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Undergraduate Engineering and Technology Student Attendance and Its Relationship to Success in Math-Intensive and Non-Math-Intensive Courses

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Undergraduate Engineering and Technology Student Attendance and it's Relationship to Success in Math-intensive and Non-math-intensive Courses

Abstract

A few years ago, members of our Engineering & Design Department began a study to determine the effects of class attendance on student success. Today's engineering and technology students have grown up in an environment that is very different from the students of 20 years ago. They access information, engage in social contact through digital media, and often have almost instant access to this digital media through portable, wireless devices. There is a thought that with this greater connectivity they may not respond in the same manner to the teaching methods of past generations of students. In addition, the students of today may not feel the same need to be physically present in their classes in order to be successful.

Initial results presented at American Society of Engineering Education (ASEE) Annual Conference and Exposition in 2012, determined that attendance does correlate with student success and the correlation changes during the progression of a student throughout their undergraduate experience. Results presented at the ASEE 2013 Conference indicated that an instructor's attendance policy did not significantly affect overall attendance rates of students that earned high grades in a course, but that it did affect the students that earned lower grades.

This current paper discusses the relationship between student attendance and success based on whether the course is math intensive or not, and tracks and analyzes the attendance behavior of students throughout their entire undergraduate studies. Combined attendance data, collected since 2008 by a variety of instructors, is tracked and analyzed for approximately 20 classes per year, ranging from freshman to senior students. The types of programs covered in this current paper include: Mechanical Engineering, Mechanical Engineering Technology, Manufacturing Technology, Design Technology, Construction Management, Applied Technology, and a service course to the general student body.

Introduction

This paper provides results from a continuing research project investigating the relationship between student attendance and student success. The data was gathered from the fall of 2009 until the spring of 2014. Previous papers utilizing this data examined the correlation between student attendance and student success to determine how this was affected by parameters such as: class standing, instructor's attendance policy [10, 23,24], gender, economic status and whether the student is first-generation or not[25]. These studies showed that overall, there was a definite correlation between student attendance and their level of success in the classroom, and that this correlation was true from the freshman standing to the senior one[10]. It is believed some engineering and technology students look down on non-mathematical courses as not being

technical or engineering-like enough and therefore give them lower priorities. Furthermore, since math is sometimes the challenging part of most engineering and technology courses, the authors of the study were very interested in finding out how much of an effect this has on attendance. This paper looks at the entire database and analyzes the attendance trends as a function of course type (math versus non-math intensive). The analysis is done for the student population as a whole as well as by student standing (freshman, sophomore senior and junior).

Conceptual Framework of Student Attendance and Literature Review

In one of the authors' previous studies, it was determined that class attendance was positively correlated with grades for engineering and technology students and it became more important as students moved through the academic curriculum[10]. The authors' study was specific to engineering and engineering technology classes and validated conclusions on more general courses by others [7,5,9,11,16,21,26,27]. The general findings were also in agreement with Tinto, who states that what happens in the classroom is most important to the success of students[30] .The authors' conclusions were different from others for some general courses where attendance polices do not matter [1,4,6,17,28]. A previous study by the authors of this paper noted that the individual instructor's attendance policy also had an impact upon a student's attendance[24]. The conclusion disagreed with a number of studies that found that rewarding or punishing attendance has little or no effect on grades[2,3,5,12,13,18,19,20,22,29]. However, this was in agreement with some other studies that found that attendance policies do have an effect on grades [8,14,15,18]. These previous studies by others were not specific to engineering and engineering technology courses and the authors study was unique in this respect. In the last study the authors decided to look at additional factors such as first-generation students that did not have a family history of college attendance and whether that might have some impact on a student's attitude towards attendance. The authors also looked at a student's economic status and gender as well[25]. The results found showed that there continues to be a strong correlation between attendance and success but gender does not seem to make a huge difference (female students have a slightly higher attendance percentage but not significantly so) except for the middle range of attendance and performance. First-generation and economic statuses also did not have a high impact on attendance. In other words, students with the same attendance performed similarly regardless of these two categories.

The next step, addressed in this paper, was to investigate the effect of the course type. Since engineering and technology students seem to give priority to math intensive courses, the authors sought to investigate the problem by dividing the courses into math intensive and non-math intensive (NMI). The data is presented for the population as a whole as well as by academic level.

Project Design

This project involves tracking student attendance and student success. The definition of success as used in this study was the student's final grade in a course. All professors selected for the study had favorable formal student reviews before and during the study, which helped minimize the effect of professor popularity. Each professor tracked whether their students did or did not attend a class. Therefore, the attendance data was recorded as the percentage of days that a

student attended a given class. University privacy requirements did not allow us to ask students why they were absent or interview students with poor attendance as part of the process, which is why reasons for an absence were not recorded.

The data used in this paper was gathered from mainly two types of classes: math intensive and non-math intensive. In particular, the courses selected for the study came from the Mechanical Engineering, Mechanical Engineering Technology, Manufacturing Technology, Design Technology, and Construction Management Technology programs. Additionally, there was data available from a technology course, called "Technology in World Civilization," which satisfies a general education requirement at the university. So students enrolled in this course come from a broad range of majors across campus.

