A Novel Metric for Evaluating the Relationship Between Course Outcomes and Persistence

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Declines in university enrollment due to the pandemic and declining demographics has pushed retention to the forefront. The relationship between course grades and persistence is combined into a new metric coined the Persistence Differential. This metric signals courses with higher counts of students earning not-quality grades and not persisting and is used to inform academic advising and curriculum review to improve retention. Challenges and successes in reporting the data meaningfully and examples for actionability will be described.

Keywords: higher education institutions (HEI's), competing values framework (CVF), SmartPLS

INTRODUCTION

This research project occurred at a midwestern four-year, public institution. There are approximately 7200 undergraduate and graduate students, 170-degree offerings, 300+ faculty: 75% with highest degree in their field. While not an open enrollment university, there is a relatively low bar for admissions: a high school GPA 2.25. The first to third semester retention rate is 73% for the fall 2020 cohort. Looking to improve this rate the Retention Committee, led by the Dean of Students, was formed in 2019. This group was concerned that there were a number of classes that had high rates of D, F, W (withdrawal) grades and that failing these classes was related to non-retention. The Retention Committee asked the Office of Institutional Effectiveness to explore the relationships between courses with high DFW grades and retention rates. The authors collaborated on this research and the results are presented here.

RESEARCH QUESTION

Given the following questions from the Retention Committee, how can the Office of Institutional Effectiveness equip end users to evaluate course outcomes and persistence?

a. *Which high DFW classes are related to non-retention?*

b. *How do outcomes in one class relate to outcomes in another class?*

LITERATURE REVIEW AND VOCABULARY

Literature Review

Student success continues to be at the forefront of most institutions' goals and is a way to get ahead of the impending "birth dearth". (Bransberg, Falkenstern, & Lane, 2020). Grawe (2018) emphasized the decline in the U.S. college-age population with the evidence that shows low fertility rates since 2013 with no clear sign of a meaningful recovery. With this background, higher education institutions have to generate strategies to adapt to this situation and survive the threat of declining enrollment (Pavlov & Katsamakas, 2020). Thus, a focus on student retention as a solution to the problem becomes more important in this context.

Institutions are continuing to evolve in their use of analytics to evaluate student retention/persistence to address enrollment declines and, more importantly, to serve students to meet their institutional mission. Specifically, course outcomes have been identified as influential on student likelihood to retain (Kwak, 2020; Lopez-Wagner, Carollo, & Shindledecker, 2013).

Course outcomes and persistence are critical in institutional efforts to improve retention and graduation rates. Research has shown that "slower starts to academic careers compounded into lower retention rates" (Kwak, 2020). For instance, among non-returning students in good standing (2.0 GPA or higher), half had earned a DFWI in calculus (Kwak, 2020).

Course outcomes and student persistence have often been studied under "gateway courses". These courses are generally critical to setting students up for success in college (Kwak, 2020). Typically, if a student does not do well in a gateway course they may not retain, or lack the necessary knowledge and skills to do well in their major. Analyzing DFW rates can prove meaning to institutions as a mechanism to provide for early interventions to bolster their success. This is only possible if those courses of interest can be identified in a timely and efficient manner.

Institutions such as Montana State University have developed robust strategies to accomplish this task. They have a Barrier/Gateway Course Group that has a charge from the provost to "explore and develop recommendations to improve the success of students in courses that typically impede progress in the major" (Montana State, 2022). Through this process a list of courses are identified and recommendations provided that were aimed at improving the success in these courses that have historically impeded students to reaching progress in their major. Other noteworthy examples in these areas include University of Texas at San Antonio, Purdue University, and Indiana University–Purdue University Indianapolis.

The need for institutional data surfaces in all of these initiatives focused on identifying obstacle courses. There is a necessity for cross-departmental partnerships among the faculty, campus leaders, student success advisors, and the IR/IE Office. The joint statement from the Association of Institutional Research (AIR), EDUCAUSE, and National Association of College and University Business Officers (NACUBO) succinctly summarizes this necessity… "*"If you want to go fast you should go alone, but if you want to go far, you should go together." – Source unknown.* As institutions continue to face enrollment declines, cross-departmental collaboration is imperative.

