Effectiveness of mentoring in undergraduate information and operation management

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Abstract

Many educators have turned to cooperative learning programs as either a substitute or complement to their class lectures. Cooperative learning programs not only allow students to actively engage in the subject matter but also provide students with a support system. In 1999, the University of Pennsylvania implemented mentoring programs for a variety of courses, to aid students that needed additional academic support. The Operations and Information Management (OPIM) Department developed their own mentoring program in 2003 for their introductory course on spread sheeting and modeling. This paper analyzes two years of data to determine the effectiveness of OPIM's mentoring program. While no significant statistical relationship was found between a student's involvement in the mentoring program and improvements in academic performance, the qualitative data suggests that student's found the mentoring program helpful in their studies.

1. Introduction

Kenneth Bruffee in *Collaborative Learning: Higher Education, Interdependence and the Authority of Knowledge* suggests that collaborative learning can "…help college and university professors reach students indirectly who for a variety of reasons have not responded to direct instruction under traditional classroom conditions" (Bruffee, 1993, p. 93).

Most universities place first year students into large-class settings, which results in minimal student interaction and limits intellectual development (Cooper, 2000, p. 8). In order to provide students with an opportunity to work more closely with a professor and other students, many universities have implemented mentoring or collaborative learning programs. It was with this logic that the University of Pennsylvania developed their own cooperative learning program called the Penn Mentoring Program (PMP).

Although the terms cooperative and collaborative are often used interchangeably in the academia, there are many educators who suggest there is a clear distinction between the two words. Some suggest that cooperative learning differs in that although it utilizes group learning, it is more structured and aims to maintain the traditional lines of authority in the classroom. Collaborative learning, meanwhile, reduces the students' dependence on the teacher so that students and teachers work together to solve problems and gain knowledge (Barkley, 2005, p. 5-6). The Penn Mentoring Program, because it maintains a structured teaching style, will be referred to as cooperative learning for the purposes of this paper.

The goal of this paper is to examine the effectiveness of cooperative learning in an operations and information management class. We will first explain the history of the Penn Mentoring Program and how the OPIM Department has adopted its own mentoring program to help students in its introductory course, OPIM 101. Then we will look at the qualitative data that was collected, which consists of quality circle surveys filled out by students following their experience in the mentoring program. Finally, we will examine the quantitative data to see if there is a significant relationship between enrollment in the mentoring program and better academic performance.

2. Background on Penn Mentoring Program

The Penn Mentoring Program was developed in the fall of 1999 for students taking beginning level Computer Science and Engineering courses. It was developed in response to high student demand for additional academic support in these courses. The program established a cooperative learning environment around three components, which administrators thought were essential: community setting, conversation and change. A community setting allows students to be more cooperative than competitive as they can study and learn with their peers as opposed to retreating to their dorm rooms. The conversation component suggests that students learn more by talking and actively engaging in the information instead of listening to a professor speak for an extended period. Finally, cooperative learning groups have changed the way students learn, as

students are now receiving support from expert "mentors" who are able to appropriately develop methods for understanding the material. In addition, PMP looks out for students who aren't great at networking and helps these students meet and work with their peers.

The Operations and Information Management Department developed their mentoring program in the spring of 2003 to aid students in OPIM 101. Under this program, upperclassmen who have previously excelled in OPIM 101 serve as mentors for other students. Each mentor meets weekly with about 12 students in a lab to review concepts discussed in lecture and complete practice exercises designed to mirror exam questions. While mentors run each session and provide students with additional guidance, students are also encouraged to work and discuss problems with each other. In addition, mentors held extra review sessions before exams to provide further support for students. The concept behind PMP is that students will efficiently spend their studying time and also benefit from studying with other peers in their class as well as mentors who have previously excelled in the course.