Data from the courses involved tracking each student with a unique student identification number. This number remained the same for each student across all of the courses. This meant that data was available for the class as a whole and on the individual level, so changes in a student's attendance pattern throughout their college experience can also be evaluated. The courses were selected to give a representation of courses with different modes of instruction and included lecture, lecture/lab, and lecture/demonstration. The project was also conducted using multiple instructors who agreed to participate in the project research. The use of more than a single instructor is an attempt to enable a more representative sample of the type of instruction that students experience during their academic career at the university. This use of multiple instructors also helped minimize the effect of a given instructor's influence on student success.

This paper did not examine the effects of differing attendance policies among the different instructors. However, it should be noted that there is not a single universal policy in use by the courses included in this study. The variation in policies include some form of academic punishment when students miss too many classes, academic rewards for students that maintain a minimum attendance percentage, and a policy of neither a punishment nor a reward for attendance. The effect of class policy has been examined by the author's previously[24]. Data was gathered starting with the January 2009 term and ended in the spring of 2014. At the end of each quarter, additional attendance and grade information was added to the growing database. As required by the university, the data was anonymized by assigning each student a code. Because the database is extensive and spans multiple courses taught by multiple instructors, the researchers have the ability to track an individual student from their first course as a freshman until that student graduates.

This paper is based on the data from 2,836 students, who were enrolled either in non-math or math intensive classes. The detailed demographics are summarized in Tables 1 to 3. The only students not included in the following data are those who dropped out of the courses and those who arranged to receive an incomplete. At the time of this paper, there was not enough data to report on the performance of students who received incompletes. It is important to note that no math intensive courses were considered that were of the freshman level.

Table 1: Number of Students Attending

Percentage attendance	0-9 %	10-19%	20-29%	30-39%	40-49%	50-59%	60-69%	70-79 %	80-89 %	90-99%	100%	Total
Non math Intensive	4	13	24	42	51	84	109	218	352	540	318	1755
Math intensive	4	0	3	2	8	18	36	87	180	425	318	1081

Table 2: Number of Students Attending in Non-math Intensive Classes

Percentage attendance	0-9 %	10-19%	20-29%	30-39%	40-49%	50-59%	60-69%	70-79 %	80-89 %	90-99%	100%	Total
Freshman	2	8	8	20	21	37	40	63	63	64	12	338
Sophomore	2	3	10	13	14	22	23	47	66	64	17	281
Junior	0	2	6	8	16	21	42	94	199	366	165	919
Senior	0	0	0	1	0	4	4	14	24	46	124	217

Table 3: Number of Students Attending in Math Intensive Classes

Percentage attendance	0-9 %	10-19%	20-29%	30-39%	40-49%	50-59%	60-69%	70-79 %	80-89 %	90-99%	100%	Total
Sophomore	1	0	1	1	2	7	5	29	53	78	29	206
Junior	3	0	2	1	5	10	27	43	89	268	183	631
Senior	0	0	0	0	1	1	4	14	38	80	105	243

Below is a description of each class and the mode and method of instruction.

TECH 208 (Survey of Electricity) is a traditional first lecture/lab course in electronics and electrical circuit analysis. The course has a two-hour weekly laboratory. Attendance was taken with a daily sign-in sheet.

TECH 393 (Technology in World Civilization) is a traditional lecture, non-mathematical course with four hours of lecture per week. Attendance was taken with a daily roll call. This was necessitated because the class is taught in one location and broadcast by simultaneous interactive television to three additional remote locations.

TECH 320 (Non-Metallics) is a lecture/laboratory mode of instruction. This class is structured as two hours of lecture and seven hours of lab per week. Attendance was taken with a daily sign-in sheet.

TECH 341 (Strength of Materials) is a lecture and mathematically intense course. Attendance was taken daily by distributing a roll to the students requiring their signature to be marked as present.

METC 102 (Introduction to Engineering Graphics) serves as a pre-college skills course for students that come to the department without any previous high school or employment experience in technical drawings. The class is a lecture format. This class is unique in the study in that the grading is Pass/Fail. Attendance was taken daily by distributing a roll to the students requiring their initials to be marked as present.

METC 110 (Engineering Graphics) consists of laboratory/demonstration periods interspersed with lecture periods. Attendance was taken daily by distributing a roll to the students requiring their initials to be marked as present.

MENG 217 (3-D Parametric Design) consists of laboratory/demonstration periods interspersed with lecture periods. Attendance was taken with a daily sign-in sheet.

METC 340 (Statics) uses a lecture mode of course instruction. Attendance was taken with a daily sign-in sheet.

MENG 382 (Fluid Mechanics) uses a lecture-laboratory mode of course instruction. Attendance was taken with a daily sign-in sheet.

MENG 385 (Robotics and Automated Systems) uses a lecture-laboratory mode of course instruction. Attendance was taken with a daily sign-in sheet.

MENG 405 (Machine Design) uses a lecture-mode of course instruction. Attendance was taken with a daily sign-in sheet.

MENG 407 (HVAC) uses a lecture-laboratory mode of course instruction. Attendance was taken with a daily sign-in sheet.

MENG 412 (Fundamentals of Engineering) uses a lecture mode of course instruction. Attendance was taken with a daily sign-in sheet.

MENG 452 (Engineering Economics) uses a lecture- mode of course instruction. Attendance was taken with a daily sign-in sheet.