The university sought to analyze course outcomes and persistence to improve student course success and positively impact persistence and retention. The first step in the process was to determine and define the necessary data elements that would be used to analyze these data.

Vocabulary

Persistence and retention carry different meanings in higher education. In this context, persistence refers to term level re-enrollment indicators that facilitate analysis on all students enrolled in a term and their respective re-enrollment status for the next term, next fall and next academic year. For this paper retention and persistence are used interchangeably.

The next semester after fall semester is defined as winter, and the next semester after summer is defined as fall. However, the "next" semester after winter is defined as fall semester. Summer sessions are small and not required for full time attendance.

The initial data request was for high DFW classes. However, there were situations and departments where a D grade was sufficient. Therefore, clarifying language was implemented. DFW was changed to Not Quality Grades, and ABC grades are called Quality Grades. In the broadest sense this means pass/not pass.

METHODOLOGY

Data Structure

Data is replicated daily from the institutional systems into the enterprise data warehouse (EDW). After which data from across the student life cycle is integrated with each data model (i.e.: admissions, enrollment, retention/persistence, completion).

With the EDW in place, the Office of Institutional Effectiveness (IE) initially reviewed DFW data. Data from the last five years of 100 level courses with DFW rates 25% or more, 5 or more out of the last 11 semesters, serving more than 200 students total, and taken by a wide range of students were considered. Only courses that were either general requirements or were taken by several majors included. While this gave the Retention Committee an initial set of classes to consider it did not determine which classes were most related to non-retention. Thus, there was a need to further visualize and interrogate the data, research questions one and two were further contextualized, the persistence differential was developed, and dashboards were built in order to visualize the data. Research question one was answered using the data model in the EDW; to answer research question two, an additional step was necessary to look at course pairs. Data was further modeled using a self-join process; allowing for the ability to look at grade outcomes of courses taken in sequence or simultaneously.

Data Elements/Key Metrics

Latest Grade Flag

An indicator for only keeping the most recent attempt of a class. Many students repeat courses and there was a need to limit the data to the most recent attempt of a course.

Admit Term and Term Taken

A metric that takes the difference between the admit term sequence number and the term sequence number and calculates when the course was taken in the career of the student 1st term, 2nd term, and so on.

Class 1 and Class 2 Term Gap

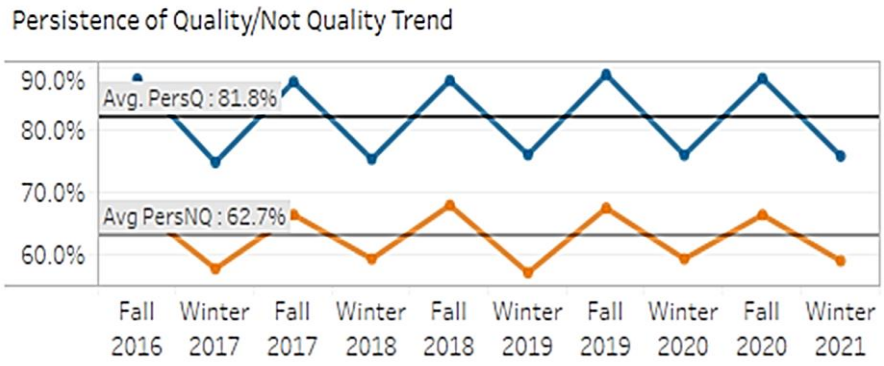
A metric used to evaluate course 1 and 2 being taken simultaneously, and number of terms between courses, and grade outcomes in course 2 for that sequence and term gap. Using the self-joined extract, this is calculated using the term number of the course 1 and course 2.

Persistence Differential

The persistence differential is a metric that is used to signal classes in which students that earn a non-successful grade are less likely to re-enroll at a higher rate than other classes.

A simplified description of the persistence differential is the persistence rate of students earning quality grades subtracted from the persistence rate of the students earning not quality grades. See the difference in the top reference line and the bottom reference line in Figure 1 below.

