Meet Me in the Middle: Retention in a "MOOC-Based" Degree Program

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ABSTRACT

"MOOC-based" degrees are degree programs often offered in partnership with MOOC providers that provide the flexibility and scale of MOOCs while also awarding accredited degrees. This positioning between MOOCs and degrees raises interesting questions regarding retention: MOOCs are famous for their low completion rates, but accredited degree programs often strive for high retention rates. This paper aims to answer the broad question: what does retention look like in a "MOOC-based" degree program? To answer this question, we analyze retention at two levels: first at the program level, then at the course level. We find that retention is far higher than in MOOCs, but notably lower than in traditional in-person programs, both when looking at the program as a whole and at individual courses. We provide discuss several hypotheses for this phenomenon, as well as implications for program evaluation and course design.

CCS CONCEPTS

•Applied computing~Education~Distance learning •Social and professional topics~Professional topics~Computing education~Adult education

KEYWORDS

MOOCs, MOOC-based degrees, online education, retention

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1 Introduction

In *The World is Flat*, Thomas L. Friedman recounts a conversation he had with then-Georgia Tech President G. Wayne Clough [14]:

"When I came to Tech as an awestruck freshman back in the sixties," Clough told me, "they had this drill for the incoming students. They would tell us: 'Look to your left. Look to your right. Only one of you will graduate."

A similar quote was said to be common in law schools in the 1900s, predicting that one out of three students would not return for their second year [5]. That these were issued to incoming firstyear students suggests that their intent was to warn students about the rigor of the respective programs. There is certainly some logic to the connection as well: a high rate of failure could imply the program is rigorous and thus valuable.

This narrative began to shift toward the latter part of the 20th century. As tuition rose, the notion of saddling students with enormous debt for a program they did not complete became less digestible. Colleges instead began to take pride in their retention and graduation rates. A high rate of student success is now a hallmark of a reputable school; low completion rates are often cited in criticisms of predatory colleges. Again, the logic here is easy to follow: a good school is one that helps a greater fraction of its students succeed. Drop-out rate was thus implicitly replaced by selectivity in the calculus of evaluating universities: a good school was one that admitted good candidates, and then ensured they succeeded. Scarcity and its implicit connection to reputability was preserved, but a more student-centric mindset entered the conversation.

Against this backdrop, massive open online courses—MOOCs arrived in earnest in the early 2010s. MOOCs built on decades of progress toward open access to education through initiatives like The Open University [9], PLATO [7], and MIT OpenCourseware [8], but the arrival of a handful of massive courses by prominent professors—along with the creation of platforms to support the courses—was a watershed moment in the emergence of MOOCs. In a now-familiar story, the New York Times dubbed 2012 the "Year of the MOOC" [33], only for the reality of low completion rates to emerge a year later [13]38].

Lost in this criticism of high attrition is the relationship between selectivity and retention: retention only rose when selectivity rose as well. MOOCs are unselective; anyone can sign up. For this reason, many have noted that completion rates are the wrong metric to use in assessing MOOC success [1, 4, 37, 41]. Nonetheless, the stigma of low completion rates has persisted.

This negative stigma was still relatively recently established when the first MOOC-based Master's degrees began to emerge. Endowed with other names in other contexts, such as affordable degrees at scale [34] and large internet-mediated asynchronous degrees [24], these programs use MOOC-like technologies and innovations—as well as partnerships with actual MOOC providers—to expand access and reduce costs while offering an accredited degree. First on the scene were Georgia Tech's online Master of Science in Computer Science program (OMSCS), offered with Udacity [29], and the University of Illinois's (UIUC) online Master of Business Administration (iMBA), offered with Coursera [46]. Today, there are over 50 similar programs.