The makeup of tracked courses ranges from freshman to senior level, as shown by the course numbers.

Project Outcomes

This paper follows up on initial studies of the data that found a correlation between student attendance and academic success[10]. This current analysis was conducted to see if there were any significant differences in student attendance based on whether the course is math or non-math intensive. The data was analyzed for the students' body as a whole as well as by student standing i.e. freshman, sophomore, junior and senior. The results are discussed below.

Figure 1 is a plot of student grade vs. attendance for math intensive and non-math intensive. The graph clearly shows that increased attendance results in increased success in the course for both math intensive and non-math intensive courses. The interesting result shown is that math intensive courses are more sensitive to attendance than non-math intensive courses overall. This difference is clearly shown soon as attendance decreases form 100% attendance.

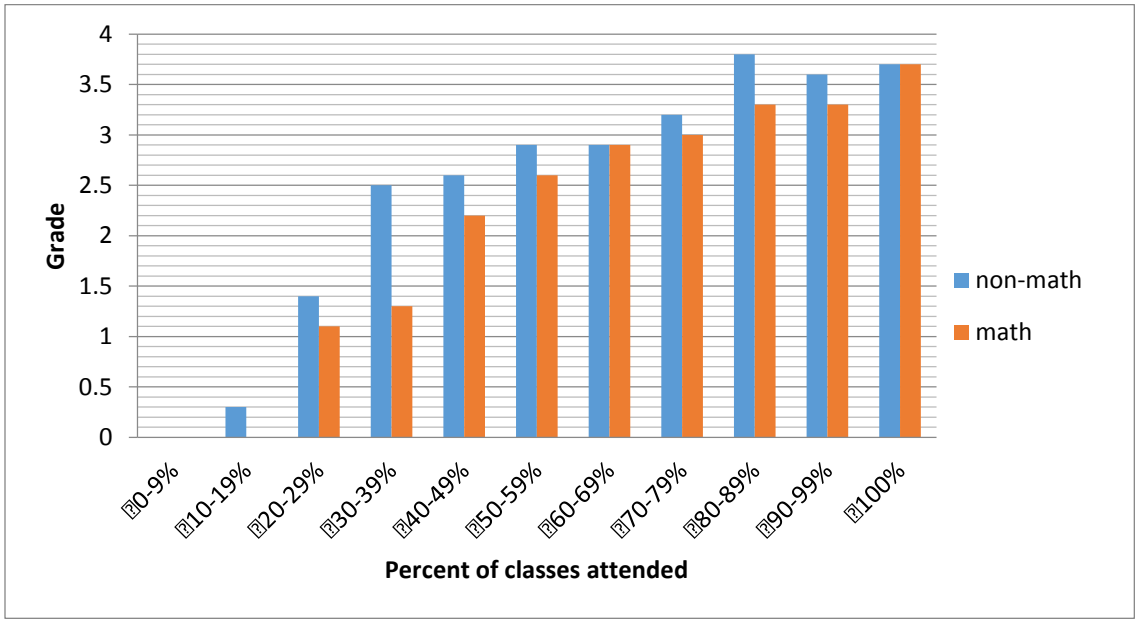

Figure 1. Plot of student grade versus attendance for math intensive and non-math intensive courses.

The graph appears to show that student performance in a non-math intense course is fairly stable until attendance level dips below the 80-89% level, while the math intensive courses show an immediate drop in performance as attendance decreases from 100%. The math intensive courses show a steeper rate of decline in grades after attendance decreases 60-69%. This major tipping point seems to be also happening in non-math intensive courses but is delayed until attendance falls to 30-39%. Both of these seem to indicate that there is a tipping point of non-attendance at which student learning falls off at a marked increased rate.

The overall conclusion can be made that for math intensive courses the success of a student is directly related to attendance and that as soon as attendance falls off the success of the student also decreases. There is a tipping point after which the likelihood of the student to be a success in the course is greatly in doubt.

The overall conclusion for non-math intensive courses is that a small amount of missed classes will not necessarily have a direct effect on the success of the student. However, there is also a tipping point for these courses after which the likelihood of the student to successfully pass the course is greatly in doubt.

Figure 2 is a plot of the student percentage versus class-attended percentage for math and non-math intensive courses. This figure shows that overall less than 30% of the students have a perfect attendance in the courses. However, there is a marked difference between math intensive and non-math intensive courses.

