2026 ASEE ANNUAL CONFERENCE June 21–24, 2026 | Charlotte Convention Center, NC
Host Sponsor UNC Charlotte
Paper ID #50955

Accelerated Education: An Assessment of Students' Performance in Fast-Paced Engineering Courses

Dr. Felix Ewere, North Carolina State University at Raleigh

Dr. Felix Ewere is the director of Aerospace Engineering capstone design at North Carolina State University. He has mentored several successful aerospace vehicle design projects, and his student teams have consistently been in the top teams in national competitions. Outside senior design, he has taught several aerospace engineering courses including engineering mechanics (statics and dynamics), numerical methods and aerodynamics. His research involves analytical modeling, numerical analysis, simulation and experimental approaches. He has expertise in goal-oriented design, prototype development and research to re-invent. Educational research interests include engineering design education, developing better-equipped graduates for the workforce, bridging the core competencies gap, improving diversity and collaboration within disciplines. Felix is an Associate Teaching Professor in the department of Mechanical and Aerospace Engineering.

Dr. Joel J. Ducoste, North Carolina State University at Raleigh

Accelerated Education: An Assessment of Students' Performance in Fast-Paced Engineering Courses

Abstract:

At regional land grant university, courses are offered in fifteen-week traditional semesters and summer courses are offered in shorter five-week semesters. Using a database of over 21,000 observations over a 15-year period, we investigate the link between students' performance in post-requisite courses after taking the prerequisite course in a traditional semester versus a shorter summer semester. Students' final grades in the mechanics course sequence of a mechanical engineering curriculum in the department of mechanical and aerospace engineering are adopted in this study. Three different analyses that relate the final student grades to the semesters the courses were attempted were conducted. The findings show that a greater percentage of students that take the prerequisite course in traditional semesters have a higher pass rate in the post-requisite courses than students who take the prerequisite course in the fast-paced semester. We also noticed that the student performance in summer or traditional length semesters courses is similar despite the difference in pace of the course.

Keywords: Accelerated Education, Fast Paced, Mechanical Engineering, Engineering Mechanics, Dynamics of Machines, Engineering Statics, Engineering Dynamics

Introduction:

Accelerated education refers to any attempt to speed up or compress the educational process beyond the traditional semester or quarter systems that are used in most colleges and universities. Sometimes this means simply shortening the duration of the course (e.g., from 15 weeks to 5 weeks) without changing the number of contact hours in the classroom (e.g., 38 hours) [1]. Typically, most studies addressing the effect of the course pace on students' performance have been a quasi-experimental design with multiple study groups of student participants taking the same course in different semesters [2], [3]. Subsequently, the student group's performance is analyzed and a conclusion is derived. Studies to extend this analysis to investigate students' performance in the post-requisite courses have been limited. At the department of Mechanical and Aerospace Engineering (MAE) in a regional land grant university, several courses are offered in traditional 15-week fall and spring semester and fast-paced 5-week summer semester. These fast-paced summer courses provide students with the opportunity to get back on track after skipping a semester due to co-op or a bad performance in a prerequisite course. Like most mechanical and aerospace engineering curriculums, the engineering dynamics and controls path is regimented. For the introductory engineering mechanics course, engineering statics is a pre-requisite to engineering dynamics and engineering dynamics is a prerequisite to dynamics of machines. At regional land grant university, these courses are also offered in both fall/spring 15-week semesters and 5-week summer semesters. Therefore, a pertinent question is, *do students who take these fast-paced courses perform as well as students in a traditional semester course when it comes to the application, or evaluation of what they have learned?* In this paper, an assessment and comparison of the performance of engineering students in these courses over a 15-year period (2009 – 2024) is explored. Students' final course grades are tracked from Engineering Statics (ES206) to Engineering Dynamics (ED208) to Dynamics of Machines (DM315) to decipher the trends of the student's performance. Typically, these courses are taken in the sophomore first semester (ES206), sophomore second semester (ED208), and first semester junior year (DM315). DM315 is also a prerequisite to principles of automatic controls course which is not part of this study. The sequence is not arbitrary; each course builds upon conceptual frameworks, mathematical tools, and physical intuition developed previously. Mechanical engineering is fundamentally concerned with the analysis, design, and control of systems involving motion and force. To support this objective, undergraduate curricula are structured as a hierarchical progression of mechanics courses, beginning with Engineering Statics, advancing to Engineering Dynamics, and culminating within the core mechanical curriculum in Dynamics of Machines (also offered as Engineering Vibrations or Theory of Machines at several institutions). Therefore, students' performance in these courses represents a reasonable approach for assessing their performances in the post-requisite courses for the different course length semesters. Due to the length of time, the authors recognize that there would be sources of variance like differences in instructors, course structure, grading rubric, pedagogical approach, and course repeats that affect students' performance in this study. Furthermore, the effects on students' performance during the recent pandemic are examined. This study will contribute to the broader discourse on engineering education reform by offering actionable insights for curriculum designers, faculty, and administrators. The goal is to recommend a data-informed approach to course pacing and optimize student performance without compromising the rigor that defines elite engineering education.

