TO PRE-REQ OR CO-REQ: AN ASSESSMENT OF WHY CHEMICAL ENGINEERING STUDENTS ELECT TO TAKE A COURSE AS A PREREQUISITE OR AS A COREQUISITE

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INTRODUCTION

Prerequisite courses are often used in chemical engineering curricula to help students move through a guided path in the major. For example, material and energy balances (MEB) is usually one of the first courses a chemical engineering student takes and thus serves as a prerequisite for future courses in the major. Additionally, a thermodynamics lecture course may serve as a prerequisite to a thermodynamics laboratory course. The historical reasons for establishing prerequisite courses may vary but likely build on constructivist theory, thereby providing an opportunity for students to build a base of knowledge so that they can successfully navigate and learn more advanced concepts in the future.[1] However, other reasons may also exist for having prerequisite courses, such as ensuring that instructors know what knowledge students should have prior to enrolling in a subsequent course, controlling class sizes, and helping to manage how many sections of a course need to be offered in the future. In addition to offering courses as prerequisites, some degree programs may allow students to enroll in a course as either a prerequisite or a corequisite; there may not be a clear justification for one option or the other, thus leaving students unsure of which path to pursue.

Since prerequisites are ubiquitous, research has explored the impact of prerequisites on student learning and performance in future courses. In a longitudinal study in chemical engineering, Felder et al.[2] found that student performance in future courses (computational methods, fluid dynamics, mass transfer, etc.) depended on their performance in a MEB prerequisite course. Students felt that the MEB prerequisite prepared them for future courses to varying degrees based on how the MEB prerequisite was taught (lecture-based versus active learning-based). In other science fields there has been some evidence for the value of prerequisite courses. The incorporation of a mathematics prerequisite prior to enrolling in a general chemistry course improved student performance in the chemistry course.[3] Similar results were also found with organic chemistry preceding a biochemistry course[4] and for an undergraduate anatomy course preceding a medical school anatomy course.[5] Other studies, however, have found little if any benefits of prerequisite courses on future course performance. Wright et al.[6] found that it did not matter when students took an introductory mechanical engineering thermodynamics course prior to enrolling in an advanced thermodynamics course. Similarly, Karimi and Manteufel[7] reported that students' grades in an introductory mechanical engineering thermodynamics course were more dependent on the course instructor and therefore were not predictive of their performance in an advanced thermodynamics course. Studies from other STEM disciplines have found similar mixed results.[8-13]

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Another question related to prerequisites and corequisites is why students choose to enroll in a course as a prerequisite or corequisite if given the choice. While the literature on this topic is minimal, Sato et al.[10] interviewed undergraduate biology students who had the option of taking a microbiology lecture course as a prerequisite to or as a corequisite with a microbiology laboratory course. While about half of the students enrolled in the lecture course as a prerequisite, a majority of students felt that taking the lecture course as a prerequisite would help their performance in the subsequent laboratory course. In addition, students gave many reasons for taking the lecture course as a prerequisite, including that the lecture course would give them strong background knowledge and also due to scheduling issues that required them to take it first. Reasons provided for taking the lecture course as a corequisite included scheduling issues that prevented them from taking it earlier and that they did not think that they needed it as a prerequisite.

In the chemical engineering curriculum at Colorado School of Mines (hereafter referred to as Mines), students have the option to enroll in introductory thermodynamics (Thermo) as a prerequisite to or as a corequisite with MEB in the spring of their sophomore year. This course sequence is somewhat unusual compared to the typical chemical engineering curriculum in which students take MEB in the fall of their sophomore year and then take Thermo in the spring. Our curriculum is set up this way for two main reasons: 1) if students do not pass Thermo in the fall of their sophomore year, they have a chance to take it again in the spring of their sophomore year and thus stay on track with the curriculum schedule; and 2) this allows new transfer students who join our major in the spring to join the major immediately and stay on track for graduation. While most students choose to enroll in Thermo in the fall of their sophomore year and thus as a prerequisite to MEB, some students (10% to 15%) choose to enroll in both courses simultaneously in the spring of their sophomore year. The goals of this study were therefore to 1) determine the reasons why students choose to take Thermo as a prerequisite to or as a corequisite with MEB; and 2) determine whether there is a performance effect in MEB depending on when Thermo is taken. The results from this study can help inform curricular design and advising programs to help guide students through the chemical engineering major.