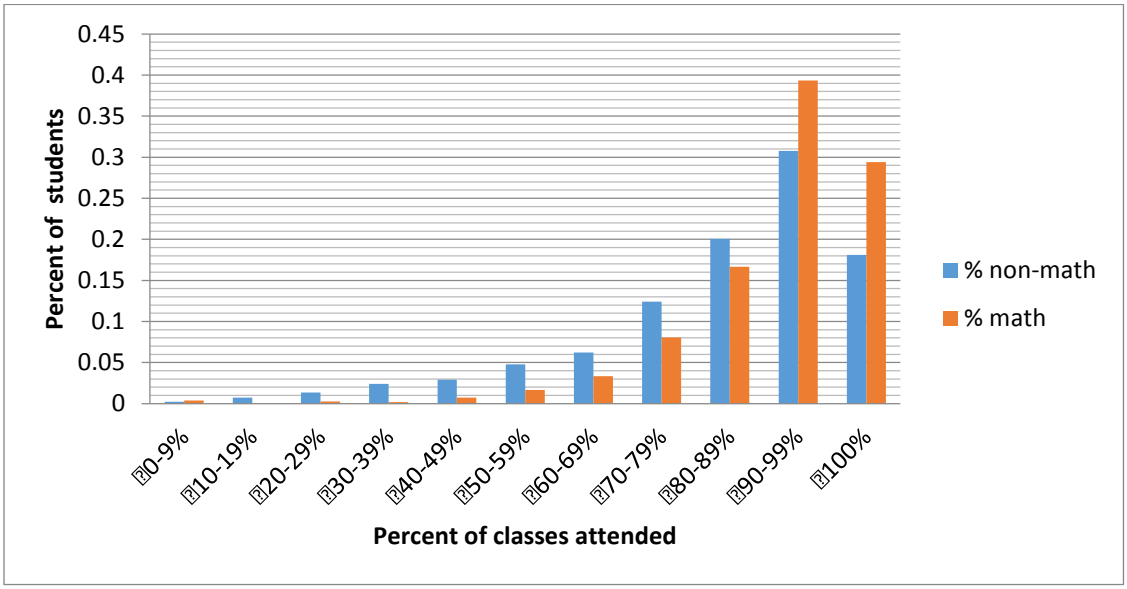

Figure 2. Plot of the student percentage versus class attended percentage for math and non-math intensive courses.

Math intensive courses exhibited a higher level of student attendance, with 68% of students attending 90% or more of their classes. This contrasted with the non-math intensive courses, with only 48% of students attending 90% or more classes.

The data seems to imply that the students in math intensive courses value and/or need the in-class time to master the course more than those in non-math intensive courses. This trend continues at the 80% attendance or more with values of 85% of the students in math intensive course attending 80% or more of classes contrasted with 69% of the students in non-math intensive courses.

Figure 3 shows the grade of students versus their attendance by student standing, that is freshman, sophomore, junior, and senior. This graph is interesting in that it indicates that seniors have a sharper and earlier tipping point at which a lower attendance starts to greatly affect the grade than any other rank. This might be because senior courses are more difficult or the subjects might not be as easily understood in the books used for the courses.

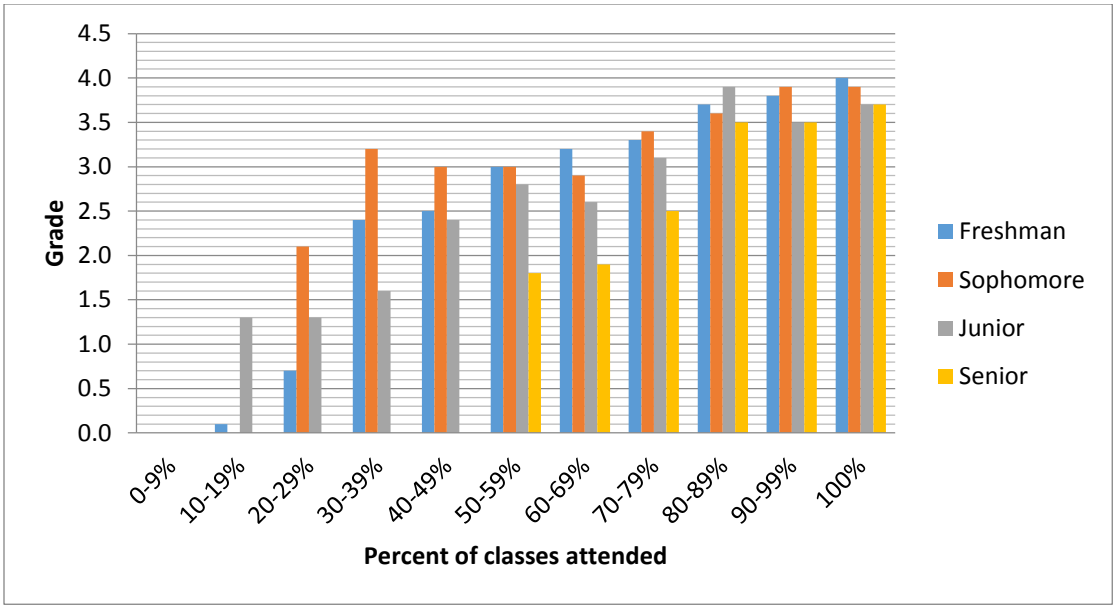

Figure 3. Plot of the grade of students versus their attendance by student standing.

The freshman, sophomore, and junior ranks are fairly grouped together until attendance falls below 40%. The flattest curve is for sophomore classes and might be due to the fact that the subject textbooks for sophomores are more standard and therefore further developed than the specialized senior courses. The other item of note is that the freshmen have the most linear relationship between grades and attendance.

Figure 4 is a plot of student grade vs. attendance for math intensive courses broken down by class standing. The graph clearly shows for sophomores and juniors that increased attendance results in increased success in the course. The sophomore and junior plots are almost identical which indicates that the rate of attendance corresponds with an equivalent level of success across these two groupings.