Background and Methodology

Fast-Paced Courses in Engineering Education

Literature that exists to answer the question of whether engineering students learn better in shortened or traditional semester length courses is limited [2], [3], [4] . Yet a significant portion of engineering colleges use this for strategic planning and, for example, offer courses in five weeks summer courses and traditional sixteen-week semester courses. Most literature that exists [2], [3], [4] has been from other disciplines and the results of these studies preclude generalization beyond the courses involved in the study due to uncontrolled variances and nonrandom sampling. These studies on accelerated education have been of different types from a variety of institutions and disciplines with no conclusive demonstration of the effectiveness of one over the other [1]. The pattern of most studies has found little or no difference between the accelerated versus traditional semester courses. In fact, when there's a difference between them it has tilted towards accelerated semester courses. However, these studies have been for disciplines outside of engineering and at this point none for mechanical or aerospace engineering courses. Typically, the studies have been quasi-experimental design with multiple study groups of student participants taking the same course in the different semesters [2], [3]. Subsequently, the student group's performance are analyzed and a conclusion is derived.

An explanation that often arises for equivalent student grades in accelerated and regular semester courses is that instructors may ease academic rigor due to the compressed summer course schedule [5]. Another could be that students are focused on a smaller number of courses at the same time. Miller, et. al. reported that instructors often altered their teaching methods during fast-paced courses (i.e., less likely to lecture, assign a term paper, cover as much material, etc.), a change that makes comparisons between regular semester and abbreviated courses difficult [4]. Thus, instructors teaching summer courses may lower or change standards, resulting in little change or even an increase in student academic performance. In addition to equivalent academic performance, Scott demonstrated that students may prefer fast-paced courses. Specifically, students reported that summer courses encouraged more focused learning, created a more collegial atmosphere, and fostered more classroom interactions and in-depth discussions than regular semester courses [6].

The pertinent question now is: *if we assume that students' performance is similar in both fast-paced and traditional semesters, how does the content learned in these semesters affect their performance in future courses? Do they achieve better learning outcomes?*

<u>Prerequisite Content from ES206 Applied in ED 208 and from ED 208 Applied in DM 315</u>

Most Engineering curricula are intentionally sequenced to ensure conceptual continuity and cognitive scaffolding across foundational and advanced courses. In mechanical engineering, a critical sequence is the progression from Engineering Statics to Engineering Dynamics, and subsequently to Dynamics of Machines (Engineering Vibrations). Statics establishes equilibrium-based reasoning and vector mechanics; dynamics introduces motion and time-dependent behavior; dynamics of machines apply these principles to interconnected mechanical systems operating under realistic constraints. Although Engineering Statics deals exclusively with systems in equilibrium, its role in preparing students for Engineering Dynamics is foundational. Dynamics can be viewed as an extension of statics into time-dependent behavior, where equilibrium no longer holds but force analysis remains central. Four critical prerequisites from Statics to dynamics include: (1) Force Systems and Free-Body Diagrams, (2) Vector Mechanics and Coordinate Systems (3) Equilibrium and Constraint Understanding and (4) Friction and Contact Forces. Engineering Dynamics expands the statics framework by incorporating kinematics and kinetics, providing the essential bridge to machine dynamics. The course equips students with the analytical tools required to analyze motion, forces, and energy in systems where movement is prescribed or results from applied forces. Four critical prerequisites from Engineering Dynamics to Dynamics of Machines include: (1) Kinematics of Particles and Rigid Bodies (2) Newton–Euler Equations of Motion (3) Work–Energy and Impulse–Momentum Methods and (4) Relative Motion and Reference Frames. Dynamics of Machines represents the application and synthesis of prior mechanics knowledge to real mechanical systems. Unlike introductory dynamics, which often focuses on idealized problems, machine dynamics emphasizes interconnected components, design constraints, and performance metrics.