METHODS

Course Descriptions

The MEB course in this study is taken primarily by students during the spring semester of their sophomore year. Topics included process variables, material balances for systems with and without reactions, single-phase systems, multiple-phase systems, first law energy balances for systems with and without reactions, and transient systems. Student performance is evaluated primarily by weekly homework sets, weekly in-class quizzes, and written exams (two midterms and one final). For the sections included in this study, two sections were taught by the same instructor primarily through didactic instruction and problem solving demonstration, and the other two sections were taught at the same time (MWF at 11am in each semester) by one of the authors (JFS) primarily with active learning and a high-structure format[14, 15] that included optional pre-class reading guides, graded pre-class reading quizzes, and the use of iClickers for formative in-class assessment. The course is typically taken by students in the spring semester of their sophomore year. Students in the study were equally divided between the two instructors.

The Thermo course in this study is taken by students in the fall or spring semester of their sophomore year and thus serves as the first formal introduction to the chemical engineering curriculum. Topics covered include process variables, single-component systems and phase diagrams, first law non-reactive and reactive energy balances, second law balances, and simple material balances. Student performance is evaluated primarily by weekly homework sets, weekly in-class quizzes, and written exams. The recommended path is for students to enroll in Thermo in the fall semester prior to enrolling in MEB in the spring semester; however, students have the option of taking Thermo concurrently with MEB in the spring semester.

Study Population

Undergraduate chemical engineering students enrolled in four total sections of the MEB course in Spring 2019 (two sections, n = 177) and Spring 2020 (two sections, n = 171) were invited to participate in this study. Of these students, 324 (93.1%) consented to being in this study. Of these students, only those who were previously enrolled in Thermo as a prerequisite and passed Thermo, or those who were taking Thermo as a corequisite with MEB for the first time, were included in the study (n = 270). The population demographics were 52.3% female and 47.7% male, 69.3% white, 13.1% Hispanic, 6.5% Asian, 5.2% multiple races, 3.3% international, 0.7% African American, 0.7% American Indian, and 1.3% unknown ethnicity. This study was determined to be exempt by the Mines Human Subjects Research Committee.

Data Collection

Two types of data were collected in this study: survey data and grade data. First, students from the Spring 2019 semester completed both pre- and post-course surveys online using Canvas® during the first and last weeks of class, respectively. On the pre-course survey students were asked about the reasons why they enrolled in Thermo before or during MEB, their grade in Thermo (if taken previously), their level of agreement with the statement "I believe that someone completing Thermo prior to enrolling in MEB would earn a higher grade in MEB compared to someone who did not complete Thermo first" on a five-point Likert scale, and their thoughts on the positive and negative aspects of prerequisite courses in chemical engineering in general. On the post-course survey, students were again asked for their level of agreement with the aforementioned statement on a five-point Likert scale and were also asked to explain their reasoning for their choice. In addition to survey data, end-of-course letter grade data for MEB were also collected and used in regression models (see below).

Data Analysis

To quantitatively assess student comments regarding reasons why they enrolled in Thermo as a prerequisite or corequisite, why they thought Thermo would improve one's grade in MEB (or not), and their general thoughts on prerequisites, an iterative qualitative analysis of the written comments was performed similar to that in previous studies.[10, 16-18] Student comments for each survey question were read and coded independently by the two authors of this study. They then met to discuss the emergent themes and agree upon an initial set of themes. After reviewing the same set of comments, the researchers met again to discuss whether the initial set of themes was viable and whether changes were necessary. At this time the initial set of themes was revised, and the researchers agreed upon a final set of themes (Tables 1 to 3). The percentage of students who responded within each theme were quantified and are presented in a tabular format (Tables 1 to 3).

Inter-rater reliability was determined at the conclusion of the coding process. As comments tended to have more than one theme applied, inter-rater reliability was characterized in terms of a complete match (all assigned themes matched between the researchers), a partial match (some, but not all themes matched between the researchers), and no match (no assigned themes matched between the researchers). Overall, the researchers had complete matches with 66.2% of the comments and partial matches with 33.8% of the comments. Any conflicts in themes were discussed until a consensus was reached. To analyze students' level of agreement with the pre- and post-course survey Likert question, a chi-square test was used with the students who answered this question on both the pre- and post-course surveys (n = 113).