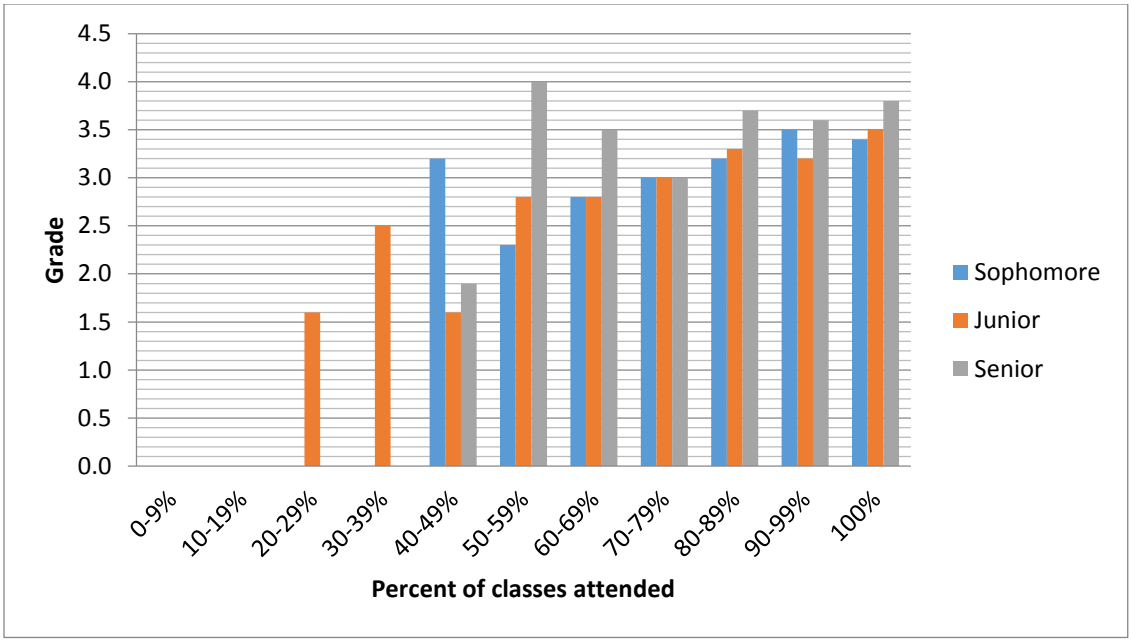

Figure 4. Plot of student grade vs. attendance for math intensive courses broken down by class standing.

The data for the seniors is somewhat different. Previous research that has been published in the area of attendance in college courses has indicated that there can be a lull in student attendance as they approach senior status. This has often been attributed to the idea that seniors are starting to burnout in their course work and that they are also looking ahead to post-school employment. Some seniors may already have a job lined-up for after graduation and so it is possible to assume that their attitude towards school has changed from something to excel at into something that must merely be endured until graduation. Data from our previous research did not find this disaffection among seniors in the engineering and technical courses that were covered in the study[29].

An interesting observation from Figure 4 is that it does show a significant percentage of seniors that have chosen to attend just over half of the scheduled classes but they are still getting good grades in the class. The details of this are not exactly known, however, anecdotally, faculty know of students that frequently miss class and rely upon a close friend in the class to help them stay up on the course material and due dates for assignments. It is also interesting to note that this peak in the senior line around the 50-59% attendance range does not occur in the previous graph for non-math intensive courses.

Figure 5 is a plot of student attendance percentage versus class standing for non-math intensive courses. It is interesting in that it indicates that seniors are more likely to strive towards 100% attendance than lower classmen. This also contradicts rumor about a lack of interest by senior students towards their courses as they are getting close to leaving school and entering the work force. The percentage of seniors that attended 100% of the time was just under 60.

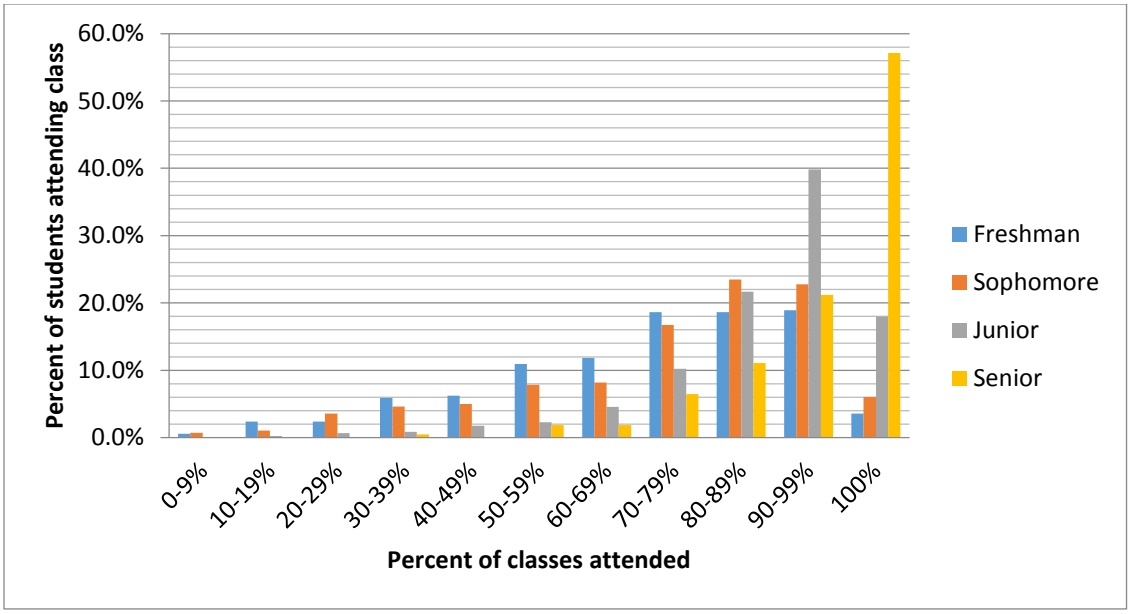

Figure 5. Plot of student attendance percentage versus class standing for non-math intensive courses.