These programs may allow us to expand our understanding of retention in online programs. On the one hand, they have some hallmarks of MOOCs. First, their lower tuition expands access to audiences who could not afford traditional programs. More significantly, the lower cost means students may enter even if they have a less commitment to finishing-dropping out would not saddle them with as significant a financial hardship. Second, these programs are typically more flexible: not only does their online nature expand access to anyone with an internet connection, but most MOOC-based Master's programs also keep the asynchronous flexibility of MOOCs. Third, while joining these programs is more complex than joining a MOOC, they are nonetheless less selective than capacity-restricted in-person programs. Georgia Tech's online MSCS program, for instance, "accepts all applicants who meet the program's basic qualifications" and has accepted 74% of all applicants so far, compared to only 10% accepted to the oncampus program [31].

On the other hand, these programs have much in common with traditional in-person programs. First, while tuition is lower than in-person programs, it is higher than a MOOC: a typical UIUC iMBA class costs \$1200, while a typical OMSCS class costs \$540, both excluding student fees. Second, while these programs are more flexible than traditional offerings, they generally are not as flexible as MOOCs, with hard grade deadlines and strict requirements to remain enrolled. Students may be academically dismissed if their GPA falls too low, a policy that has no analogue in MOOCs. Third, attendance requires admission to the university, a long process of applying, submitting letters of recommendation, and collecting previous transcripts.

MOOC-based degrees thus lie between traditional programs and MOOCs: more affordable, accessible, and scalable than the former, and more rigorous, respected, and comprehensive than the latter. Given the gap in retention between MOOCs and traditional programs, where do these new degrees fit?

This study examines this research question: what trends in retention rates do we see in a MOOC-based degree program? To answer this, though, we must also note that retention and completion rates have subtly different meanings in these different contexts: in MOOCs, we typically refer to the completion rate of a single course, while in a degree program, we typically refer to retention across the degree as a whole. This study thus examines retention in a MOOC-based degree program from both angles: first at the level of the program as a whole, and second at the level of individual courses.

2 Related Work

Retention rates in higher education have long been a topic of analysis and debate; the majority of research, however, has focused on the undergraduate level [3, 43, 45], with special attention paid to at-risk populations [28, 44]. Some targeted research has focused on retention in online classes and programs, again at the undergraduate level [21, 22, 30]. Among the most comprehensive investigations created a model of undergraduate drop-out behavior based on student expectations, demographic background, and institutional characteristics [42]; while this addresses the undergraduate level, some lessons may be transferrable to the graduate level. As mentioned previously, significant research has also documented the dismal retention rates most often associated with MOOCs [13, 38].

Turning instead to Master's level education-the level at which most MOOC-based degrees reside-Girves & Wemmerus investigated what factors predict success in graduate degree programs, with student and department characteristics largely predicting degree progress [15]. Ott, Markweich & Ochsner found that retention is higher among students entering as full-time students than part-time [32], a finding relevant as most MOOCbased degree programs emphasize part-time students balancing studies with full-time employment [23]. Girves & Wemmerus go on to say, "Given that grades is the only intervening variable to predict master's degree progress and that master's degree programs are typically one or two years, it appears that at the master's level selection of students is a critical factor in degree completion" [15]. Separately and more recently, significant attention has been paid to specific groups, such as women [19] and underrepresented minority groups [35] especially in STEM-related fields, noting particular challenges to both access and retention among these audiences.

A major trend throughout these studies on retention in college programs is that student commitment to success is a significant predictor of retention and completion [15, 32, 42]. Given the barriers to joining college programs-tuition costs, commitment to synchronous co-located attendance, prior qualifications-a sizable commitment to success is necessary for students to enroll in traditional programs in the first place. This contextualizes MOOCs' low retention: in removing as many obstacles as possible, these courses draw students with lower levels of commitment to success, shown to be a chief predictor of completion. This phenomenon supports the suggestion that completion rates are subpar measures for MOOC success [1, 4, 37, 41]. As we turn to our analysis of retention in a MOOC-based degree program, we might hypothesize retention rates will fall in the middle: there are larger barriers to entry than MOOCs, but lower barriers than traditional programs, suggesting retention may fall somewhere in the middle.