FIGURE 1
PERSISTENCE DIFFERENCE VISUALIZED WITH REFERENCE LINES



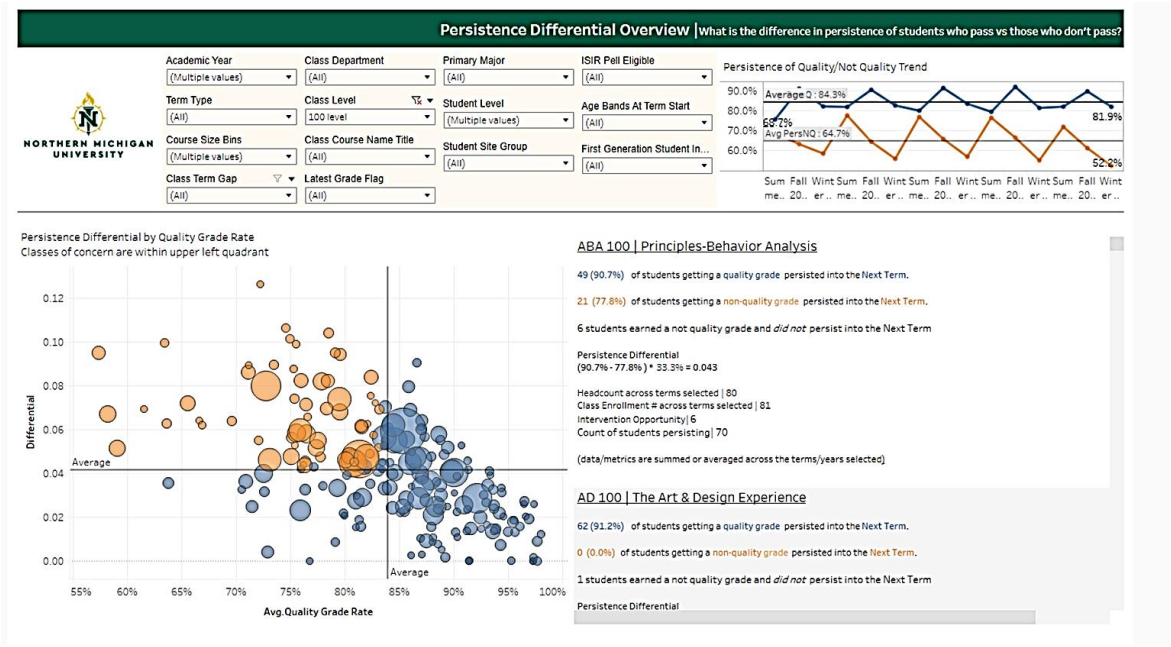
The greater distance between the reference lines indicated a stronger relationship between failing the class and not retaining. The problem with this simplified metric was that small classes could have skewed differentials. For example: if there were 10 students: one failed and didn't return (0% return) but there 9 passed and all returned (100%) the persistence differential was 1 (calculated as follows 100%- 0%). However, the DFW rate was only 10%. To address this issue, a DFW Rate multiplier was included. This weighted differential was then coined the Persistence Differential and is calculated as follows:

(Rate of Persistence with Quality Grades - Rate of Persistence with Non-quality Grade) * DFW Rate (1)

In the current example the *weighted* persistence differential is now (100%-0%) (0.10) = 0.10. The novel metric is coined the **persistence differential**. For brevity, the word "weighted" is not included in the metric name but the weighting does occur.