To control for student aptitude as a potentially confounding factor in the analysis, two regression models[19] were developed in the statistical software package R.[20] First, to determine the impact of having Thermo as a prerequisite on MEB performance, a linear regression model was developed where student MEB grade (as a percentage out of 100) was the response variable and college GPA and Thermo course status (prerequisite or corequisite) were explanatory variables. Second, to see if there was an impact of having Thermo as a prerequisite or corequisite on passing MEB, a logistic regression model was developed using a binary variable for whether students passed or failed MEB as the response variable and college GPA and Thermo course status (prerequisite or corequisite) as explanatory variables. Only students who were either enrolled in Thermo as a corequisite with MEB or who previously enrolled in Thermo as a prerequisite to MEB (and passed Thermo) were included in the models (n = 270). College GPA was included to control for student aptitude.

RESULTS

Student Explanations for Their Decisions

Students had the option to take Thermo as a prerequisite to MEB or as a corequisite with MEB. In this study population 90.4% of students (n = 244) enrolled in Thermo prior to enrolling in MEB and 10.6% of students (n = 26) enrolled in Thermo for the first time with MEB concurrently. We next sought to determine why students chose to take Thermo as a prerequisite to MEB or as a corequisite with MEB. To do this, written survey responses from a pre-course survey were analyzed using an iterative qualitative analysis. The final sets of themes and their frequencies are shown in Table 1. The main reasons why students enrolled in Thermo as a corequisite with MEB were due to logistics of either scheduling issues (58.9% of responses) or being a transfer student (29.5%). In a similar vein students who enrolled in Thermo as a prerequisite to MEB cited course planning (38.2%) and examining the chemical engineering major catalog or curriculum guide (38.2%) as major reasons for selecting this course sequence.

Impact of Thermo Timing on Student Performance in MEB

Since we know that students enroll in Thermo as a prerequisite to or as a corequisite with MEB for different reasons, we next examined whether student performance in MEB is different depending on when Thermo was taken. We compared end-of-course student performance in MEB for students who took Thermo as a prerequisite and for those who took Thermo as a corequisite with MEB. As shown in Figure 1, there were differences in the proportions of students who earned each letter grade or withdrew from MEB based on their Thermo course status. Notably, more students passed MEB (earning a grade of A, B, or C) if they took Thermo as a prerequisite compared to taking it as a corequisite. There was a higher fraction of corequisite students who withdrew from MEB compared to prerequisite students (15.4% vs 5.3%). Overall, the average MEB grade for students who took Thermo as a prerequisite was not significantly different than that of corequisite students (79.3 ± 10.1 [n = 231] vs 76.2 ± 10.4 [n = 22], $p = 0.17$ [unpaired t-test]). However,

TABLE 1 **Summary of student explanations for why they enrolled in Thermo as a prerequisite or corequisite.** **A total of 143 students from the Spring 2019 semester responded to this survey question.**		
Category	**Fraction of survey responses with representative comment**	**Example quote**
A. Students who enrolled in Thermo as a corequisite with MEB (n = 19)		
Planning	58.9%	"I am concurrently taking both classes solely due to scheduling."
Transfer	29.5%	"First semester at Mines."
Advisor	11.8%	"My CASA counselor and I chose a different course completion path."
B. Students who enrolled in Thermo as a prerequisite to MEB (n = 124)		
Planning	38.2%	"The course lined up appropriately with my other courses."
Catalog	38.2%	"I took it because it was on the catalog."
Value	16.5%	"I took it to give me a foundation of what to expect in this class in terms of how the class is arranged and knowledge."
Confusion	15.5%	"I thought it was a pre-req."
Advisor	4.2%	"I took [Thermo] prior to enrolling in [MEB] as I was put in this class for my first semester at Mines."
Transfer	1.1%	"I am a transfer student, at my previous university we were required to take the equivalent thermodynamics course prior to taking the Mass and Energy Balances course."