3 Program & Student Context

Girves & Wemmerus noted that two of the chief predictors of completion in a graduate program are student characteristics and program characteristics. Thus, to understand retention and completion, we must discuss the student and program context. In addition to contextualizing our analysis, these also provide the vocabulary for further discussion.

3.1 Program Context

The MOOC-based degree program under investigation here is a Master's degree in computer science offered by a public research institution in the United States. To enroll in the program, students must apply to the university through the normal admissions process: they must pay an application fee and submit prior transcripts and other documents. To be admitted, students must meet a number of minimum qualifications, including possessing a prior four-year Bachelor's degree and some experience in academic computer science classes. The Graduate Record Examinations (GRE) exam is not required; instead, all students are provisionally admitted and must earn a grade of B or better in two foundational courses within the first year to be fully admitted; this is referred to as the "foundational requirement". Most courses available in the program count towards this foundational requirement. Students may also transfer in up to two classes from prior graduate work (though if they do so, it does not fulfill the foundational requirement).

Once matriculated, students enroll in classes according to a typical semester-based system. There are three semesters per year: spring, starting in January; summer, starting in May; and fall, starting in August. Students may join the program in spring or fall semesters, and may graduate from the program in spring, fall, or summer. Students are only permitted to enroll part-time, which is a maximum of three classes per semester. Students pay \$540 per class, plus \$300 in student fees per semester; the total degree costs between \$6,900 and \$8,400 depending on how many semesters the student requires to graduate, assuming they take the minimum required number of classes; this positions the degree as cheaper than most comparable programs [34].

To remain actively enrolled in the program, students must not skip two consecutive semesters; students may take one semester off, but if they skip a second semester in a row, they are considered to have dropped out and must apply for readmission. Within a semester, students may also withdraw from an individual class any time before roughly the halfway point of the semester; withdrawing leaves a grade of W on their transcript but qualifies as having been enrolled that semester. In our vocabulary, a withdrawal is a student withdrawing from a single class; a dropout is a student skipping two or more semesters in a row. Students may also be academically dismissed from the program if their GPA falls too low, if they are found responsible for misconduct too many times, or if they fail to make adequate progress in a reasonable time frame; the rules governing these dismissals are complex and involve information absent from our dataset, and so we do not categorize students by their reason for dropping out, although significant efforts have been made at better-identifying misconduct in the program [40]. We may infer it from our later analysis of course progress at the time of drop-out, however.

To graduate the program, students must complete 10 classes with at least a C grade of C or better, fulfill the requirements of a specialization (which dictates specific classes that must be completed with at least a B), and earn an overall GPA of 3.0 or higher. Only classes taken within the last six years may automatically count toward degree requirements when a student is ready to graduate; students must petition to have older classes counted.

3.2 Student Context

Prior studies have identified several criteria of students in MOOC-based degree programs: historically, they have largely been working professionals in their mid-30s [23] motivated primarily by interest in the subject, followed by career advancement or transition [10]. In the final year of our dataset, 20% of enrolled students were women, and the fraction of women has been steadily rising by 1% per semester for several years. 14% of students are members of an underrepresented minority group. 55% students are US citizens and 7% are permanent US residents; the remaining 38% reside internationally, a fraction that has been rising steadily [25].

On average, students take three years to graduate, enrolling in an average of 1.4 classes per semester but typically taking at least one or two semesters off or failing to complete their class once or twice. Research has found that programs like these are reaching an audience that otherwise would not have pursued a graduate-level education [17], that learning outcomes are comparable in a class that spans online and on-campus programs [16], and that learners' grades are largely derived from open-ended human-graded assessments [11].