The other three classes of students had a much lower number of students that attended all of their classes but they did exceed the seniors in the range of "near-perfect" attendance (80-99%). The number of students attaining perfect attendance increased with each increasing year in school. This would seem to indicate that seniors actually get more interested in their course work and place increased importance on attendance.

It may be tempting to think that since this data is for non-math intensive courses that perhaps more emphasis was placed on attendance since the course grade would more likely be based upon learning material presented in class versus learning how to work problems with equations as would be in math-intensive courses. This is not borne out when looking at the identical plot for the math intensive courses discussed next.

Figure 6 is identical to Figure 5 except it is for math intensive courses. Just like in the non-math intensive courses, in the math intensive courses seniors far exceeded their younger classmates in their level of perfect attendance. The number of seniors that attained perfect attendance for this plot was 43%.

Once again, the non-seniors had greater levels of attendance in the upper ranges of attendance percentages than the seniors. This was also the case for the non-math intensive courses shown earlier. In this case the sophomores and juniors exceeded the senior attendance almost all across the board except at the 100% level. The differences in attendance levels were not very large between the class standings but this graph would seem to lend a little weight to the idea that seniors start to lose interest in their courses as they look forward to graduation.

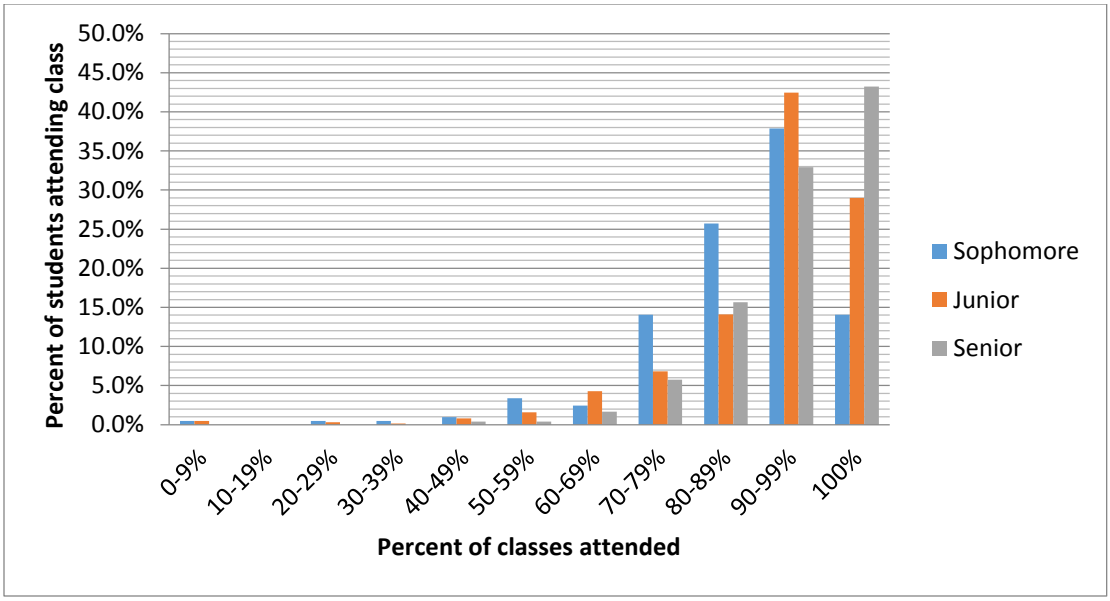

Figure 6. Plot of student attendance percentage versus class standing for math intensive courses.

It is important to note that this graph is for math intensive courses and perhaps more students feel that they can "find the correct equation in the book" and solve homework problems without feeling the necessity to attend class. It is also known that seniors in these classes often have developed close friendships with other students over the years, and they can rely upon these friends to supply them with material and assignments that were given in class on the days they were absent.

Figure 7 shows the sophomore attendance for math and non-math intensive courses. Overall, less than 15% of the students have a perfect attendance in the courses. However, there is a marked difference between math intensive and non-math intensive courses. Math intensive courses exhibited a higher level of students with 90% of attendance or greater representing 52% of the students. This contrasted with the non-math intensive courses with only 29% of students attending 90% or more classes.

The data seems to imply that even at the sophomore level, students in math intensive courses recognize the value and/or need the in-class time to master the course more than those in non-math intensive courses. This trend is also evident at the 80% or more attendance level showing that 78% of the students in math intensive course are attending, while only 52% of the students in non-math intensive courses are attending at the 80% level.