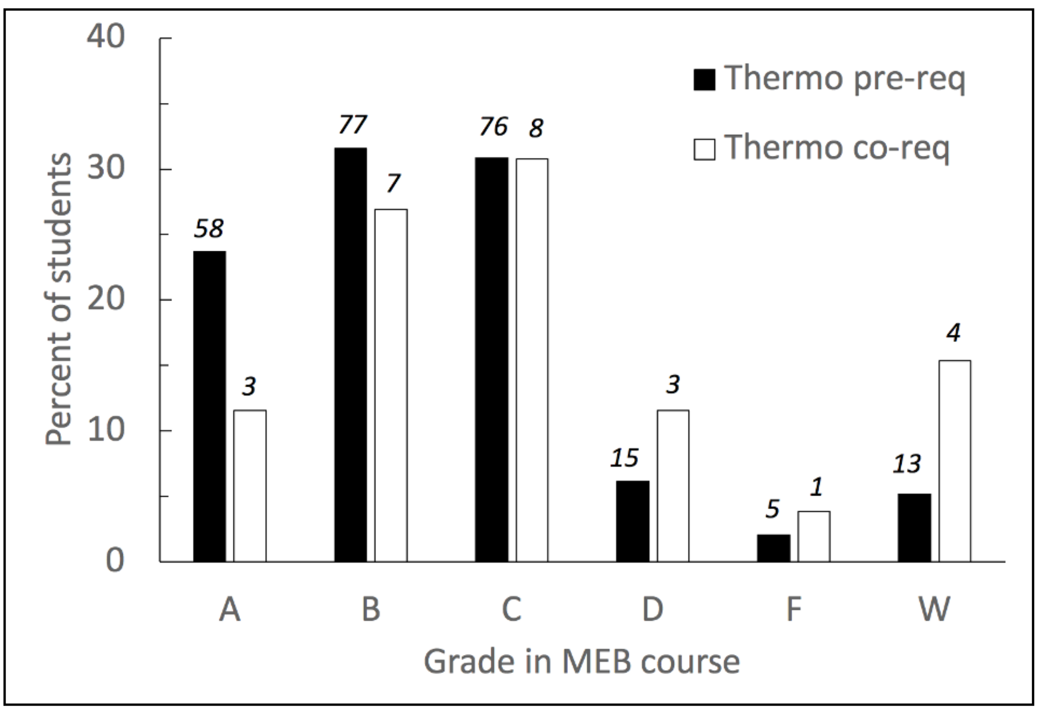

Figure 1. *Summary of student end-of-course performance in MEB as a function of whether they enrolled in Thermo as a corequisite with MEB or as a prerequisite to MEB. Actual student numbers (n) for each letter grade are shown in italics above each bar. For Thermo prerequisite, total n = 244; for Thermo corequisite, total n= 26.*

this grade does not include those students who withdrew from MEB and therefore did not finish the course. Additionally, as this analysis does not control for student aptitude (i.e. college GPA) or other demographic factors, additional interpretations may be possible.

To therefore attempt to control for student aptitude as a potentially confounding factor, a linear regression model was first developed to compare student performance in MEB based on when they enrolled in Thermo. This model used student performance in MEB (as a percentage out of 100) as the response variable and college GPA and Thermo course status (prerequisite or corequisite) as explanatory variables. Students who withdrew from MEB were not included in this analysis since they did not finish the course, so the total number of students analyzed was 22 corequisite students and 231 prerequisite students. The linear regression model showed that college GPA was a significant predictor of performance in MEB. However, while there was a positive effect of having Thermo as a prerequisite, it was not significant (model intercept = 28.60 ± 3.70 [p = 2.46E-13], Thermo prerequisite estimate = 2.51 ± 1.68 [p = 0.14], college GPA estimate = 14.33 ± 1.00 [p < 2E-16]). The results from the model signify that for two students with equal college GPA, a student who enrolled in Thermo as a prerequisite would earn 2.51 percentage points higher on their overall MEB grade compared to the student who enrolled in Thermo as a corequisite, although this comparison is not statistically significant (Thermo prerequisite estimate = 2.51 ± 1.68 [p = 0.14]).

To analyze the impact of Thermo on passing MEB, a logistic (odds) regression model was used to compare whether or not a student passed MEB based on when they enrolled in Thermo. This model used a binary explanatory variable of if a student passed (i.e. earned an A, B, or C) or did not pass (i.e. earned a D or F or withdrew) MEB and when they enrolled in Thermo (as a corequisite or as a prerequisite) and their college GPA as explanatory variables. The logistic regression model showed that there was a significant positive effect of having Thermo as a prerequisite towards a student passing MEB (model intercept = -10.33 ± 1.74 [p = 3.55E-9], Thermo prerequisite estimate = 1.30 ± 0.59 [p = 0.03], college GPA estimate = 3.55 ± 0.54 [p = 5.53E-11]). The results from the model signify that for two students with equal college GPA, a student who enrolled in Thermo as a prerequisite would be 1.30 times more likely to pass MEB compared to the student who enrolled in Thermo as a corequisite. This comparison is statistically significant (Thermo prerequisite estimate = 1.30 ± 0.59 [p = 0.03]).

