six sections was driven by several competing factors: desire to span all days of the week and times of day when labs were offered, requiring that any given TA had no more than one section receiving the intervention, and most importantly, to give a wide representation of the procrastination tendencies of the sections as portrayed by the TA tallies.

The pre-lab interventions were designed to focus the attention of the student on some aspect of the experiment they were preparing to do that week. As mentioned earlier, currently, in Chem 10, the second semester of general chemistry, pre-lab exercises

are due as the student enters the laboratory. This was the method adopted for this investigation as well. Assignments received no grades, thus leaving the rubric by which lab reports were graded uniform between sections.

Scores received on lab reports were used to analyze the effect of the pre-lab exercises on student understanding. Since the pre-labs focus the attention of the students on the skills and/or science in the experiment at hand, the students should have been able to write more clearly and precisely than otherwise, thus earning a better grade on the lab report. Together, the average lab report scores and the average procrastination scores were used to develop a picture of the effectiveness of pre-labs related to section procrastination tendencies.

### Results & Discussion

Survey 1 included a self-identification question which yielded a numerical result for the average procrastination tendencies of each of the 16 lab sections. The results were divided into quartiles, and are presented in Table 2. Scores in red represent the sections that received the pre-lab intervention.

Table 2. Procrastination Self-Identification Scores

Procrastinators	Average Time-Managers		Active Time-Managers
2.48	2.70	2.74	3.14
2.50	2.80	2.83	3.19
2.50	2.84	2.86	3.29
2.55	2.94	3.06	3.41

An interesting side-note is that the four lab sections conducted on Wednesday were the four active time-manager sections, while three of the four procrastinating sections were Thursday labs! This is not arbitrary, but rather the result of reasoning about what day of the week best serves the purposes of the student. This would be in line with research findings on student course scheduling [2] in which student success was enhanced when the student had more ability to accommodate their scheduling preferences. Additional information extracted from the surveys appears in Appendix A.

Survey 2 was given at the last lab session and asked several questions regarding what activities the students found useful. The results from the question, "If you did Pre-Lab Exercises, do you think they helped you understand the concepts of the laboratory?" appear in Figure 2. A majority of students agreed that they were helpful.