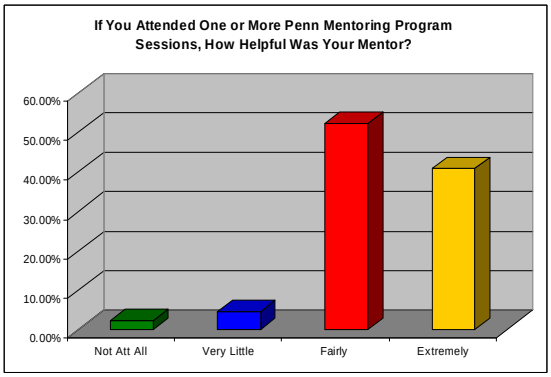
To prepare for their sessions, mentors agree to attend mentor meetings with program coordinators as well as participate in a training workshop held by the Office of Learning Resources and other administrators from the department. If a student were to have a question, which the mentor was unable to answer, the mentor would consult with faculty or teaching assistants to accurately answer the question.

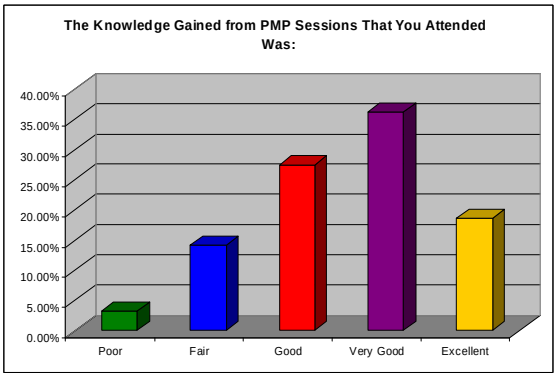
OPIM 101 is an introductory course, which intends to provide students with a foundation in spread sheeting and modeling. Using Microsoft Excel and VBA programming, students learn to solve problems as if they were working for a client. Topics covered include budgeting, analytical modeling, sensitivity analysis, decision analysis and optimization. Lectures are held three times a week for one hour and those students who wish to receive further help in a more intimate setting are encouraged to attend the mentoring sessions.

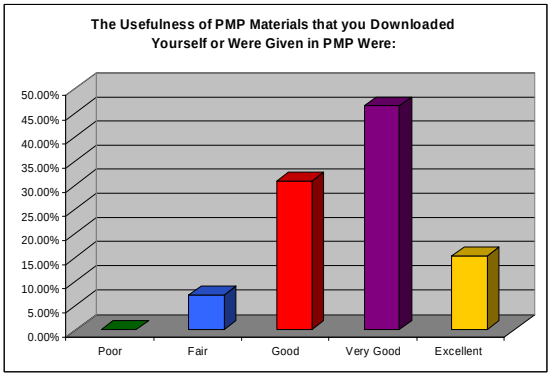
3. Data Gathered

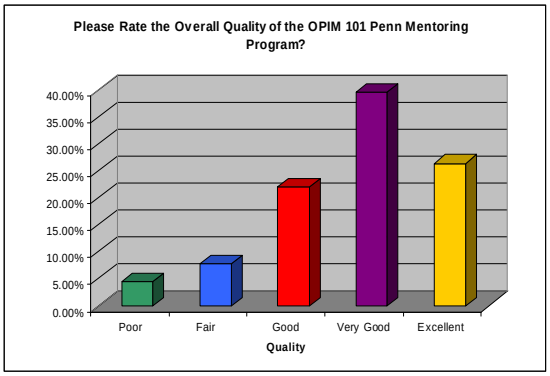
The research was completed using two years of data, which included both qualitative and quantitative information.