Course Sequence and Data Description

The analysis considers three mechanics-based courses in the controls path of the mechanical engineering curriculum in the department of mechanical and aerospace engineering as follows:

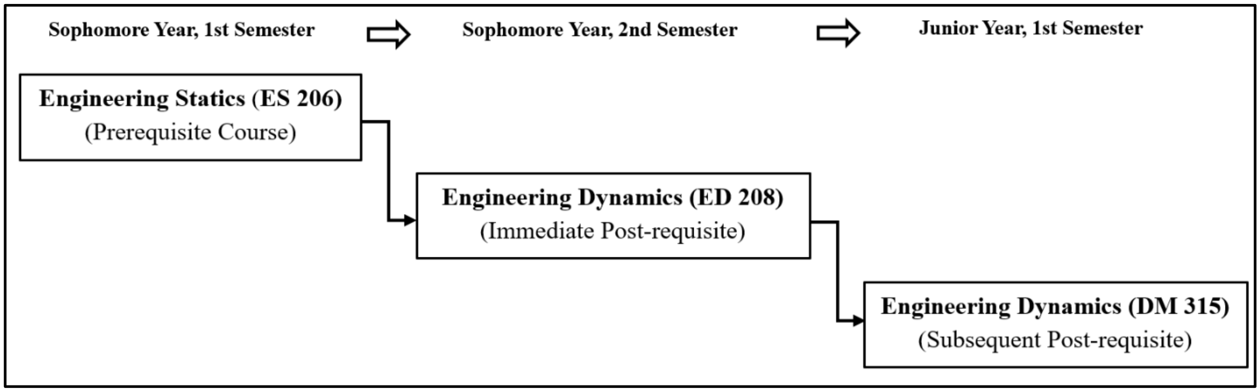

Figure 1: Mechanics-based course sequence analyzed

All observations are for full-time students that took these courses for a grade in the MAE department. They were graded on a standard 4.0 GPA scale, and the courses have a "C-" as passing grade. Not passing included the grades D, W, F, AU, S, U, and NR. Final passing course grades were converted to numerical GPA equivalents as follows: (A+ = 4.333, A = 4.0, A- = 3.667, B+ = 3.333, B = 3.0, B- = 2.667, C+ = 2.333, C = 2.0, C- = 1.667). The total number of contact hours for both 15-week and 5-week semesters is 37.5, i.e. 1.25 hours twice a week for 15 weeks or 1.5 hours, five days a week for 5 weeks. Majors are the student majors at the time they took the course.

Table 1: Students in this study

Course	ES206	ED208	DM315
# of observations	8245	8482	4508
MAE (%)	57.83	63.74	97.78
Non-MAE (%)	42.17	36.26	2.22
Transitions			
Courses	ES206 → ED208	ED208 → DM315	ES206 →ED208 → DM315
# of observations	6290	3972	3463
MAE (%)	66.34	94.96	97.54
Non-MAE (%)	33.66	5.14	2.46

Table 1 shows the number of observations for this study. Transitions show the number of students who took prerequisite and post-requisite courses. The MAE department offers these courses to non-MAE students that require them in their curriculum. Therefore, some of these non-MAE students are not required to take the post-requisite courses. Some students transferred the prerequisite courses, but sources of variance due to transferred courses are not within the scope of this study. As expected, from sophomore to junior courses, the number of students taking the post-requisite courses reduces and the ratio of the MAE students taking the post-requisite courses increases.