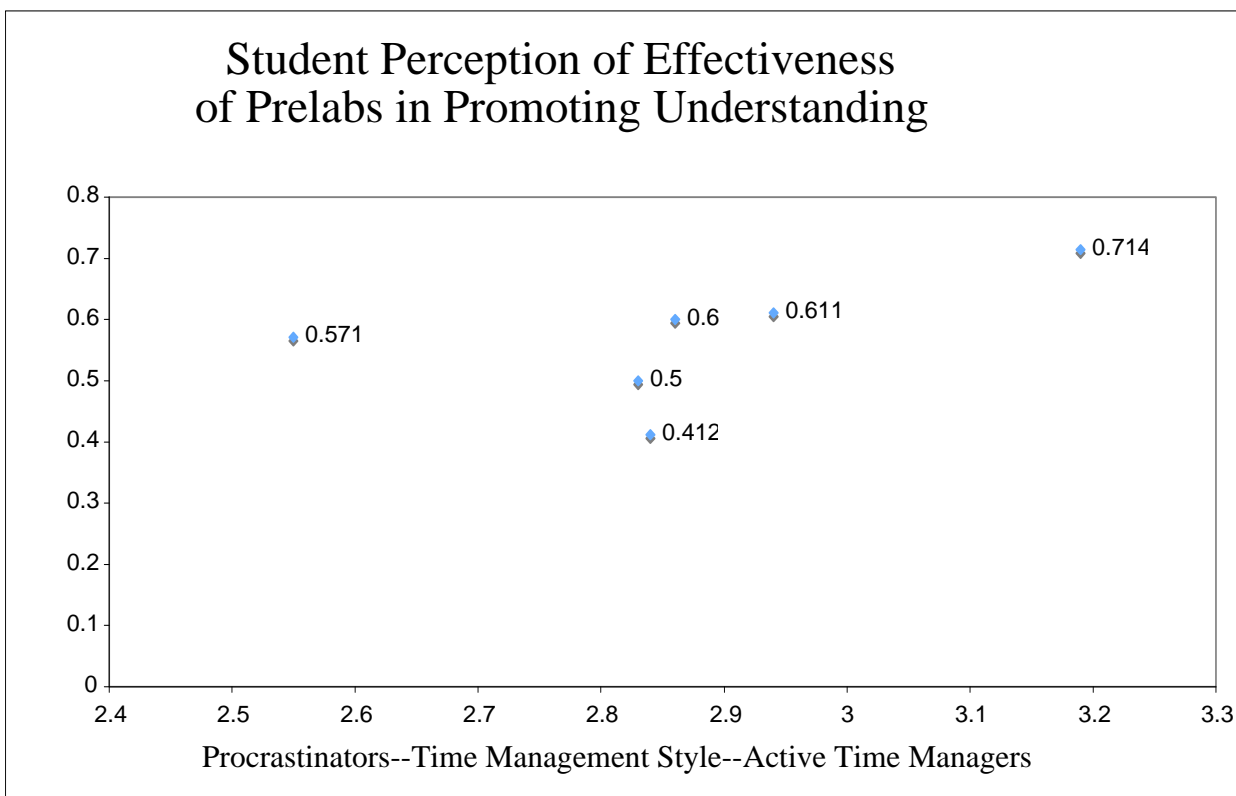


Figure 2. Student Perceptions

Another survey question that focused on the engagement of students with the pre-lab exercise was “What resources did you use to prepare for laboratory?” Students were offered four choices, not mutually exclusive. Table 3 shows the results. Only the response of Careful Reading exceeded that of using the Pre-Lab Exercise.

Table 3. Resources

On-Line Slides	Careful Reading	TA	Pre-Lab Exercise
44%	60%	39%	54%

Finally we turn our attention to the measured effects of pre-labs on the lab report scores of students. Figure 3 summarizes the average scores in sections with and without pre-lab exercises. Again, as in Table 2, red represents the sections who participated in the pre-lab intervention. It should come as no surprise that Active Time-Managers, with or without the pre-lab intervention, are seen to score highest. It appears from the raw data that procrastinators thrive on enforced time on task, while the extremely small gain in scores shown by the average sections makes one wonder if those students simply used time they would have devoted to lab preparation for the pre-lab without putting additional time in.