Student Perception about Importance of Thermo as a Prerequisite to MEB

While the results from Figure 1 and the regression models suggest that there is a performance advantage if students enroll in Thermo prior to MEB, we next wanted to know if students had this perception that Thermo offered an advantage to MEB. Figure 2 displays a summary of student perceptions about the potential advantages a student might garner from enrolling in Thermo prior to MEB from a pre-course and a post-course survey. We asked this question both before and after the course to determine if working through the MEB course changed students' perceptions about the importance of Thermo. While the majority of students agreed on both the pre-course and post-course surveys that there would be an advantage if a student enrolled in Thermo prior to MEB, there was not a significant difference between the survey response distributions (chi-square test, p = 0.18), suggesting that actual exposure to the MEB course did not change students' perceptions of the impact of Thermo on MEB performance.

In order to further understand why students thought that there would be an advantage (or not) if a student enrolled in Thermo prior to MEB, we analyzed written response data from the end of the course asking students to explain their reasoning behind their agreement levels shown in Figure 2. As shown in Table 2, students who strongly agreed or agreed with the survey statement in Figure 2 stated most commonly that they felt that Thermo provided an advantage for MEB because of the preparation developed in Thermo based on concepts or content (63.9%), skills (14.9%), or general preparation (12.8%). Students who neither agreed nor disagreed that Thermo would provide an advantage for MEB mentioned that the courses were different enough such that one would not help the other (26.7%) or that the potential benefits were irrelevant and thus depended on each individual student and their situation (26.7%). Only three students strongly disagreed or disagreed with the statement that Thermo would provide an advantage for MEB, with two students stating that the courses are different and thus not helpful to have Thermo prior to MEB and the other stating that it is beneficial to have them at the same time.

Student Perception about Importance of Chemical Engineering Prerequisite Courses in General

We also asked students about their positive and negative perceptions about chemical engineering prerequisite courses in general (Table 3). A vast majority of students responded that the most positive characteristic of prerequisite courses is that they prepare you in some way for future courses, with the most common type of preparation being content preparation (such as the background information or concepts in one course helping in a future course), followed by general preparation (the prerequisite helps in some unspecific way), and finally skills preparation (the prerequisite course helps develop problem solving skills, good study habits, etc.).

Additionally, students reported that continuity between courses was the single most valuable aspect of prerequisite courses, as courses could build on one another. On the other hand, the most commonly reported negative aspect about