Table 2: Final Grades for all semesters

Course	ES 206		ED 208		DM 315	
Major	MAE	Non-MAE	MAE	Non-MAE	MAE	Non-MAE
Pass Rate (%)	84.18	75.27	77.56	70.19	68.48	61.00
Mean	2.59	2.26	2.81	2.54	2.38	2.23
Median	B	C+	B	B	B-	C
Std. Dev	1.19	1.29	1.13	1.20	1.26	1.43

Table 2 shows student final grades in these courses for MAE and non-MAE students. The MAE students performed better than the non-MAE students over the period of this study. The pass rate is higher for MAE students in all three courses.

Table 3: Final Grades, All Summer and Traditional semesters

Course	ES 206		ED 208		DM 315	
Semester	15-Week	5-Week	15-Week	5-Week	15-Week	5-Week
Pass Rate (%)	80.07	85.11	74.71	76.55	68.27	68.69
Mean	2.43	2.72	2.71	2.75	2.38	2.41
Median	B-	B	B	B	B-	B-
Std. Dev	1.25	1.19	1.17	1.13	1.27	1.21

Table 4: Student Average Term GPA

Course	ES 206				ED 208				DM 315			
Semester	15-Week		5-Week		15-Week		5-Week		15-Week		5-Week	
Year	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
09/10	3.16	0.64	3.19	0.94	2.91	0.81	3.00	0.99	2.84	0.72	2.31	0.98
10/11	3.12	0.64	2.91	1.18	3.06	0.74	2.85	1.00	2.98	0.70	2.72	0.85
11/12	3.12	0.65	3.17	0.70	2.96	0.83	3.22	0.75	2.90	0.86	3.19	0.70
12/13	3.21	0.68	3.09	0.96	3.02	0.81	3.02	0.95	3.01	0.73	3.07	0.74
13/14	3.20	0.59	3.11	0.92	3.09	0.73	3.00	0.91	3.22	0.68	3.04	0.91
14/15	3.16	0.67	3.17	0.74	3.09	0.73	2.92	0.97	3.07	0.63	2.79	1.10
15/16	3.17	0.67	2.84	1.03	3.12	0.72	3.07	1.18	2.95	0.70	2.50	1.13
16/17	3.17	0.62	3.07	0.86	3.16	0.69	3.02	0.90	3.07	0.69	2.99	0.55
17/18	3.22	0.62	2.99	1.00	3.17	0.70	3.38	0.94	3.14	0.82	2.48	1.22
18/19	3.13	0.75	3.26	0.87	3.20	0.81	2.98	0.90	3.14	0.70	2.73	1.13
19/20	3.20	0.73	2.31	1.58	3.35	0.80	2.48	1.45	3.23	0.83	3.50	0.66
20/21	3.43	0.80	2.59	1.24	3.30	0.95	2.67	1.18	3.46	0.85	2.41	1.08
21/22	3.13	0.71	3.22	0.67	3.17	0.78	2.72	0.74	3.10	0.77	2.51	1.37
22/23	3.09	0.73	2.86	0.64	3.06	0.81	2.71	0.93	3.10	0.77	3.12	0.79
23/24	3.24	0.64	3.36	0.65	3.13	0.79	2.42	1.03	3.10	0.81	2.62	1.09

Table 3 shows student grades in the fast-paced and traditional semesters over the course of 2009 – 2024. The pass rate for the 5-week courses is slightly higher than the traditional semesters. The median grade is a "B" or "B-" for all the courses showing that most student performed well in all the courses and semesters with the period of study. Table 4 shows the average term GPA for all students in the semesters, which was calculated as control for the semesters. This compares the students' overall performance in the semesters being compared, which could be a source of variance. If there's a grade difference in the average term GPA is outside one standard deviation, then that could be a source of variation for that semester. Notice that the only terms with GPA's less than B range were during the summer semester during the pandemic (2020 and 2021).