## Score Improvement as a Function of Time-Management Style

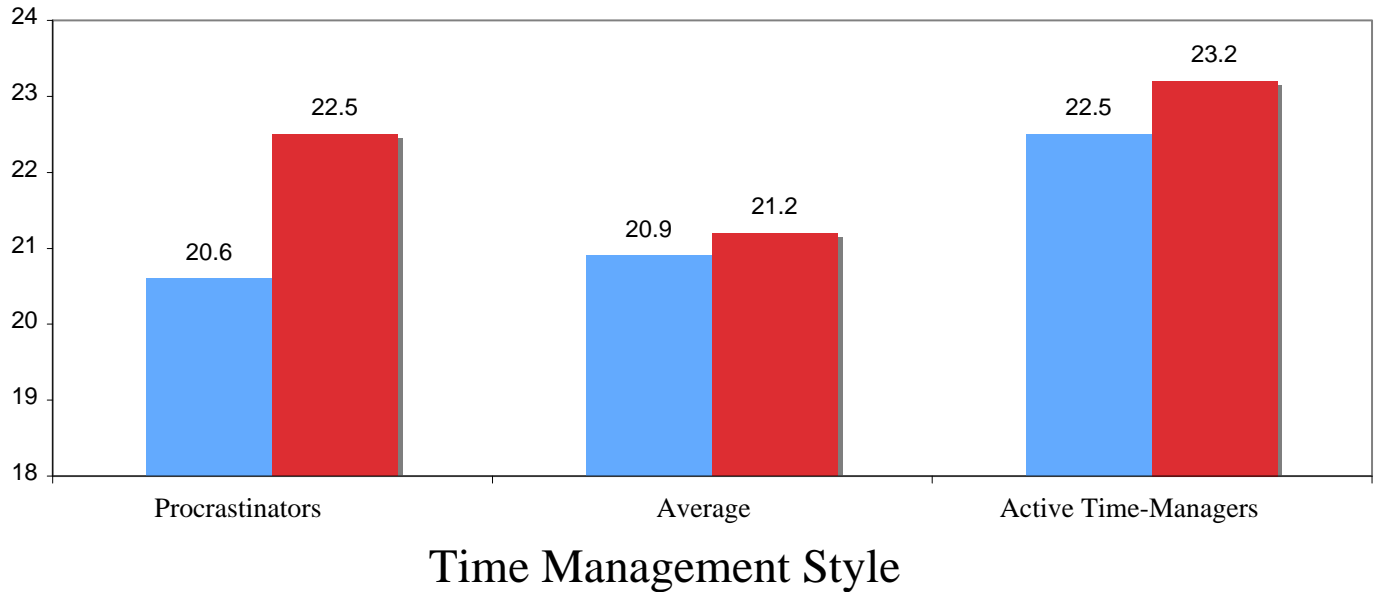


Figure 3. Score Improvements Derived from Raw Data

When the uncertainties in score reporting are considered, it is clear that one cannot claim that the sections in the average time management category received any benefit at all. Figure 4 is an approximation based on normal distributions of scores that shows how the two sets of data would appear for the average time management sections.

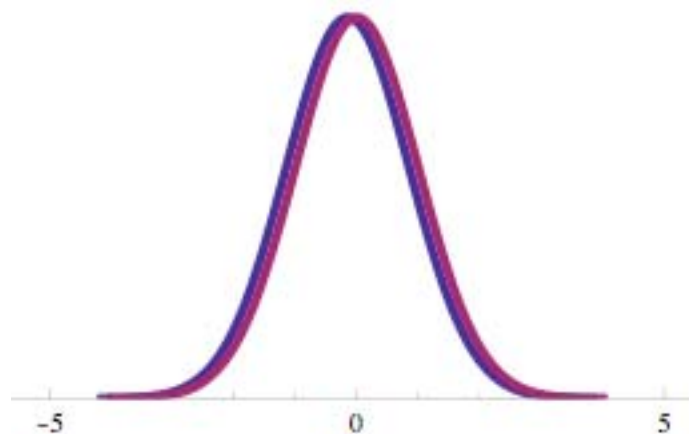


Figure 4. Normal Distributions

Separated by 0.15 of a Standard Deviation

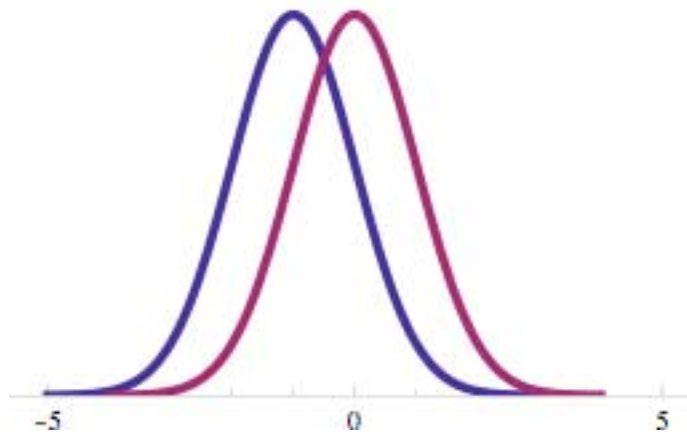


Figure 5. Normal Distributions

Separated by One Standard Deviation

Figure 5 is a representation that corresponds to the procrastination sections' situation. Here one can discern two peaks clearly and this leads to confidence in the scores reflecting an actual benefit to the group given the pre-lab intervention. This situation meets the requirements for clinical significance.

The situation for the active time-managers falls in between the two cases shown. The reader is encouraged to consider the extent to which he or she believes this to be a significant increase in scores.