In year 1, students filled out quality circle surveys at the end of the semester, in which they were asked a variety of questions concerning their mentoring experience. Overall students seemed to believe the mentoring program served as a good compliment to the lectures they attended. Students were first asked to evaluate the knowledge they gained from the mentoring sessions (n = 91). Students seemed satisfied with the material as good, very good and excellent received 28%, 36% and 19% of the responses, respectively. They were then asked how helpful their mentor was and the results suggest that students were appreciative of their mentors advice (n = 89). 52% answered that their mentor was fairly helpful while 40% replied extremely helpful. We also wanted to determine how useful the mentoring material was in aiding the students' studies. Students who answered this question were both those that received the material during the mentoring session and also those that downloaded the material from the course website and completed the exercises individually (n = 97). Students seemed to find the material useful as good, very good and excellent received 31%, 46% and 16% of the replies, respectively. Finally, when asked to rate the overall quality of their experience 22% replied good, 40% said very good and 26% answered excellent. Meanwhile, fair and poor received 8% and 4% of the replies, respectively (n=91). As about 2/3 of the students rated the overall quality of the program as very good or excellent, we deemed that students were satisfied with the PMP program and were appreciative of the added value that the program brought to their studies. It was the rare case that students did not find the material useful or thought that they gained little knowledge from the program.









The quantitative data was provided by four sections of OPIM 101 professors at the University of Pennsylvania. For year one data was provided for 500 students, 281 of which were enrolled in mentoring and 219 were not enrolled. Meanwhile, for year two we obtained data for 445 students of which 120 were enrolled in mentoring and 325 were not enrolled. Each section had about 100 to 125 students enrolled while each mentoring session contained 30 to 40 students except for two mentors who had 50 and 58 students.

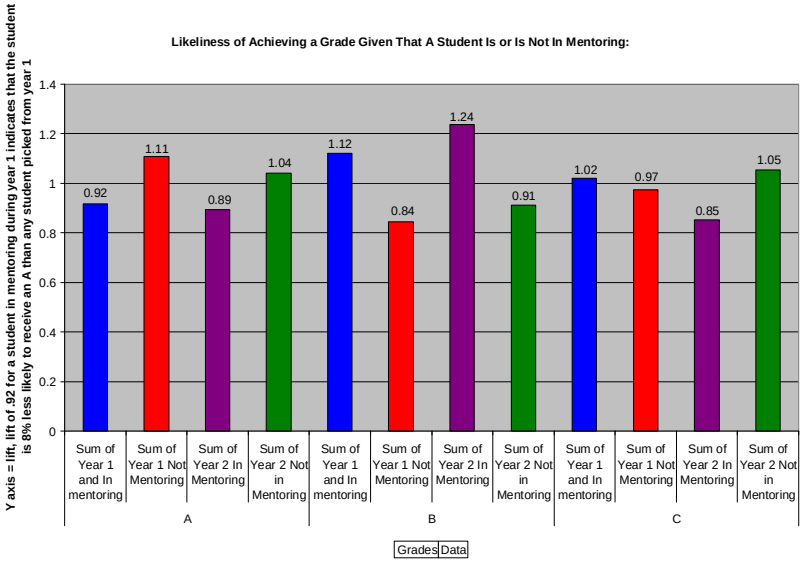
For the first year, students were first divided by which section they were in, A, B, C or D. We were also told whether they had enrolled in mentoring or not and if so how frequently they attended. The frequency of attendance data was gathered by asking the mentors, at the end of the semester, how often they had seen each student: Always, Often, Rarely, Never or Unknown. For those students that were enrolled in mentoring we were also given the mentor that they had spent the semester with. Lastly, we had access to the final letter grades that these students received as well as their relative score change between the midterm and the final. Unfortunately, we were unable to control for the section students were enrolled in.

For the second year, students were again divided into the 4 sections and we were also told if they had enrolled in mentoring. However, we did not have information as to which mentor they had or how often they attended. Their relative score change between the midterm and final, was provided to us, along with how many extra credit points (0 to 15) they received. It should be noted that the mentors did not enforce a turn away policy. Therefore, students who had not registered for a mentoring session were still able to attend the sessions but are not included in the data.

