

Work-in-Progress: Developing a Research Plan for a Retrospective Analysis of the Effect of Bridging Courses on Student Success in Graduate Studies

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1. Introduction

North Carolina State University's Department of Chemical and Biomolecular Engineering (CBE) regularly accepts accomplished students to its graduate program with backgrounds such as chemistry, physics, or biology. However, these students may lack the prerequisite knowledge of key chemical engineering topics, such as transport phenomena and thermodynamics. Other students may have an undergraduate background in chemical engineering but enter graduate study after an industrial career and would like a refresher on complicated topics. There is a need to bridge this knowledge gap in order to position each accepted student to succeed in graduate studies.

Since 2018 the department has offered a self-paced online course sequence consisting of two courses, three credit hours each which are typically taken Fall/Spring or Spring/Summer, for students with a BS degree in a non-CHE science or engineering field. This two-course sequence serves as a "bridging course" and teaches the core concepts in chemical engineering to students, covering material including material and energy balances, thermodynamics, transport phenomena, and reactor design. The course content, organization and continuous improvement have been previously presented and documented [1-5].

Now that the two-course sequence has been offered seven times since Fall 2018, we wish to assess whether students who have taken the bridging course performed better when they took the core graduate courses – Process Modeling, Thermodynamics, Transport Phenomenon, and Chemical Reaction Engineering – than students who were admitted to the graduate program without a BS CHE degree and did not take the bridging course. We will analyze graduate admissions data back to 2009 in performing this comparison.

2. Data Collected

At this time no student data has been collected for the purposes of this study, and thus no human subjects are involved at any point thus far in this study. Proper human subjects research approval will be secured prior to presentation of any student data. However, data to be used in this study will be provided through university records, and the types of data that would likely be provided for each student in the study are known at this time. These data categories are:

- Identifying information (name and student ID)
- Academic Plan (MS or Ph.D.)
- Starting Year in the Program
- Undergraduate Degree (e.g. biology, chemistry)

- Letter grade in each of the department's four core graduate courses (transport, thermodynamics, kinetics, and mathematical methods)
- Letter grade in first course of bridging course sequence (if applicable)
- Letter grade in second course of bridging course sequence (if applicable)
- Degrees (if any) conferred

The data above will be collected for all students who were enrolled in a graduate academic plan since 2009 who had an undergraduate degree outside of chemical engineering. One sample of students (referred to here as "Group 1") to be considered in the analysis will be those students who enrolled in a graduate academic plan prior to 2018; the bridging course sequence did not exist until 2018, so this represents a group of students whose preparation did not include instruction from the bridging courses. Typically, remedial preparation for these students toward succeeding in ChE graduate study included ad-hoc measures of preparation such as sitting in on designated undergraduate lecture courses. The other sample of students ("Group 2") considered in analysis will be the students who were enrolled in the bridging courses as part of their graduate instruction; enrollment in the bridging course sequence has been mandatory for students entering a CBE graduate program with only a BS degree in a non-CHE science or engineering field degree since the course were first available in 2018. The goal of this paper, presentation and discussion with the community is to suggest and devise comparisons which will indicate the relative rates of "success" of these groups of students; in other words, we aim to determine if the bridging course sequence is more effective than ad-hoc measures at helping students achieve success in ChE graduate study.

3. Suggested/Intended Analyses

An immediately obvious measure of success based on the data to be provided is whether a student successfully earned a graduate degree in ChE through their studies. With this in mind, one comparison that we intend to make is comparing the frequencies of earning a degree between Groups 1 and 2. This comparison would seem to show whether the graduate bridging courses helped students achieve their ultimate goal: a graduate degree in ChE. However, this comparison is somewhat fraught by the idea that some students may take the bridging courses (or ad-hoc measures) and realize that they no longer wish to pursue a graduate degree in ChE, thus not applying to or dropping out of the graduate program entirely (which is not necessarily a "bad" outcome and does not necessarily reflect the quality of their preparation - graduate ChE is not everyone's cup of tea!) We are unsure of the most effective way to address this concern, but our initial inclination is to simply acknowledge that a student realizing they no longer want to pursue graduate ChE study is a possibility, but that the rate of this occurring should be somewhat similar regardless of whether they are in Group 1 or 2.

Another common measure of success is classroom performance, and thus we also plan to compare the letter grades of students in Groups 1 and 2 for the core graduate courses. One area of concern in this comparison is how to deal with those students who drop out of the program before completing the graduate program. These students may (as a hypothetical example) only have grades in two of the four core graduate ChE courses, and if each of these grades is low, then their overall GPA would be low even though it is only informed by two letter grades (rather than four letter grades for successful students). Our initial plan is to ignore that smaller sample size for students who drop out of the program before completing all graduate courses and calculate their GPA based on the courses they completed.

In order to determine if the bridging course sequence has an effect on grades in individual core courses, we also plan to compare the GPAs of students in Groups 1 and 2 who earned a letter grade in each of the core graduate ChE courses. It is possible that the bridging course sequence effectively prepares students for success in, for example, graduate transport, but may be weaker toward preparing students for success in graduate kinetics; it is desired to find any of these strong/weak points via this comparison.

We also aim to complete an analysis only for Group 2 which contrasts student GPA across the two courses in the bridging course sequence against their GPA in later core graduate ChE courses. It is hoped that this will indicate whether success in the bridging courses portends success in the rest of the core graduate curriculum.

An additional measure of success we are considering would require collection of additional data (and also IRB approval) by searching websites such as LinkedIn to determine whether students in Groups 1 and 2 eventually secured jobs in technical fields. Though this would be interesting, we are concerned that it would be difficult to determine through listed job titles whether the job position is considered “technical” or “engineering” and also whether a former student’s eventual job is something we should be concerned with at all.

This work-in-progress paper aims to solicit feedback from the chemical engineering education community on the quality of the above comparisons, as well as any adjustments to the suggested comparisons. Suggestions for entirely new comparisons we have overlooked thus far, or additional data we should consider collecting, are also welcome.

4. Conclusions

North Carolina State University’s CBE has offered a two-course graduate bridging course sequence since 2018 which intends to help students with undergraduate degrees outside of ChE succeed in ChE graduate programs. This paper describes setup of a study which intends to compare different measures of success for those students with undergraduate degrees outside of

ChE who enrolled in North Carolina State University's ChE graduate program prior to the first offerings of the bridging courses in 2018 with similarly-situated students who were able to take the graduate bridging courses as part of their course preparation. A selection of measures and comparisons intended to be drawn in a later study are presented, and the authors desire feedback from the ChE education community on the perceived quality of these measures and comparisons, as well as ideas for any additional measures and comparisons.

References

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