

Do undergraduates need prerequisites for common courses?

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ABSTRACT

A good design of common courses is the starting point for a business school student's academic success. Oklahoma State University (OSU) Spears School of Business (SSB) requires 12 common core curriculum for all business school majors, and students may choose which course they want to take first. From a student's point of view, the lack of prerequisite allows the student more freedom in their schedule. However, enrolling in high-level courses before low-level courses may end up with more students either getting lower grades or even worse, getting a D, failing the course or withdrawing from the course (DFW). To test the value of requirement of more structured schedule or potential prerequisite requirement, this paper is going to analyze the order and prerequisite effect of common courses on students' DFW rate and grade for business common courses. About 5,000 students' demographic information and 50,000 common course enrollment outcomes datasets were supplied by OSU Institutional Research & Information Management department. This research used SAS Studio for data preparation and SAS Enterprise Miner for data modeling including decision tree and logistic regression. The results show that variables influencing DFW rates most are Entry Type, High School GPA, Race, Order Effect, the course need prerequisite or not, the student has taken the prerequisite or not. Courses that need prerequisites have lower average grade than courses that do not need prerequisites. Students who take prerequisites have higher average than students who do not take prerequisites. According to the results, courses which need prerequisites are more difficult and taking prerequisite courses can improve students' academic performance. SSB may encourage student to follow prerequisite requirement.

INTRODUCTION

Students sometimes complains about prerequisites and try to break prerequisite rules, because the rules block them from taking the courses they want. The students may think they can accomplish the course without taking its prerequisites. However, taking higher level courses before lower level courses may lead to higher D/Fail/Withdraw rate. It is a waste of education resources, which can be avoided by taking courses in order.

SSB required 12 common core courses for all business undergraduate students: ACCT2103, ACCT2203, ECON2103, ECON2203, MSIS2103, EEE2023, FIN3113, MGMT3103, MKTG3213, LSB3213, MSIS3223, and MGMT4513. There are prerequisite requirements, but student can easily bypass them. Oklahoma State University Spears School of Business (SSB) is considering whether they should enforce prerequisites for business school common course.

The purchase of the research is to help SSB to find out if taking courses following prerequisite requirement will decrease DFW rate and help students have a better academic performance when controlling other demographic information.

DATA PREPARATION

Raw data

Bio_test_data.sas7bdat: demographic information of each student

Courses.sas7bdat : courses supplied by OSU

Degree_granted.sas7bdat: degree granted to each student

Gpa_term.sas7bdat: GPA of students in each semester

Term_data.sas7bdat: major of students in each semester

Data cleaning

We first filtered out missing or unrecognizable grades, incomplete student information in the data, and then, filtered out courses which are not SSB core common curriculum. After that, we joined students demographic information with each course the students have taken. In the end, we add DFW indicator(DFW as 0, A, B, C as 1), multinomial grade indicator(A as 3, B as 2, C as 1, DFW as 0), indicator of whether a course has prerequisite or not, and indicator of whether a student has taken the prerequisite or not.

Final dataset includes demographic information of each student, courses the student took this semester, grade of the course and its prerequisite information. An example of final dataset is in Appendix(Table 1).

Define Prerequisite Indicator

We define three variables to measure prerequisites in total. They are Need_Pre, Taken_Pre and Order.

A table of prerequisite requirement information of SSB is shown in Appendix(Table 2). 7 of 12 core courses have prerequisite requirements. Need_Pre is defined as that if a course has prerequisite requirement, its Need_Pre equals 1, otherwise it is 0.

Taken_Pre is defined as that when a student took a course which has prerequisite requirement, if they had taken the prerequisite course, then Taken_Pre equals 1, otherwise it is 0.

Order is defined as the order of courses that students took them. If the order matched the designed prerequisite curriculum order, the student was following prerequisite requirements. If it did not, then the student did not follow the rules. For example, a student with ID = 1, entered OSU at 2011 in Fall and graduated at 2015 in Spring. They took ACCT2203 at 2012 in Fall. The order is 3 because this is their third semester in OSU. Order is an indirect indicator of prerequisite. Because the larger the Order is, the more courses the student had taken before the current course they were taking. But on the other hand, the larger order may also related to higher Drop/Fail/Withdraw rate regarding a required course.

DESCRIPTIVE ANALYSIS

There are 30,306 records for courses which have prerequisite requirements. Their average grade is 1.5502. There are 15,521 records for courses which do not have prerequisite requirements. Their average grade is 1.9752. The average grade of courses which do not have prerequisite requirements is higher than courses which need prerequisites. An independent t-test showed that the difference is significant(p -value <0.0001). Students performed better generally on courses which do not have prerequisite requirements. This may tell us that courses which need prerequisite requirements are more difficult to get a better grade.