4 Study Dataset

In order to address our research questions, we obtained a dataset of every individual program enrollment over the program's seven-year history, from the initial incoming class in Spring 2014 through the Summer 2021 semester. Each element represents a single student enrolling in a single class for a particular semester. Each element in the dataset consists of the following parameters:

- An anonymous identifier of the individual student, allowing a single student's academic trajectory across semesters to be tracked.
- The course number for the individual class represented by the enrollment.
- The semester of the enrollment (Spring, Summer, or Fall and the year).
- The final grade the student received for the course: A, B, C, D, F, W, or I. W represents a Withdrawal, while I represents an Incomplete, typically assigned due to either a personal emergency that prevented a student from completing the class or a pending academic misconduct case. Incomplete grades are changed to the final letter grades once the work is completed, the misconduct case is resolved, or a set period of time has passed.

The dataset contained 149,808 individual enrollments from 23,835 individual students. The dataset is regularly updated to change any Incomplete grades to the ultimate assigned grade. A separate dataset also provides a straightforward list of the anonymous identifiers of graduates of the program.

Unfortunately, this dataset lacks information about what students did prior to enrolling or after dropping out, which could lend a bit of context to the subsequent analyses. Students may transfer in up to 6 credit hours from other universities; they may transfer any number of credit hours from other programs (online or on-campus) at the same university. Those prior credits are not included in this dataset. As this analysis is interested only in retention, the absence of this prior credit is only relevant in attempting to establish how close to graduation a student was when they dropped out; if they graduate with transfer credit or remain enrolled, the presence of that transfer credit does not alter their status insofar as this analysis is concerned. Similarly, this dataset contains no information about a student's actions after leaving the program: a student who disappears from the dataset prior to graduating may be simply dropping out but may alternatively be transferring to the on-campus program, transferring to another university, or transferring to one of the college's other online graduate degrees. Thus, treating all students who do not graduate as "drop-outs" represents the most negative possible interpretation; conversations with program staff, however, suggest that the reality is not far off, as it is estimated that fewer than 200 students have transferred from the online program to either the on-campus program or to another online program at the same university, representing fewer than 3% of drop-outs. Lastly, students are permitted to continue to enroll in classes after graduation; however, as these students are henceforth classified as alumni, these added enrollments do not cloud this drop-out analysis.

5 Program-Level Retention

As noted under the Program Context, students in the program are permitted to skip a single semester and remain enrolled as active students; skipping two semesters in a row constitutes dropping out of the university, requiring students to apply for readmission. In analyzing program-level retention, we adopt this same definition: a student is considered to be actively enrolled if they have enrolled in either of the two most reset semesters in the dataset. A student who is no longer actively enrolled is considered to have dropped out. To analyze program-level retention, then, we ask four questions:

RQ1: What fraction of *all* matriculating students has graduated, remains actively enrolled, and has dropped out?

RQ2: What fraction of each incoming class has graduated, remains actively enrolled, and has dropped out?

RQ3: For each student who has dropped out, how much of the program had they completed at the time of their drop-out?

RQ4: What fraction of students who at one point dropped out have since returned to the program, and what fraction might we expect to do so in the future?

5.1 Overall Program Retention

As noted in the prior description of the study context, 23,835 individual students are present in the dataset. Each of these students can be categorized into one of three broad categories: either they have graduated, they have enrolled in one or both of the most recent two semesters (Spring and Summer 2021), or they have dropped out. The label "dropped out" may mean they have transferred on campus, to another online program at the same school, or to another university; however, we generally group these all together as drop-outs as our conversations indicate such transfers are uncommon. We may further delineate drop-outs by whether they completed the program's foundational requirement prior to dropping out; only those who had completed this requirement had attained full student status.

Figure 1 provides the breakdown of all students by current status. 68% of students who have ever matriculated into the program are either currently enrolled or have graduated; 19% dropped out prior to meeting the foundational requirement, and 13% dropped out after meeting it.

Matriculated Students by Current Enrollment Status



Figure 1. Total fraction of students who have graduated, remain enrolled, or have dropped out from the program.

5.2 Per-Class Program Retention

This high-level snapshot leads to a natural follow-up question regarding the timing with which students drop out from the program. At what stage of enrollment do students drop out? We explore this in two ways. First, we separate out overall graduations, enrollments, and drop-outs by semester of matriculation. Matriculation semester is the first term in which a student appears in the dataset: that may mean they matriculate with some course credit already earned from a prior program.