Results and Discussion:

Students' final semester grades were analyzed by comparing consecutive semesters. For example, fall 2010 is the consecutive semester spring 2010 and summer 2010. Consecutive semesters when analyzing students grades in prerequisite and post-requisite courses offer some advantages. It enhances cohort comparability, reduces issues due to retention, and provides clearer insights into the relationship between prerequisite preparation and subsequent academic performance.

Sources of Variation: <u>The effect of sources of variation is beyond the scope of this paper</u>. There are noticeable spikes in some years versus dips in others which then begs the research question of instructor(s) or other effect. One major factor is cohort variation: different groups of students bring different levels of preparation, motivation, and prior knowledge, which shifts averages and distributions. Instructional differences also matter. Changes in teaching style, pacing, or instructor experience can influence how well students grasp material, even when the syllabus remains similar. Assessment design is another key source of variation. Exams and assignments may differ in difficulty, format, or grading criteria across semesters, making direct comparisons challenging. External factors such as changes in academic policies, access to resources, or disruptions like illness or broader societal events like the COVID pandemic can also affect performance trends.

Analysis 1: <u>Different Prerequisite, Same Post-requisite Semester</u>: First, we investigate how students who took the same course in two different semesters perform in the post-requisite course in the same semester (Figure 2). For example, the pass rate of students in the post-requisite course (Engineering Dynamics) in Fall 2010 that took the prerequisite course Engineering Statics in the Spring 2010 and Summer 2010 semesters of the same year are compared. The fall semester is assumed to be the next consecutive semester to spring/summer since most students take courses in the next traditional length semester. The results show that for 11 of the 15 semesters (73.33%) analyzed students who took Engineering Statics in the traditional spring semester had a higher pass rate than students who took Engineering Statics in the summer semester. Also, notice the dip in pass rate for fall semester 2020 during the pandemic. Figure 3 shows the results for Engineering Dynamics and Dynamics of Machines. The results show that 12 of the 15 semesters (80%) considered, students who took Engineering Dynamics in the traditional spring semester had a higher pass rate than students who took Engineering Dynamics in the summer semester.

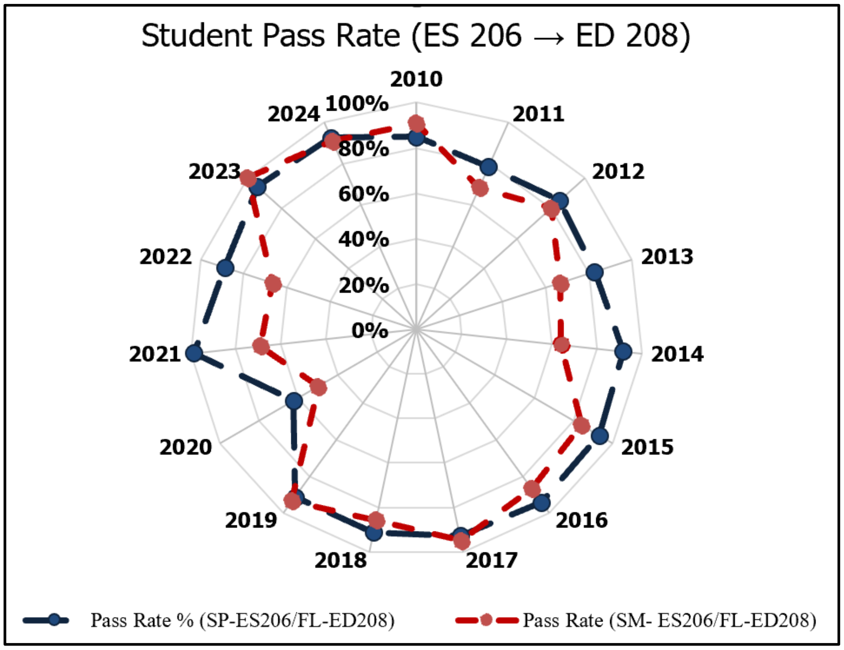

Figure 2: Student Pass Rate in the same fall (FL) semester for the post requisite course (ED 208) for students who took the prerequisite course (ES 206) in spring (SP) and summer (SM)