Among courses which have prerequisite requirements, the average grade of students who took prerequisite courses is 1.5908 and the average grade of students who did not take prerequisite courses is 1.3566. An independent t-test showed that the average grades of students who took prerequisite courses are significantly higher than students who did not take prerequisite courses (p -value <0.0001).

MODELING:

To predict DFW rate and Grade, we first imputed missing categorical variables with the value with most count and interval variables by their mean value. After that, we split 70% of data to train the model and 30% of data to validate the model. To predict DFW rate, we used Logistic Regression and Decision Tree. For grade prediction, we used Multinomial Logistic Regression model(HP regression Node in SAS Enterprise Miner).

RESULT:

DFW Rate

Stepwise Logistic Regression selected African American, Entry Type, High School GPA, Order, White, Need_Pre, Taken_Pre into the best model to predict DFW rate. According to Odds Ratio estimates, odds of DFW rate of courses which need prerequisite requirements is 2.821 times of odds of courses which do not need prerequisite courses. Odds of DFW rate from students who did not take prerequisite is 1.279 times of odds of DFW rate from students who took the prerequisites. When order increases by 1, Odds Ratio of DFW/Non DFW rate increases 3.4%. A detailed Odds Ratio table and Parameter Estimate table are in Appendix(Table 3 and Table 4).

In the decision tree model, Need_Pre, High school GPA, and Order were selected as important variables. For courses that do not need prerequisites, DFW rate is as low as 10.99%. For a course which need prerequisites, the probability that a student who has high school GPA higher than 3.565 will drop or fail is 12.21%, but for the same course, a student who has high school GPA lower than 3.565 is 26.95%. However, for a course that need prerequisites, if the student with good GPA(>3.565) took it in their eighth semester or even later, the DFW rate is 66.67%. A table of tree is in Appendix(Table 5).

Grade

Enter Type, Gender, African American, High School GPA, Order, Native American, Need_Pre, Taken_Pre are the significant variables which were selected into the best model to predict students' grade. Order increases by 1, grade decreases by 0.0517. Grade of courses which need prerequisite is 0.4868 lower than grade of courses which do not need prerequisite controlling other factors. But if a student had taken the prerequisite, their grade will increase by 0.1039. a table of Parameter Estimate is in Appendix(Table 6).

CONCLUSION:

Based on the modeling results, prerequisite requirements are necessary. Courses that have prerequisite courses are more difficult than courses that do not need prerequisite requirements. Following prerequisite requirements and taking prerequisite courses can significantly increase a student's grade and reduce DFW rate. The later semester a student took a core common course, especially when the order is larger than 7, which usually means the student has drop/fail/withdraw the course multiple times, the DFW rate increases significantly.

We recommended that Spears School of Business may implement prerequisite requirements more strictly to improve students' academic performance in advanced core business courses. .

APPENDIX

| ID | GENDER | ENTRY_TYPE | HS_GPA | FINAL_GRADE | COURSE | Num_Academic_period | DFW_FLAG | grade | Native_American | Asian | African_American | Pacific_islander | White | order | taken_pre | need_pre |
|----|--------|------------|--------|-------------|----------|---------------------|----------|-------|-----------------|-------|------------------|------------------|-------|-------|-----------|----------|
| 50 | M | F | 3.23 | B | MSIS2103 | 200620 | 0 | 2 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 |
| 50 | M | F | 3.23 | C | ECON2103 | 200660 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 2 | 0 | 0 |
| 50 | M | F | 3.23 | C | MSIS3223 | 200740 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 3 | 1 | 1 |
| 50 | M | F | 3.23 | B | ECON2203 | 200740 | 0 | 2 | 0 | 0 | 1 | 0 | 0 | 3 | 1 | 1 |

Table 1. Example of joined dataset.