So far, raw data has been presented, but there are modifications that can be taken into account to refine the picture. First, students in general tend to perform better as the semester progresses as they develop their understanding of what is expected in a lab report. Second, one can account for trends in different sections, whether that is due to better prepared students in a section or the grader's toughness, one can establish that section Q typically scores 0.35 points higher than section R. One can then observe whether a variation occurred after the pre-labs were introduced. This leads to a slightly different view of the data as summarized in Figure 6.

The average time-managers exhibit such a small increase in scores that once again it would be hard to make a case for statistical significance. The procrastinators and active time-managers have much more robust increases. Rather than expressing these as the average number of points earned on a lab report, I have converted them to a percentage increase in Figure 6. My reason for this is to facilitate understanding the meaning of the increase to the student. In the case of the active time-managers, 5.1% is half a letter grade. To the student, this could be the difference between a B- and a B+ on a lab report, and could strongly influence the extent to which the positive feedback loop is encouraged in

the student. Seeing the benefit of positive work habits is essential in establishing and developing them.

The inversion of procrastinators and active time-managers as the beneficiaries of the intervention once the trends are taken into account begs for an explanation. My view on it is that the procrastinators benefit because of the enforced time on task while the active time-managers utilize the pre-labs as additional guidance for their already well-developed study habits. Thus, they may benefit not only from the enforced time on task but also from the focus the pre-lab gives to their efforts. When viewed in this way, the peculiar result is that the average sections received so little benefit. Perhaps they are not currently capable of using the pre-labs as a focus point for guiding their study.