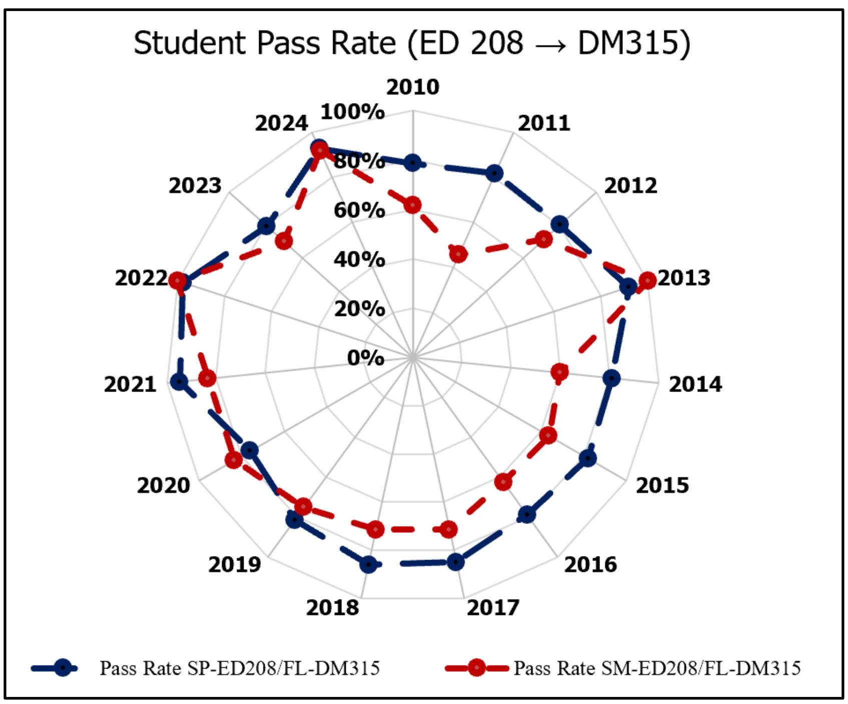

Figure 3: Student Pass Rate in the same fall (FL) semester for the post requisite course (DM 315) for students who took the prerequisite course (ED 208) in spring (SP) and summer (SM)

Analysis 2: Same Prerequisite and Post-requisite fast-paced Semester: Next, we investigate students' performance in the same post-requisite and prerequisite semesters, e.g. students who took Engineering Statics or Engineering Dynamics in summer 2010 (Figure 4). Students' pass rate in Engineering Dynamics in summer 2010 who took Statics in the previous Fall 2009/Spring 2010 was compared to student performance in Engineering Dynamics in Fall 2010 who took Statics in summer 2010. This will compare the effects on students' performance of either pre- or post-requisite courses in the same fast-paced semester.

In Figure 4, the results show that for 10 of the 15 semesters (63.33%), students who took the prerequisite course in a traditional semester and the post-requisite course in a summer semester performed better than students that took the prerequisite course in a summer semester and the post-requisite course in the traditional semester. Similarly, there's a dip in pass rate during the pandemic year 2020.

Figure 5 shows the results for ED 208 and DM 315. 8 of the 15 semesters (53.33%), students who took the prerequisite course (ED 208) in a traditional semester and the post-requisite course (DM 315) in a summer semester performed better than students that took the prerequisite course in a summer semester and the post-requisite course in the traditional semester.