Figure 2 provides this breakdown, with the most recent semesters at the top of the chart. The matriculating class of Spring 2021 is 100% currently enrolled as enrollment in Spring 2021 qualifies on its own as enrollment in one of the most recent two semesters.



Current Enrollment Status Per Incoming Class



From there, drop-out percentages rise quickly: 11% of the Fall 2020 incoming class dropped out as soon as possible, skipping the next two semesters. For the Spring 2020 and Fall 2019 incoming classes, 29% and 30% of students had dropped out by Summer 2021; the last majority of these (23% and 22%, respectively) did so prior to meeting the program's foundational requirement. After four semesters, however, the numbers begin to stabilize: for every incoming class from Spring 2014 through Spring 2019, between 37% and 45% of students had dropped out as of Summer 2021. Unsurprisingly, pre-foundational requirement drop-outs peak early and then remain consistent given that failure to meet the foundational requirement precludes students from continued enrollment.

Turning to graduations and current enrollments, 12 members of the incoming Spring 2020 class had already graduated by Summer 2021; 3 of these 12 transferred in prior credit while the other 9 completed 10 classes in 5 semesters to graduate as quickly as possible. Graduations continue to increase approximately linearly with each passing semester before to balancing out at around Fall 2016. Meanwhile, 9 students who began the program in its inaugural semester of Spring 2014 remained actively enrolled as of Summer 2021: for 7 of these 9, they dropped out and reenrolled at some point during their academic career.

5.3 Progress at Time of Dropping Out

Examining retention per matriculating class provides insights into at what point in time after matriculation students graduate or drop-out; however, it does not reveal what actual degree progress those students had made. For example, a student who enrolls in and withdraws from a class six semesters in a row would be considered actively enrolled during that entire time, but they are not making any degree progress. We likely want to differentiate students who enroll several semesters in a row and fail to make progress before dropping out from those who enroll several semesters in a row, earn adequate grades, and then drop out anyway.

This analysis can be complicated, however, as adequate degree progress is not always apparent from grades alone: students must meet certain requirements which include earning a B or above in certain courses, a C or above in at least ten courses overall, and a GPA of at least 3.0. A C in a particular course for one student could be considered a failure to make progress if they required a B or better based on their graduation plan, but for another student that C may be adequate. However, as we will discover in Section 5.1, 95% of all grades are either As, Bs, Fs, or Ws; thus, it is relatively insignificant whether we define completion as B or above, C or above, or even D or above. We choose here to use the number of grades of B or above as our metric for progress toward degree completion as even if a grade of C would ultimately count toward graduation requirements, it would have to be counterbalanced by an A elsewhere to meet graduating GPA requirements.

Thus, we can formalize RQ3 as: how many grades of B or above had students earned when dropping out from the program? As an added bit of context, we may also include how many classes students had attempted: a student who attempts five classes and earns only one B may have made the same amount of progress toward their degree as a student who attempted only one class and earned a B, but it would be fair to interpret these withdrawals differently.

Figure 3 shows a heatmap of the number of classes each student had completed and attempted at the time they dropped out of the program. As it is impossible to complete more classes than are attempted, the area below the diagonal is empty. For space, the chart is truncated at 10 classes completed and 15 classes attempted; 37 students (fewer than 0.5% of all withdrawals) attempted more than 15 classes and are thus excluded from this chart.

		Classes Attempted														
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
lasses Completed	0	1694	964	362	229	87	36	16	11	6	3	2	4	0	1	0
	1	318	475	386	197	107	49	25	12	8	4	4	2	5	0	1
	2		202	285	226	139	93	36	26	13	5	7	3	3	3	4
	3			131	160	136	91	70	40	18	7	16	10	2	2	2
	4				70	100	55	59	33	22	14	8	9	4	6	0
	5					45	39	39	32	28	18	12	9	8	1	2
	6						15	17	20	25	22	13	11	2	3	0
	7							10	12	6	9	6	3	4	5	8
U	8								3	5	6	5	3	6	1	3
	9									5	7	5	4	2	4	0
	10										2	0	0	1	1	3

Heatmap: Classes Attempted vs. Classes Completed Classes Attempted

Figure 3. A heatmap of the number of classes attempted and completed with a score of at least a B at the time at which each student dropped out of the program.