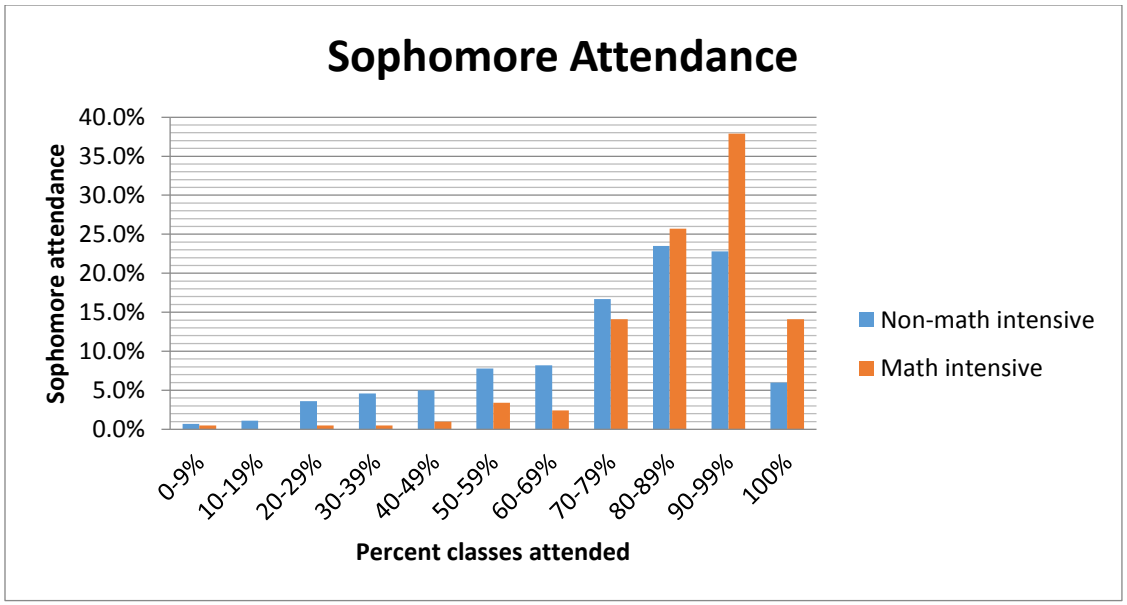

Figure 7. Plot of the sophomore attendance for math and non-math intensive courses.

In contrast to Figure 7, showing the students at the sophomore level, Figure 8, showing students at the junior level, has noticeable changes in attendance in relation to both the math intensive and non-math intensive classes. The graph shows that overall less than 30% of the students have a perfect attendance in the courses.

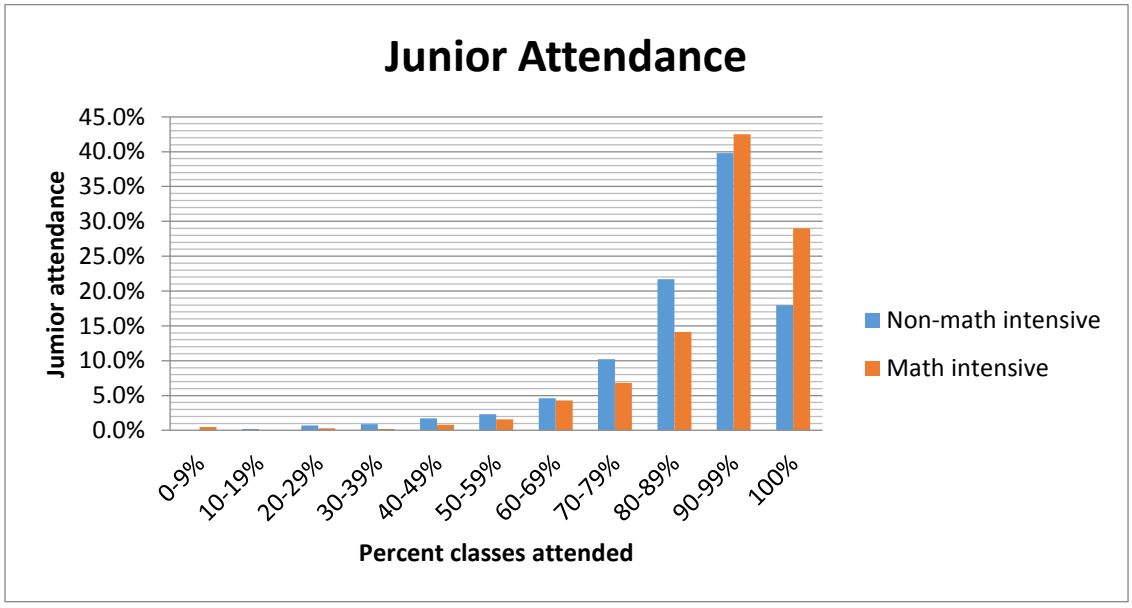

Figure 8. Plot of the junior attendance for math and non-math intensive courses.

Math intensive courses exhibited a higher level of juniors with 90% of attendance or greater representing 72% of the students. This contrasted with the non-math intensive courses with only 58% of students attending 90% or more classes. For the math intensive course attendance level, this is a 20% increase from the sophomore level, while for the non-math intensive course

attendance, this is a 29% increase from the sophomore level. This trend is also evident at the 80% or more attendance level showing that 86% of the students in math intensive course are attending, while only 80% of the students in non-math intensive courses are attending at the 80% level.