A Male student(Gender = M) with ID=50, a African American(African American=1), has high school GPA 3.23. He entered OSU at 2006 Spring semester(Academic period = 200620). He took MSIS2103 at his first semester(order = 1). He got B, did not drop/fail/withdraw(DFW = 0).

| Course | Prerequisite |
|---|----------------------------|
| ACCT2103 | ENGL1113, MATH1483 |
| ACCT2203 | ACCT2103 |
| ECON2203 | ECON2103 |
| MSIS3223 | MSIS2103 |
| FIN3113 | ACCT2103,ACCT2203,ECON2103 |
| MKTG3213 | >=45 Credit hours |
| LSB3213 | Junior Standing |
| EEE2023, ECON2103, MSIS2103, MGMT3013, MGMT4513 | No |

Table 2. Prerequisite Requirement in Spears School of Business

| Odds Ratio Estimate | |
|---------------------|----------------|
| Effect | Point Estimate |
| African American | 1.808 |
| Entry Type F vs T | 0.617 |
| High School GPA | 0.308 |
| Order | 1.034 |
| White | 0.904 |
| Need Pre | 2.821 |
| Taken Pre | 0.782 |

Table 3. Odds Ratio Estimate of DFW Rate Logistic Regression

| Analysis of Maximum Likelihood Estimates | | |
|--|----------|---------|
| Variable | Estimate | P-value |
| intercept | 1.9209 | <.0001 |
| African American | 0.5921 | <.0001 |
| Entry Type | -0.2416 | <.0001 |
| High School GPA | -1.1778 | <.0001 |
| Order | 0.0321 | 0.0003 |
| White | -0.0224 | <.0001 |
| Need Pre | 1.037 | <.0001 |
| Taken Pre | -0.2465 | <.0001 |

Table 4. Parameter Estimate of DFW Rate Prediction Logistic Regression

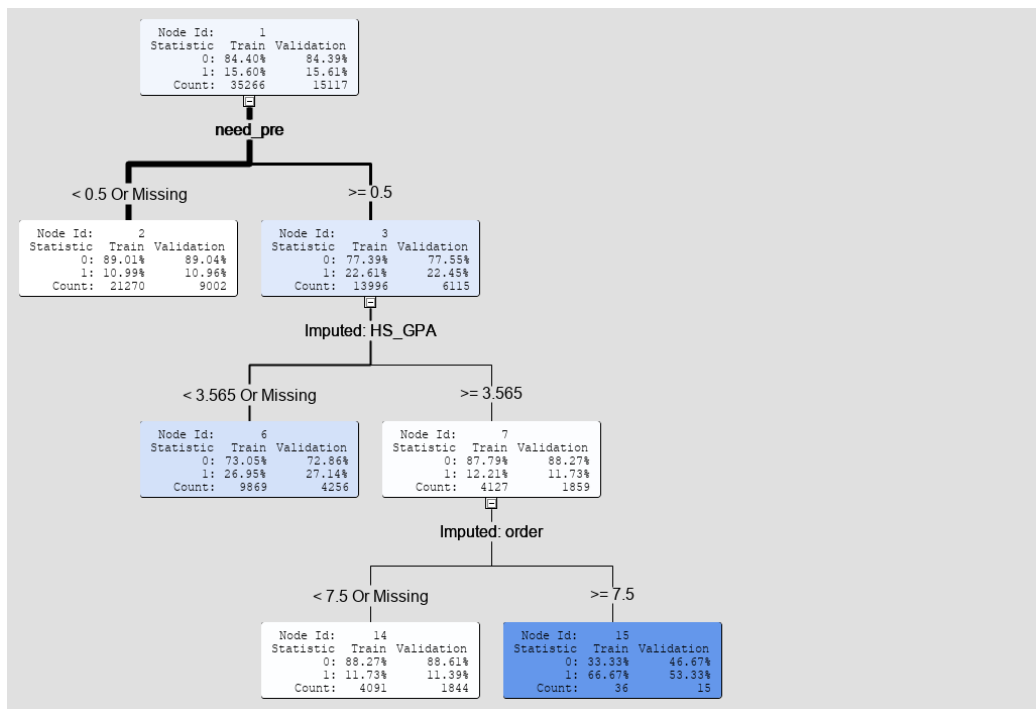


Table 5. Decision Tree of DFW Rate Prediction

| Analysis of Maximum Likelihood Estimates | | |
|--|-------------|---------|
| Variable | Estimate | P-value |
| intercept | -198.430446 | <.0001 |
| Entry Type F vs T | 0.245866 | <.0001 |
| GENDER F | -0.083101 | 0.5573 |
| GENDER M | -0.05028 | 0.7223 |
| African_American | -0.355825 | <.0001 |
| High School GPA | 0.702502 | <.0001 |
| Order | -0.051572 | <.0001 |
| NativeAmerican | -0.068135 | <.0001 |
| Need Pre | -0.486773 | <.0001 |
| Taken Pre | 0.103914 | <.0001 |

Table 6. Parameter Estimate of Grade Prediction Logistic Regression