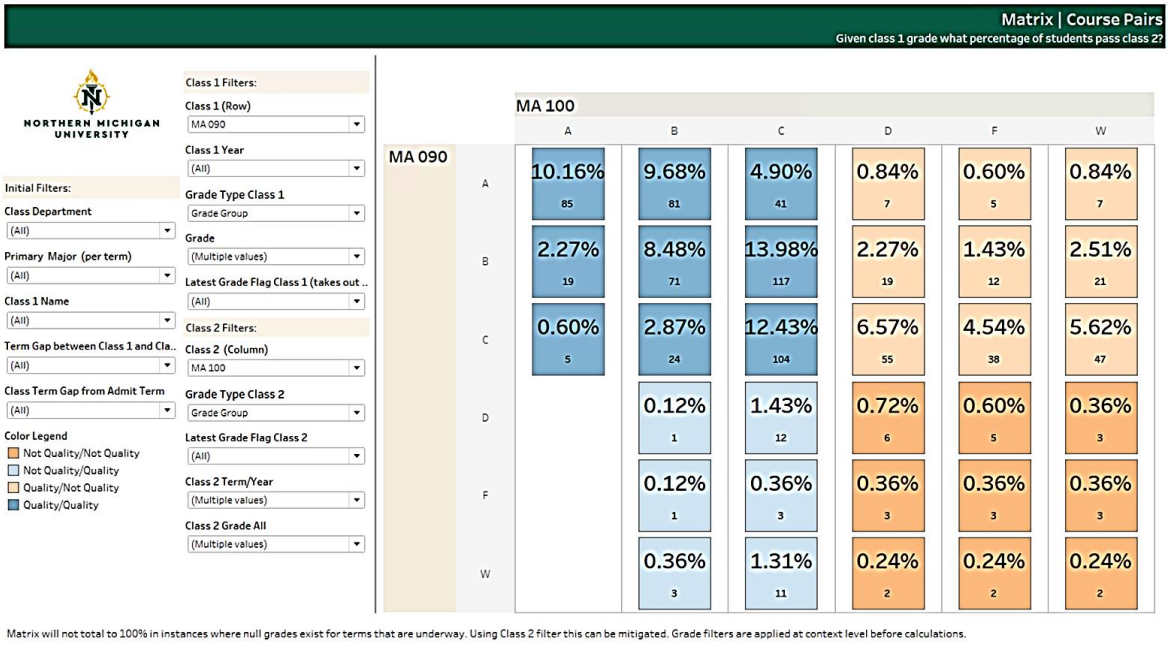
A zero score was assigned if the persistence differential was negative (which happened sometimes but rarely). Thus, the persistence differential ranges from 0 to 1, with 0 meaning the students *do **not** retain at a lower rate* when they fail the course, and 1 meaning students *do retain at a lower rate* if they fail the course. This novel metric gives a clearer picture of which classes were most related to non-retention. Dashboards were built to share the information with advisors, academic departments, and leaders. Presentations to stakeholders will be detailed in the Results section. See figure 2 for Persistence Differential Overview Dashboard. The dashboard included a visualization of the classes that had low quality grade rates and high persistence differential (see the orange bubbles). Other dashboards allow end users to export tables of classes meeting the criteria they chose. Filters included courses, time frames, semesters, class sizes, majors, student level, Pell eligible, age, first generation, and latest grade flag. This allowed departments to explore the data as they desired.

FIGURE 2
PERSISTENCE DIFFERENTIAL OVERVIEW DASHBOARD



To address the next research question, a dashboard was created that allowed the end user to select two courses to see how the outcomes of the course relate to one another. This dashboard also allows for users to see courses taken simultaneously.