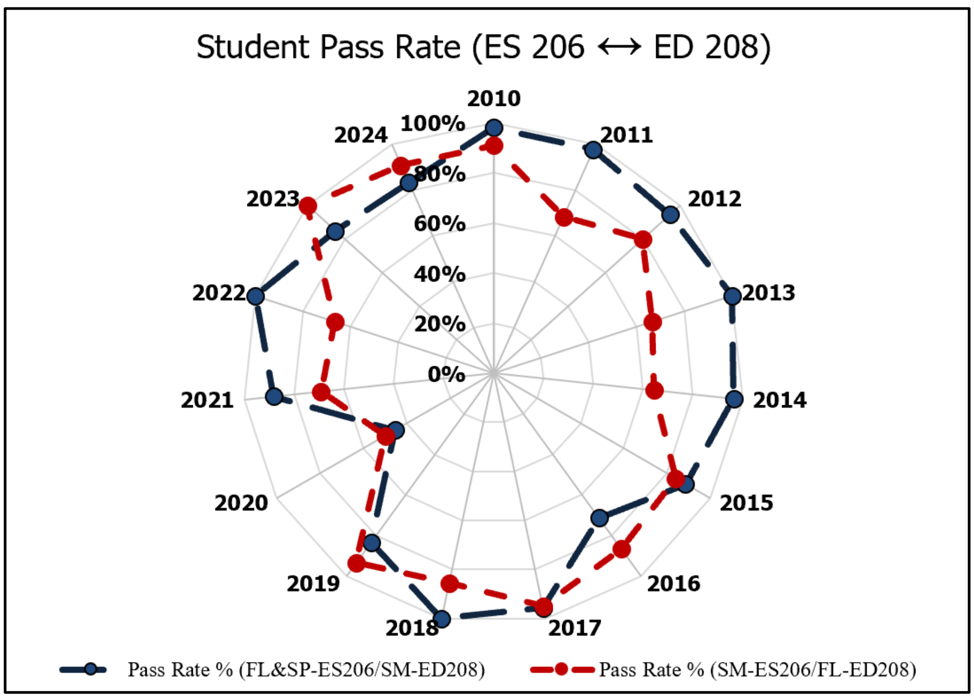

Figure 4: Student Pass Rate in the same prerequisite and post requisite fast-paced semester for the prerequisite course (ES 206) the post requisite course (ED 208) (Summer-SM, Spring-SP, Fall-FL)

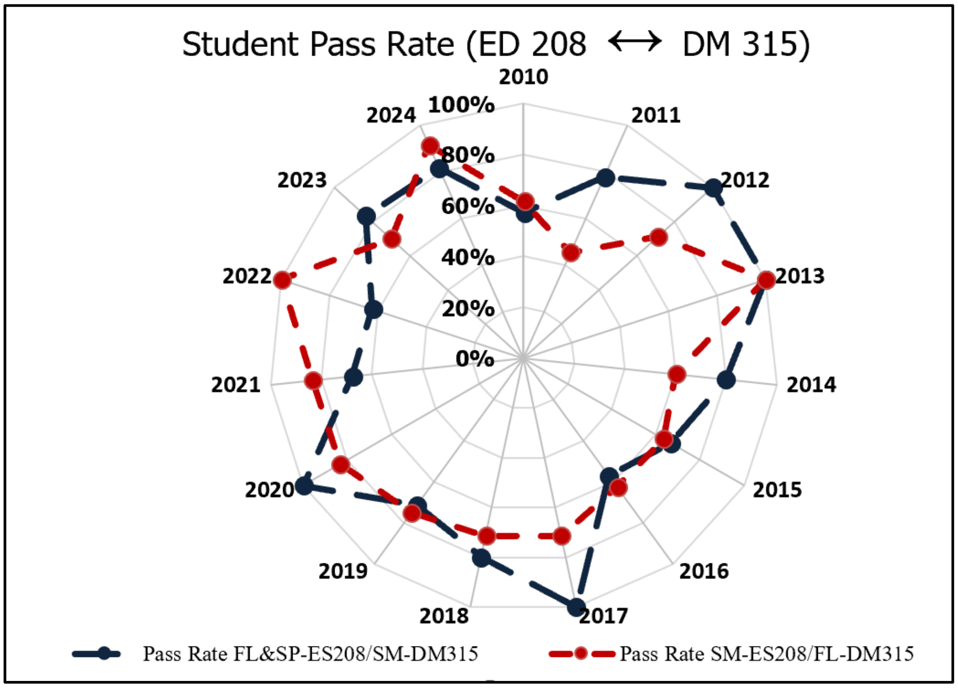

Figure 5: Student Pass Rate in the same prerequisite and post requisite fast-paced semester for the prerequisite course (ED 208) the post requisite course (DM 315). (Summer-SM, Spring-SP, Fall-FL)