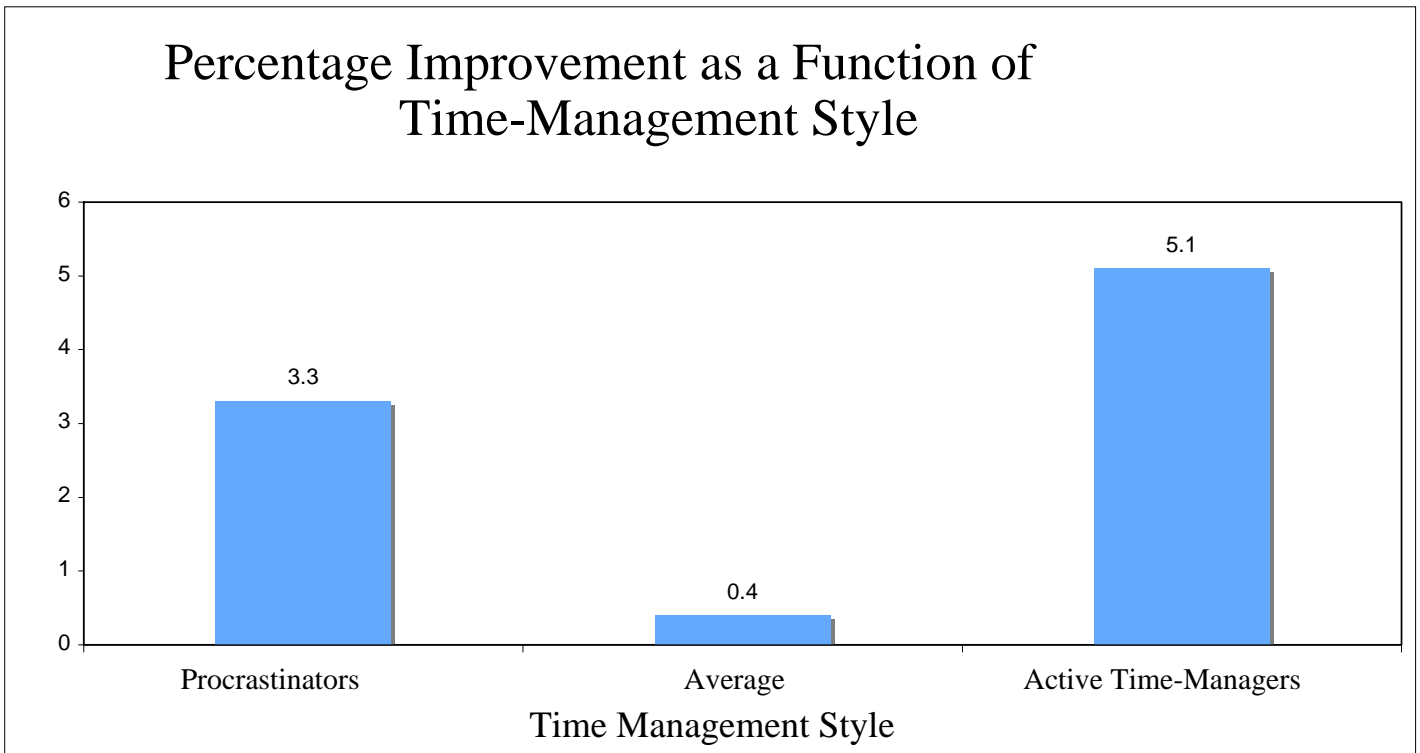


Figure 6. Improvement after Refinements in Analysis of Data

## Conclusions and Future Directions

Since most students fall into the category of average time-managers, and this study shows that the current method of pre-lab exercises has a null effect for this group, other methods of pre-lab preparation should be investigated and incorporated if proven both effective and efficient.

The concept of using aggregate data to access relationships based on individual metrics worked in the present case. It should be stressed that the wide range of times and days on which laboratory sessions were offered was fundamental to the success of this method. A course in which fewer lab sections were offered would be unlikely to be able to utilize this method effectively.

The obvious, but extremely time-consuming, next step would be to follow individuals instead of the aggregate lab sections. While the information gathered here supports the idea that those students labeled as Procrastinators have more in common with the Active Time Managers than they do with the average students [1], it would be informative to follow individuals and see whether additional support could be found.

Another interesting result, which could bear further study, concerns the effect of the individual pre-lab activities. In particular, the effect of curriculum could be studied. The pre-labs that students used in this study varied in their appeal to the various learning styles and skills. It is interesting to note that the most effective pre-lab, (Lab 8, Chemical Equilibrium) which appears in its entirety in Appendix B, was also the one highest on Bloom's Taxonomy of Learning as it required Analysis, Synthesis and Evaluation to complete successfully.

While the current research focused on enforced time on task, an attempt to distinguish between the effectiveness of pre-labs based on time for reflection has been done during Spring 2011. A paper on that work is forthcoming<sup>3</sup>.

## Acknowledgements

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<sup>3</sup> Contact me if you'd like to see: the surveys, pre-labs, or the spreadsheets developed from the study. Deborah L. Lair, 1012 Almond Avenue, Patterson, CA 95363 [dlair@ucmerced.edu](mailto:dlair@ucmerced.edu) or 209 895-4070

## References

- [1] C.H. Lay, "At Last, My Research Article on Procrastination," *Journal of Research in Personality*, 20, pp. 474-495, 1986.
- [2] A.K. Dills and R. Hernandez-Julian, "Course Scheduling and Academic Performance," *Economics of Education Review*, 27, pp. 646-654, 2008.
- [3] M.D. Biderman *et al.*, "Time-on-task mediates the conscientiousness-performance relationship," *Personality and Individual Differences*, vol. 44, no. 4, pp. 887-897, March 2008.
- [4] M.K. Kirk and J.W. Layman, "A Pre-Lab Guide for General Chemistry: Improving Student Understanding of Chemical Concepts and Processes", presented at the 69<sup>th</sup> Annual Meeting of the National Association for Research in Science, St. Louis, MO, 1996.
- [5] M. Rollnick *et al.*, "Improving pre-laboratory preparation of first year university chemistry students," *International Journal of Science Education*, vol. 23, no. 10, pp. 1053-1071, 2001.
- [6] F.S. Isom and R.E. Rowsey, "The Effect of a New Prelaboratory Procedure on Students' Achievement in Chemistry," *Journal of Research in Science Teaching*, vol. 23, no. 3, pp. 231-235, 1986.
- [7] N. Jacobson and P. Truax, "Clinical significance: A statistical approach to defining meaningful change in psychotherapy research," *Journal of Consulting and Clinical Psychology*, vol. 59, no. 1, pp. 12-19, 1991.