FIGURE 3
COURSE SEQUENCE DASHBOARD

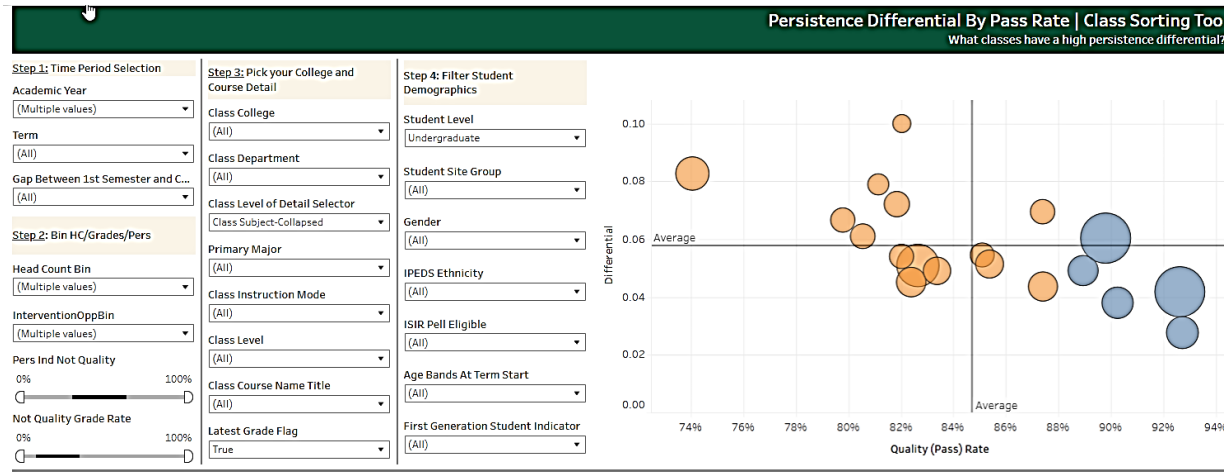


Since students repeat courses, a "Latest Grade" filter was created that allowed the end user to only consider the most recent attempt of a course. The time between classes was also relevant. The "Term Gap between Class 1 and Class 2" filter allowed the dashboard user to limit their attention.

RESULTS

This team reported back to the Retention Committee with answers to their questions. For example, 100-level classes that serve many students highly related to non-retention are indicated in Figure 4.

FIGURE 4
PERSISTENCE DIFFERENTIAL SORTING TOOL: 100 LEVEL, HIGH HEADCOUNT, LAST 5 YEARS



Headcount Bin	Class/Course	Differential	Not Quality Grade ind	Pass Rate	Pers Rate DFW	Pers Rate Pass	Enroll#	Headcount	DFW Rate	Int. Opp
501 - 1,000	BI 104	0.11	237	65%	56%	88%	676	676	35%	104
1,001 and above	BI 111	0.08	860	74%	60%	93%	3,333	3,333	26%	343
	MA 090	0.08	274	81%	47%	89%	1,432	1,432	19%	144
	MA 100	0.07	442	78%	54%	89%	2,049	2,049	22%	202
	CJ 110	0.07	279	86%	38%	87%	1,965	1,965	14%	173
	UN 100B	0.07	219	84%	45%	90%	1,407	1,407	16%	120

Presentations were given to the deans and department heads. This led to further requests for data from eight departments. Based on their individual requests the dashboards were modified to answer their questions. For example, Global Campus (online programs) wanted an age-filter to compare their non-traditional and traditional students.

A workshop was run for the College of Arts and Sciences department heads. Department heads were able to log into Tableau and access DFW data for their own departments. This led to more data requests and more follow up meetings. A similar workshop was delivered for the College of Health Sciences and Professional Studies department heads, College of Business, Technology and Occupational Sciences, and Global Campus.

Presentations were given through the Center for Teaching and Learning Faculty Focus program, Data Day (a full-day of presentations by the IE office on current student success projects), and to the advising groups on campus.

DISCUSSION

Successes

There were many successful outcomes of this project. As a direct result of these workshops, departments are engaging in difficult conversations about classes with high rates of DFW and how that

relates to retention. Suggestions are being discussed: consistency between instructors, co-requisite courses, and curricular adjustments. Additional tutoring was made available to students in the high persistence differential classes. Advising will avoid putting students in multiple high-persistence differential classes. A community of practice was formed to brainstorm other interventions that can be implemented to address this high persistence differential issue.

The presentations to departments were well received, in part due to the collaboration of the authors. The authors' roles are: a member of the IE office, a faculty member in the temporary role of Provost Fellow, and a consulting data analyst.

Challenges

This project also had its challenges. On the implementation end it was a challenge to get the information to transfer from the mid-level leadership to the level of actionability. Some department heads immediately asked for more information, but some listened halfheartedly. Curricular changes are slow and need one person to drive the change. Getting the data into the hands of the right person is a challenge. Limited licensing of Tableau makes it impossible to give every faculty member access. However, the community of practice that formed includes key players and advocates and they are discussing potential systematic improvements and will make recommendations to the senior enrollment team.

On the technical end there were some challenges related to self-joined extract, new fields, and dashboard revisions. First, using a self-joined extract presented itself with some run-time issues. The nature of this type of join initially resulted in long rendering time and an inefficient dashboard.