Analysis 3: Student Performance in All Three Courses: Next, we investigate the performance of students that took all three courses in the MAE department over the study period (n = 3463). This group of students are mainly MAE majors since they are required to take all three courses. The results in Table 5 show a higher pass rate for students who took their prerequisites (ES 206 or ED 208) in traditional length semesters. The lowest pass rate (64.32%) was for DM 315 students that took the prerequisite ES 206 in the summer even though the highest pass rate (94.59%) was for these students in the prerequisite ES 206 course. Although, slightly lower, these students also had the lowest pass rate in the intermediate prerequisite course (ED 208). This could be because the prerequisite content needed to perform better in the post-requisite courses were not passed on well.

Table 5: Students Pass Rate (attempted all three courses in MAE department)

Course Transition	ES 206 → ED 208 → DM 315					
Semester Attempted ES 206	15-Week			5-Week		
Course	ES 206	ED 208	DM 315	ES 206	ED 208	DM 315
Pass Rate (%)	89.87	91.73	79.16	94.59	89.73	64.32
Semester Attempted ED 208	15-Week			5-Week		
Course	ES 206	ED 208	DM 315	ES 206	ED 208	DM 315
Pass Rate (%)	90.78	91.56	78.88	82.13	92.40	72.24

Conclusion:

Student final semester grades in three mechanics-based courses in the mechanical engineering curriculum were analyzed. The student's pass rate in post requisite courses was tracked and compared to their performance in the prerequisite courses. The grades were separated to compare performance between a fast-paced summer semester and a traditional fall/spring semester. Three different analyses were conducted to investigate students' performance over the study period. In all three analyses, the results show students perform better in a post-requisite course if they take the prerequisite course in a traditional semester. The pass rate is higher in more semesters for post-requisite courses if students take the prerequisite course in a traditional semester. However, students' performance in the prerequisites or post-requisite courses is similar in both the 5-week or 15-week semesters. This could mean that there's a discrepancy in final grades pass rate and imbibing the requisite content required to perform well in the post-requisite course. This is not a generalization. More analysis will have to be done to show claims of statistical significance and sources of variation which will be analyzed in future publications. The authors also plan to design an experiment including survey of students to continue this research. Data from other institutions and departments will also be collected and analyzed to decipher trends of student's performance and patterns of variation.

References:

[1] C. B. Tatum, "Accelerated Education: Learning on the Fast Track," *J. Res. Innov. Teach.*, vol. 3, no. 1, Mar. 2010, [Online]. Available: https://www.nu.edu/wp-content/uploads/2018/11/journal-of-research-in-innovative-teaching-volume-3.pdf

[2] G. W. Boddy, "Regular Vs. Compressed Semester: A Comparison Of Effectiveness For Teaching In Higher Education (Summer Session, Achievement)," Dissertation, The University of Nebraska, Lincoln, United States -- Nebraska, 1985.

[3] J. S. Anastasi, "Methods And Techniques: Full-Semester and Abbreviated Summer Courses: An Evaluation of Student Performance," *Teach. Psychol.*, vol. 34, no. 1, pp. 19–22, Jan. 2007, doi: 10.1207/s15328023top3401_4.

[4] M. A. Kretovics, A. R. Crowe, and E. Hyun, "A Study of Faculty Perceptions of Summer Compressed Course Teaching," *Innov. High. Educ.*, vol. 30, no. 1, pp. 37–51, Jan. 2005, doi: 10.1007/s10755-005-3295-1.

[5] E. Marquez and S. Garcia, "Innovations In Engineering Education For Fast-Paced Virtual Summer Courses," in *2022 ASEE Gulf Southwest Annual Conference Proceedings*, Prairie View, Texas: ASEE Conferences, Mar. 2022, p. 39187. doi: 10.18260/1-2--39187.

[6] P. A. Scott, "Attributes of high-quality intensive courses," *New Dir. Adult Contin. Educ.*, vol. 2003, no. 97, pp. 29–38, Mar. 2003, doi: 10.1002/ace.86.