4. Analysis and Interpretation of Quantitative Data

The chief goal of the mentoring program is to facilitate students in performing better in OPIM 101. One would hope to see those students enrolled in the mentoring program do better than they would have otherwise done had they not been enrolled in the program. The lift graph below takes two years of data and displays the increase or decrease in likelihood of achieving a

grade given that a person is or is not enrolled in mentoring. A lift of 1.25 for a student in mentoring would indicate that a student enrolled in mentoring is 25% more likely to achieve a certain grade than a student chosen at random. Meanwhile, a lift of .75 for a student in mentoring would indicate that a student enrolled in mentoring is 25% less likely to achieve a certain grade than a student chosen at random.



Surprisingly, students not in mentoring from both years one and two were more likely to receive an A than those students in mentoring. In year one, students not in mentoring were 11% more likely to receive an A while students in mentoring were 8% less likely to receive an A. Meanwhile in year two, students not in mentoring were 4% more likely to receive an A and students in mentoring were 11% less likely to receive an A.

However, in year two students not in mentoring were also 5% more likely to receive a C and students enrolled in mentoring were 15% less likely to receive a C. Meanwhile, in year one students in mentoring were an insignificant 2% more likely to receive a C than a student in general.

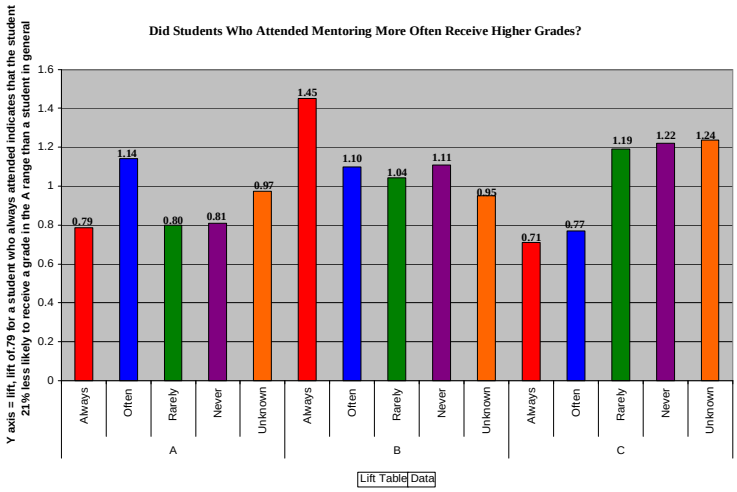
Lastly, students not in mentoring were much more likely to receive a grade of D or F. A year one student not in mentoring was 98% more likely to receive a grade of D or F than a student in general. Meanwhile, a year two student not in mentoring was 37% more likely to receive a D or F as compared to all year two students. However the data is limited, as there were only 15 students who received a D or F in year one and 9 students in year two.

A chi-squared test was conducted on this data to determine if the difference between the actual results we received and the expected results is statistically significant. Using a probability of 5%, the chi-squared value for two degrees of freedom would need to be 5.99 to indicate a significant difference. For years one and two, the chi-squared values were 4.95 and 5.08, respectively, and therefore no significant relationship could be determined between those students in mentoring and higher grades.

Although students in mentoring were less likely to receive an A than those students not in mentoring, this does not mean that the mentoring program was ineffective. One possible explanation for this is that students who weren't enrolled in mentoring had better study habits and were straight A students anyway and therefore didn't need the help of a mentor. It might have been helpful to know a students GPA, to see how they did in mentoring compared to their grade average for other classes.