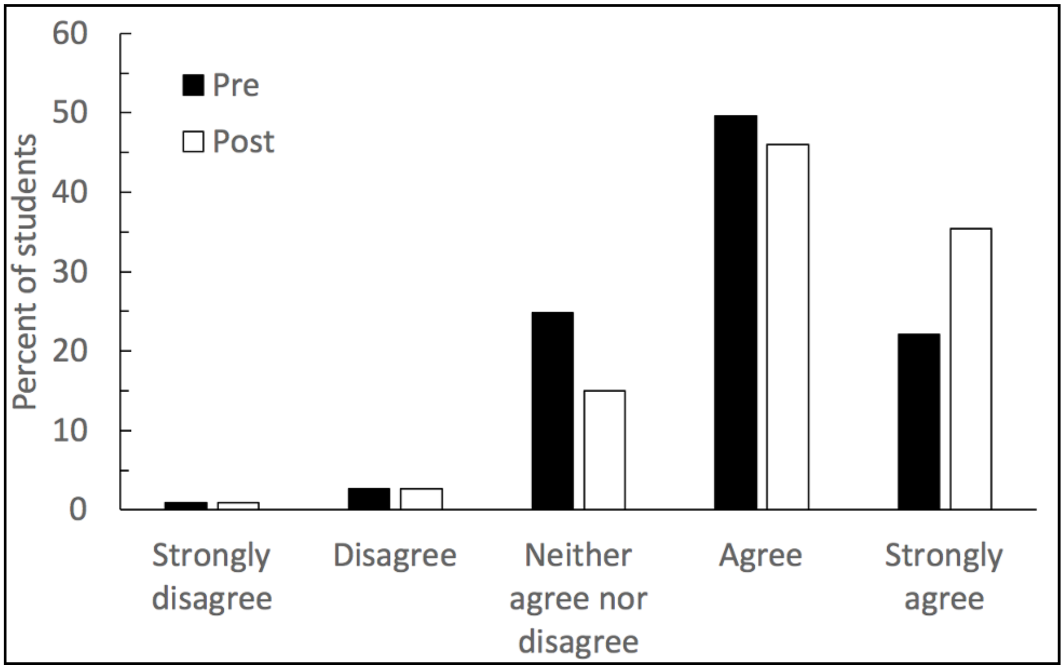

Figure 2. *Summary of student responses from the pre- and post-course surveys about their level of agreement with the statement "I believe that someone completing Thermo prior to enrolling in MEB would earn a higher grade in MEB compared to someone who did not complete Thermo first." The distributions were not significantly different before and after the course (chi-square test, p = 0.18).*

prerequisites is that they are inconvenient because they force a student to take courses in a required order or to take courses in which they are not interested. Another commonly reported negative aspect is that prerequisites can hold a student back if a student fails them. Since prerequisite courses may not be offered every semester, failing a prerequisite may delay a student's degree progression as much as an entire year.

Discussion

In this study we sought to characterize the reasons why students enroll in Thermo as a prerequisite to or as a corequisite with MEB and whether the timing of their enrollment in Thermo impacts performance in MEB. We found that students mostly chose when to take Thermo based on logistics (curriculum guides, scheduling issues, etc.) but that the reasons differed slightly depending on when students enrolled in Thermo. Additionally, students perceived Thermo as being beneficial to their success in MEB because Thermo would give them a strong foundation in conceptual knowledge from which to build on. In line with this perception, analysis of MEB performance data suggests that students who enrolled in Thermo as a prerequisite outperformed students who enrolled in Thermo as a corequisite and that students are more likely to pass MEB if they enroll in Thermo as a prerequisite. Even though these data are from a single institution, these results are important more broadly and should be considered when developing curricula and when advising students on when to take courses so as to help maximize student success and retention.

The major reasons why students chose to enroll in Thermo as a prerequisite to or corequisite with MEB came down to logistical matters. Corequisite students frequently stated that schedule planning was a major reason for taking Thermo as a corequisite because Thermo did not fit into their schedule in prior semesters. Some corequisite students also had a unique reason in that a few of them were new transfer students, and thus were required to take Thermo as a corequisite with MEB to stay on track with the major. Students who enrolled in Thermo as a prerequisite to MEB did so mainly because that is how the courses are laid out in the chemical engineering major catalog, with Thermo being taken in the fall semester of sophomore year and MEB in the spring semester of sophomore year. These students also frequently mentioned that scheduling or planning issues (i.e. the course fit well into their schedules) was a major reason for taking Thermo as a prerequisite. Similar results were found by Sato et al.[10] wherein biology students cited scheduling issues when deciding whether to take a microbiology lecture course as a prerequisite to or as a corequisite with a microbiology laboratory course. Neither prerequisite nor corequisite students noted using advisors for their decisions at high rates. This may be likely because students enroll in Thermo and MEB during their sophomore year before they are officially admitted to the chemical engineering major (which typically

TABLE 2

Summary of student explanations for why they chose their level of agreement with the statement "I believe that someone completing Thermo prior to enrolling in MEB would earn a higher grade in MEB compared to someone who did not complete Thermo first." A total of 112 students responded to this survey question (only three students disagreed and thus are not included in the table).

Category	Fraction of survey responses with representative comment	Example quote
A. Students who strongly agreed or agreed that Thermo provides an advantage for MEB (n = 94)		
Concepts preparation	63.9%	"In [MEB], we did not spend a lot of time on the basics of energy balances. Without [Thermo], I would not have been able to understand those chapters at all."
Skills preparation	14.9%	"… I think having completed thermo I had a better understanding of the type of problem-solving simply due to the practice."
Generic preparation	12.8%	"I took [Thermo] prior to taking MEB and I believe I was appropriately prepared for MEB."
Class expectations	9.6%	"it prepares you for the style of class."
Unprepared	6.4%	"I am taking both classes and seriously struggled in 201 in the beginning of the semester compared to my peers."
Synergy between courses	2.2%	"I took CBEN 210 congruently with CBEN 201 and it was extremely beneficial."
Courses are different	1.1%	"There are similarities between the classes that help, but they are still very different."
Irrelevant	1.1%	"Strongly related course material, but neither is dependent on the other."
B. Students who neither agreed nor disagreed that Thermo provides an advantage for MEB (n = 15)		
Irrelevant	26.7%	"I am taking both at the same time and it helps me but idk if it would be that beneficial for everyone. It depends on each person."
Courses are different	26.7%	"There are similarities between the classes that help, but they are still very different."
Synergy between courses	20.0%	"I think [Thermo] and [MEB] complement each other well and give extra practice helping both get better."
Generic preparation	13.4%	"Some of the things learned in thermo were useful when we got to the second unit of MEB, however they are not crucial to learning everything."
Unprepared	6.7%	"…it would have been helpful to know the process of the species tables…"
Concepts preparation	6.7%	"A lot of the topics we cover in MEB are directly related to thermo."