An additional technical challenge included the need to replicate and add several new fields to the existing data extract. Because these fields were currently being utilized in Banner, replicating and loading them into the extract that fed the dashboards was relatively straightforward. As with any new analysis, it is important to consider that new fields will be necessary in the data analysis process, and to consider these additions in time to completion, and also that some degree of data validation will be necessary. Some limitations may exist if desired data elements; such as course repeat flags, are not being utilized in the source system at inception of the project.

A final technical consideration is dashboard build and design. It is always important to recognize that in a new design or build of any dashboard, new fields and design revisions will occur throughout the process of developing a optimal tool for the end user. The suite of dashboards has gone through extensive validation and revision all of which was expected to ensure accurate data visualizations that provide meaningful insights and operational reporting options where appropriate.

Use Cases

Several use cases came to light from this project. Departments have data about barrier classes, but can also research grade and retention nuances. The following use cases are presented as examples of real and potential actionable outcomes of this project:

- Use case 1: Departments can determine how well their own majors are doing in their classes and in other classes.
- Use case 2: Departments can also see how non-majors are doing the service classes they offer.
- Use case 3: Departments can investigate how well performance in one class correlates to performance in another. This is needed to determine appropriate pre-requisites. For example: is English 111 a barrier for History majors?
- Use case 4: Departments can compare outcomes for groups, such as non-traditional vs traditional students, or Pell eligible vs non-Pell eligible.
- Use case 5: Departments can compare how students perform when classes are taken at various times in their career. For example, the Music department asked for outcomes of concurrent Music 101 and Music 102 in the first semester compared to second semester. This work informed the Music department's curricular mapping.

- Use case 6: Departments can compare the subsequent course pass rates to course grades. This is used to fine tune pedagogical decisions.
- Use case 7: Departments can investigate inequities in persistence based on first generation, Pell eligible, and age.

FURTHER IMPLICATIONS

The demographic cliff facing higher education has increased retention efforts. Creating interventions that keep students enrolled through graduation is more important than ever. The work presented here can bring attention to road blocks, barriers, and bottlenecks to continued enrollment and degree completion.

Additional support services and programs such as freshman learning communities, tutoring, and the development of co-requisite courses can be adopted and institutionalized based on the information provided by the DFW and course sequencing dashboards.

Analyzing classes with high DFW rates and their relationship to persistence can be used for academic program review. Regular review of programs helps shape curriculum maps and determine courses required for degree completion. Program review will reveal if programs are preparing students for graduation, employment, graduate school, or next steps in students' lives. DFW data combined with review of skills needed might indicate that a barrier class is no longer relevant, and curricular revisions could improve the outcomes for that program.

Programmatic assessment of learning may benefit from the course sequencing dashboard. Service level English and math classes provide basic skills for students to succeed in other classes. The course sequencing dashboard gives insight into how the service level classes are preparing students for subsequent non-math, non-English classes.

Limitations include generalizability, as this project was completed as a mid-size public institution the results may not be replicable at other institutions. The number of Tableau licenses held limits the dashboard use.

CONCLUSION

Declining enrollments in higher education continue to bring retention to the forefront of institutional concern. As a result of this focus on retention, data is necessary to plan for the future and make informed decisions about how to improve rates. The data provided for these questions is often requested of the Offices of Institutional Effectiveness. The IE Office's ability to deliver answers to these questions can directly impact institutional effectiveness in responding to critical needs. The IE Office at NMU aimed to equip stakeholders with the ability to analyze data relating to course outcomes and persistence.

This project explored the relationship between classes with high D, F, W (withdrawal) grades and retention rates. The persistence differential metric was developed to signal courses that have a strong relationship between not-quality grades and non-retention. Course outcomes of two-course sequences were evaluated. Tableau dashboards were built, presentations and workshops to advisors were delivered to deans and department heads, and a selection of faculty. This iterative process led to meaningful revisions to dashboards to benefit the end user experience and utility.

In summary, the project successfully answered the Retention Committee's questions by introducing the Persistence Differential metric and has provided meaningful data and presentations to leaders and advisors at NMU. Continued access to the dashboards is available to the deans, department heads, and advising staff, but not to all faculty. As a result of this work, curricular revisions, changes in advising, and increased student support is being offered. To be effective in improving retention, there is a continued need to refine and re-present this work regularly.

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