Contrasting from the sophomore level, there is an increase of 8% at the junior level for the math intensive course attendance level, while for the non-math intensive course attendance, there is a 28% increase at the junior level. The data seems to imply at both the 90% level and the 80% level, the junior level students in non-math intensive courses are changing their view of the value and/or need of the in-class time and are making a greater effort to improve their class attendance.

Figure 9 is again similar to Figures 7 and 8 except that it represents data for the senior level. In this case there appears to be even more noticeable changes in attendance in relation to both the math intensive and non-math intensive classes when compared to the sophomore and junior levels.

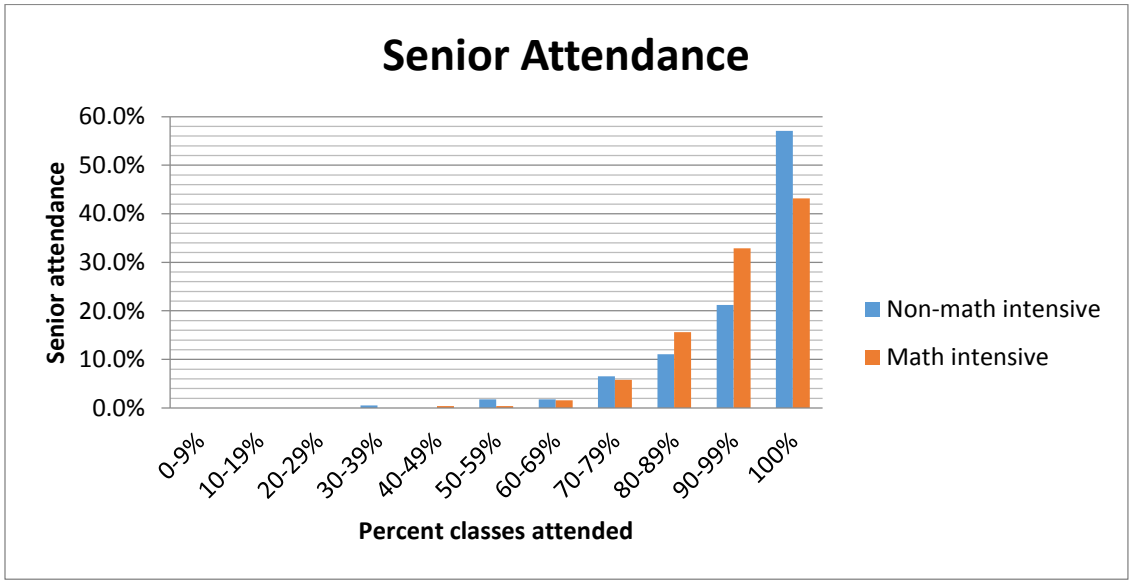

Figure 9. Plot of the senior attendance for math and non-math intensive courses.

The graph shows that overall less than 60% of seniors have a perfect attendance in the courses. Math intensive courses exhibited a lower level of students with 90% of attendance or greater representing 76% of the students, when compared with the non-math intensive courses having 78% of students attending 90% or more classes. For the math intensive course attendance level, this is a 4% increase from junior level, while this is a 20% increase from junior level for the non-math intensive course attendance.

This trend is reversed at the 80% or more attendance level showing that 92% of seniors in math intensive course are attending, while 89% of the students in non-math intensive courses are attending at the 80% or more level. Contrasting from the junior level, this is an increase of 6%

for the math intensive course attendance level, while for the non-math intensive course attendance, this is a 9% increase at the senior level.

The data seems to imply at both the 90% level and the 80% level, the senior level students in non-math intensive courses are continuing to change their view of the value and/or need of the in-class time and are continuing to make a greater effort to improve their class attendance.

Conclusions, Reflections, and the Future

The results from this study clearly indicate that increased student attendance was directly related to student success in both math intensive and non-math intensive courses. The overall success of students in math intensive courses was found to positively correlate with their attendance. The study indicated that students in math intensive courses need and value the in-class time to master the material more than those in non-math intensive courses. Seniors had a sharper and earlier tipping point than any other classification of students when lower attendance began to negatively impact their grade. Perhaps many of these students were looking forward to graduation more than they were concerned with completing their last courses with high grades.

Reflecting back to 2009 when the study was first initiated[23] to determine the effects of attendance on student success, the researchers were not sure what they would discover. Now after six academic years of data collection, information for almost 3,000 students has been gathered. The first paper[10] in 2012 showed a strong correlation between attendance and success across freshman, sophomore, and junior levels. A significant relationship between student success and different faculty approaches to attendance including incentives for attendance, penalties for lack of attendance, or no attendance requirement was reported[24] in 2013. A follow-up paper[25] in 2014 discussed the significant relationship between student attendance and the following three factors: status as a first-generation college attendee, gender, and economic status. Combining the results described in these papers along with this current paper, a clearer insight into the importance of attendance on student success has been gained.

The research project is far from completion. The opportunity to examine the impacts of attendance on individual students as they progress through their academic years toward graduation can be examined. There is still much to investigate leading to new discoveries and findings uncovering facts that can be utilized to guide and advise students on ways to be successful during their college experience. Exactly where the new direction of the study will go is unknown. One future area of research could be to focus on specific reasons for poor attendance that correlate with a drop off in grades.

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