occurs in the middle or at the end of their sophomore year). Prior to matriculation in the major, students receive general campus advising and thus may not rely on it as much since it is not specific to their intended major.

Notably, the reasons that students provided for taking Thermo as a prerequisite do not match well with their perceived value of Thermo towards their performance in MEB. While the vast majority of students reported that Thermo would be valuable towards their performance in MEB, only 16.5% of students reported the value that Thermo brings towards MEB as a reason for enrolling in Thermo as a prerequisite. While students acknowledge a perceived benefit of the value of skill and content development in Thermo as a prerequisite, they choose to enroll in Thermo as a prerequisite more so based on logistical and scheduling issues.

The data from this study also suggest that there is a performance benefit if students enroll in Thermo prior to enrolling in MEB. Students who enrolled in Thermo as a prerequisite to MEB passed MEB at significantly higher rates than students who enrolled in Thermo as a corequisite to MEB when controlling for college GPA (which is a proxy for student aptitude and was an extremely strong predictor of student performance in MEB). Additionally, Thermo prerequisite students had an overall higher MEB performance average than Thermo coreq-

TABLE 3 **Summary of student comments about positive and negative aspects of chemical engineering prerequisite courses in general. A total of 156 students responded to this survey question.**		
Category	Fraction of survey responses with representative comment	Example quote
A. Students' perceived positive aspects of prerequisites		
Continuity	38.0%	"Continuation of course material is organized and logical."
Concepts preparation	34.4%	"Some prerequisite courses are necessary in order to even conceptualize topics that build on their fundamental lessons."
Generic preparation	16.6%	"They prepare you for more difficult courses to come and ensure you can be successful in the upper level courses."
Skills preparation	7.6%	"Prerequisite courses are positive because you have been training your brain to problem solve certain problems. Not only is it beneficial for problem-solving but you learn new skills…"
Indicator	3.4%	"Prerequisite courses indicate what further classes or the major may look like."
B. Students' perceived negative aspects of prerequisites		
Inconvenient	31.5%	"Schedule conflicts, I can't take the classes I want when I want."
Fail	30.6%	"If I fail a prereq in ChemE, sometimes I would be delayed a full year before I can retake."
Filler	18.0%	"Some content is irrelevant for my major. Unrelated courses shouldn't be forced on me."
Delay	12.4%	"High achieving students are held back from their potential; basics should be optional."
Forget	7.5%	"Students forget content over the summer. Also, new classes always have a review."

uisite students (however, this result was not significant). The main reason for this is likely that Thermo provided a strong foundation in conceptual knowledge and problem-solving skills which students were able to apply to MEB. Students' explanations for why Thermo would provide an advantage for MEB largely echoed this hypothesis. However, there could be other explanations for this result, including that students who enroll in Thermo as a prerequisite and pass Thermo are more motivated students,[21] have better study habits,[22] have higher grades,[23] or have lighter course loads and time demands, all of which could impact their performance in MEB. Even with these possibilities, the failure rate in MEB may typically be high,[23] and thus offering Thermo as a prerequisite to MEB may be helpful in reducing the failure rate in MEB and thus improving student outcomes and retention in the chemical engineering major.

Limitations

A limitation in this study is that we assessed sophomore students who were in the midst of taking Thermo and MEB. While this could be considered a strength since the surveys were given very close in time to when they were enrolled in Thermo and MEB, it could also be considered a limitation since not enough time had passed for them to have perspective on the relationships between the courses. If students were instead surveyed in their junior or senior years after some time has passed, perhaps different opinions and thoughts would be revealed. A small number of the corequisite students were also transfer students taking courses at Mines for the first time, so their adjustment to a new college may also impact performance in MEB. Finally, this study reports only student opinions from a single institution with a particular course sequence and thus may not be representative of all chemical engineering students.

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