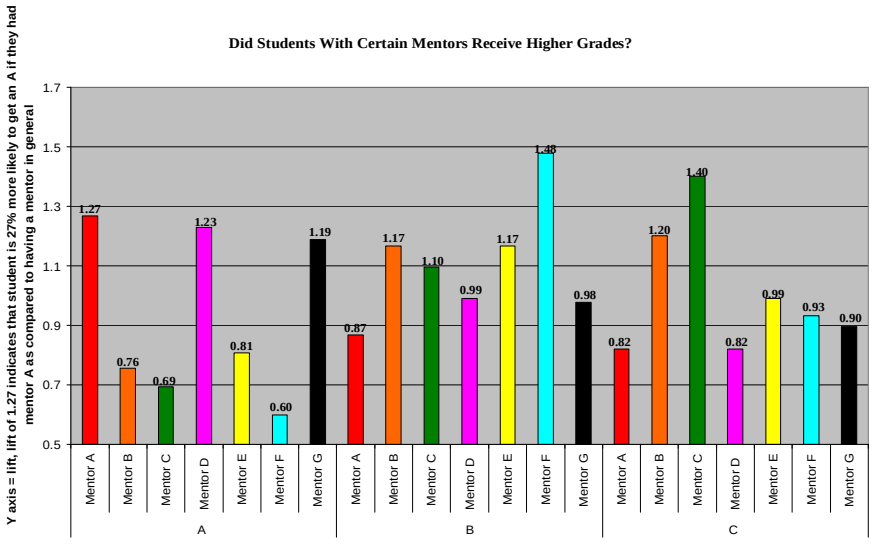
Although there did not seem to be a relationship between the grades students received and whether or not they were in mentoring, we also examined whether a student's attendance at the mentoring session impacted their grade. For the year one, students' attendance records were

broken down into always, often, rarely and never. We did not have attendance records for about 12% of the students and they were therefore designated as unknown.

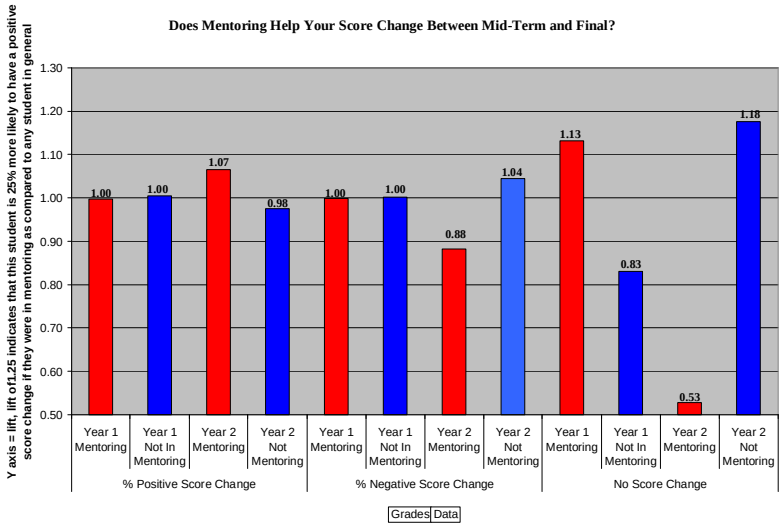


Looking at the graph above, there does seem to be some correlation between the two (attendance and grades) as students who always attended mentoring were 29% less likely to receive a C than a student in general. Furthermore, students who rarely or never attended mentoring were 19% and 22% more likely to receive a C, respectively. This might suggest that students who really put the time and effort into attending mentoring were less likely to receive an unsatisfactory grade. This is also suggested by the fact that students who always attended mentoring were 45% more likely to receive a B than a student in general. In regards to grades in the A range, students who often attended were 14% more likely to receive an A than the average student. However, students who always attended were surprisingly 21% less likely to receive an A than the average student. Meanwhile the other two attendance groups (rarely and never) had very similar results as each was about 20% less likely to receive an A than the average student. A chi-squared test was run on this data to see if there was any significant difference. The test suggested the difference was not significant as the chi-squared value was 6.8, which was less than the 12.59 needed for a 5% probability.

While attendance did not seem to have a significant impact on a student's grades we then looked at whether students with certain mentors received better grades. The lift graph below suggests that students with certain mentors (mentor A, D and G) were about 25% more likely to receive an A as compared to all students. Meanwhile students with other mentors received an A much less often. For example, students with mentors F and C were 40% and 31% less likely to receive an A as compared to all students. Students with mentor C were not only less likely to receive an A but also much more likely to receive a C, as they received a C 40% more often than the average student. A chi-squared test was performed on the data to determine if there was a significant relationship between mentors and grades received by students. The chi-squared value with 12 degrees of freedom was 13.02, much less than the 21.03 value needed to determine that there was in fact a significant relationship. Therefore it cannot be determined if certain mentors helped students achieve higher grades.



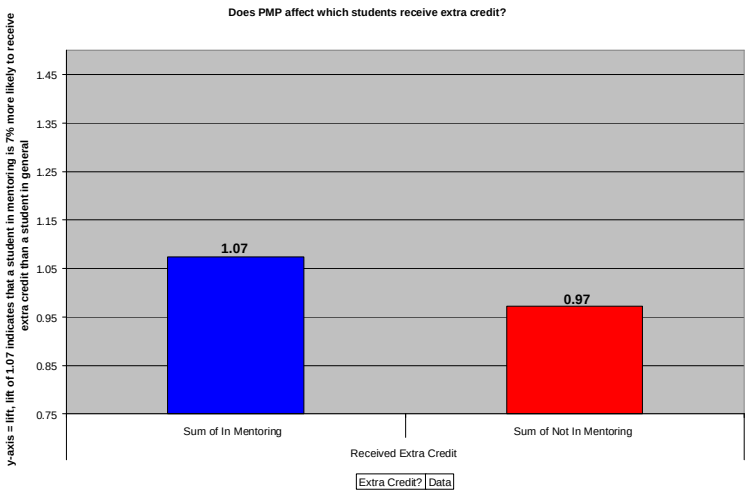
One of the goals of the mentoring program is to help students not only achieve better final grades but also help them improve as the year went on. The lift graph below looks at how a student's grades changed between the mid-term and final, depending on whether they were in mentoring or not.



If you look at the two years of data, there seems to be no difference between students that were in mentoring and those not in mentoring. In fact, the probability for students receiving a positive score change in year one was exactly the same for students in mentoring vs. those not in mentoring. The chi-squared value was a meager .25 as compared to the 5.99 needed to indicate a significant relationship.

In addition to looking at a student's final grade to determine the effectiveness of the mentoring program, we also looked at whether a student received extra credit or not[1]. The graph below suggests that students in mentoring are more likely to receive extra credit than those students not in mentoring.

[1] Extra credit is additional points that a student receives towards his grade for completing assignments. While not required by the professor, the can complete these assignments to improve their grades.



Students in mentoring are 7% more likely to receive extra credit than all students in general, while students not in mentoring are 3% less likely to receive extra credit than all students. A chi-squared test was conducted on this data and the chi-squared value was 3.78 with one degree of freedom. However, the table value was 3.84 for a p of .05 and therefore we concluded that there is no significant relationship.

5. Research Limitations

There were several limitations that we came across while examining the data. While looking at statistics regarding extra credit, the data only gave information on how many extra credit points students received. We had no data on which students attempted extra credit. Even for students that received zero points of extra credit, it is unclear whether or not these students submitted anything for extra credit.

There were also limitations when looking at the relative score changes students achieved between the midterm and final. We were able to look at how many students achieved positive score changes, negative score changes or no score change. However, we were unable to look at the magnitude of these score changes because they were all given as percentages. One problem we faced is that just because a student received a score change of 100%, doesn't mean that it was a significant change. For example, if a student had positive score change of 100% there was no way to determine if the student went from a 20 to a 40 average or a 45 to a 90 average. Had we received the absolute after the midterm and the final it would have been more valuable to us understanding the effectiveness of the mentoring program.

There appeared to be some correlation between how often a student attended mentoring and the grade they received. However, this data was limited because there was an unknown category which included 12.6% of the students. The frequency of attendance data was gathered by asking the mentors at the end of the semester how often they had seen the students. Not only was the information they provided subjective and imprecise, but they also were unable to provide data for all 500 students.

Other limitations include: 1) Only year two provided data for extra credit received by students. 2) Only year one provided attendance data.

6. Literature Review

Much has been written regarding the effectiveness of cooperative learning and there is ample evidence which suggests that peer learning is able to help a student both academically and non-academically. Through cooperative learning students are able to participate in exchanges that

allow them to "develop and support assertions, negotiate meanings, and adjust their ways of thinking" (Lazar, 1995, p. 61). Some academics go even further and suggest that group learning environments also prepare students for complex workplace problems. In her article "Collaborative Learning," Mary Beckman suggests that through teamwork students are able to look beyond the grading curves and contribute their knowledge to the overall group effort (Beckman, 1990, p. 129-130).

There are, however, several dysfunctions that can arise when forming peer groups that reduce the efficacy of cooperative learning. Obstacles include the formation of cliques, students choosing teams based on their friends, and students getting locked into fixed roles (Lederer, 2001, p. 133). Students also may lack the necessary motivation to participate in peer groups, which will not only prevent them from learning the material but can also lead to absenteeism (Falchikov, 2001, p. 205). It is important to examine both the successes and failures of various peer learning schemes when trying to implement a cooperative learning environment.

Some academics have proposed ways to improve education through various forms of collaborative learning. One such suggestion is to introduce group exams to allow for thoughtful discussion and examination of problems. Susan Stearns writes in her article "Collaborative Exams as Learning Tools," that "When the communication occurring vocalizes rationales of the students' choices, they are teaching each other, which then offers the potential of learning from each other" (Stearns, 1996, p. 111). But she notes that exam questions must be difficult enough to arouse meaningful discussion. In quality surveys that students completed after the semester, some students expressed disappointment with the problems used for PMP in that they were too easy in comparison to the midterm and final exam questions. Had questions been structured differently to reflect the difficulty that students would experience on the exams, there may have been a stronger correlation between those students that enrolled in mentoring and improved exam grades.

Another topic that is often debated in regards to cooperative learning is whether students benefit more from homogenous or heterogeneous groups. Stearns is a proponent of heterogeneity in regards to both personal characteristics, such as gender and nationality, and also ability (Stearns, 1996, p. 112). John Baer's research, however, suggests that homogenous groups formed on the basis of ability, outperform heterogeneously grouped students. His study grouped students based on their scores on their first quiz and he found that students in the homogenous groups outperformed those in the heterogeneous groups. One suggestion that Baer makes as to why this is the case is that students "with similar levels of knowledge and understanding of the topic may be more interesting to the students and more likely to take place at a level appropriate the knowledge and skills of the students involved" (Baer, 2003, p. 173). PMP formed heterogeneous groups based on student's availability. However, PMP might want to consider moving to homogenous groups, based on the assumption that students with similar levels of knowledge are able to get more out of cooperative learning environment.

7. Conclusion

While there was no significant relationship found between those students enrolled in the OPIM mentoring program and improved academic performance, the quality circle surveys did suggest that students found the cooperative program beneficial to their studies. There are several possible explanations for the lack of evidence found to suggest a meaningful relationship. There might be other variables that accounted for student's grades that superseded the impact of mentoring. It is also possible that those enrolled in the mentoring program were on the average not as good students when compared to those not in mentoring. If this were the case then it would be of no surprise that the data did not show a significant relationship between enrollment in the program and student's grades. Unfortunately, we were not able to set this research up as a controlled experiment because doing so would have made it inequitable to the students. Instead, it

was a retrospective review of students' performances. Because of limited funding and space, admission to PMP was initially based on a lottery system open to only 150 students. However, due to student outcry the program was opened to all students.

Although our quantitative data did not suggest that the OPIM mentoring program improved student's grades, other tests could be conducted in the future that better determine the effectiveness of the program. One such study would be to look at how many OPIM students enrolled in the mentoring program went on to a higher level OPIM course. Another study might look at different groups of students with similar GPAs and compare those students that were in mentoring against those that were not.

The OPIM Department has decided to continue using the mentoring program to supplement the class lectures and to allow students an opportunity to interact with the material in a more intimate setting.

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