The majority of students who drop out of the program do so very early. 22% do so after attempting only a single class, and an additional 13% after attempting two classes. 45% of students who drop out do so without earning a B or above in single class. 21% earn a B or above in one class prior to dropping out, and 14% earn a B or above in two classes prior to dropping out. Only 7% of dropouts reach or pass the halfway point (five classes completed) prior to leaving the program. A total of 16,999 students have completed at least two courses in the program, generally meeting the program's foundational requirement; of these, 84.5% either remain enrolled or have already graduated.

Turning to the relationship between courses completed and courses attempted, 10% of drop-outs did so after completing every course they attempted; for 3% this was a single course, for 2% two courses, and for 5% three or more courses. 36% of drop-outs had completed at least half the courses they attempted, mostly one course out of up to two (10%), two courses out of up to four (9%), or three courses out of up to six (7%); the remaining 64% attempted more than twice as many courses as they completed. Among those 7% of drop-outs who had reached the halfway point of the program, these students attempted an average of 1.6 times more classes than they had completed.

This analysis thus corroborates per-semester retention measured at the program level: nearly half of drop-outs never make any progress toward their degree, and 80% drop-out before completing more than a fifth of the degree requirements. Among those drop-outs that did make more significant progress, most were requiring several attempts to complete courses the courses.

5.4 Prevalence of Hiatuses

As described under the Program Context section, students are considered to have dropped out if they skip two or more consecutive semesters. When this occurs, students may still apply for readmission and resume their degree progress. This opportunity means that the drop-out numbers described above represent a "floor" on the total number of drop-outs: it is the maximum number of drop-outs, but the number may fall as some students return. We describe this as a "hiatus": a student is said to take a hiatus when they skip two or more consecutive semesters (and thus, would at one point have been considered dropped-out), but later return.

To complete our analysis of drop-outs, we examine the dataset for the prevalence of hiatuses. Because four semesters are required for a hiatus to occur (the initial enrollment semester, two semesters away, and the first reenrollment semester), only those students who began the program prior to Summer 2020 could have taken a hiatus—a student beginning in Fall 2020 would have to skip Spring 2021 and Summer 2021, returning in Fall 2021, which is beyond the end date of our dataset. Given this, a total 18,936 students could have taken a hiatus as of Summer 2021.

Our analysis found 1,309 students took a hiatus—that is, for 1,309 students, there is a multiple-semester gap in enrollment, indicating that had this analysis taken place during that gap, we would have considered them dropped out. This represents 7% of students who could have potentially skipped multiple semesters since matriculation. Of these 1,309, 41% are now actively enrolled, 22% have graduated, and 38% have dropped out again. For all students who matriculated during that time period, 30% have graduated, 31% are enrolled, and 39% have dropped out: this suggests the hiatus has delayed graduation but has not increased the chances of dropping out altogether.

Of the 1,309 students to have taken a hiatus, the large majority (94%) have taken only one; 6% have taken two, and fewer than 1%

(six students total) have taken three, for a total of 1,394 hiatuses. Figures 4 and 5 go into greater detail on the length and positioning of these hiatuses: Figure 4 shows the length of each hiatus, and Figure 5 shows at what point during a student's studies that required a hiatus. The large majority of hiatuses are short: of the 1,394 total hiatuses, 48% are only two semesters, the shortest hiatus possible. Only 32% are longer than a year. There is a small resurgence at a length of 11 semesters; this may be purely anomalous or it may be connected to the six-year limit on counting credits toward degree requirements.

Length of Hiatus in Semesters



Figure 4. Length of hiatus in number of semesters.



Figure 5. Semesters of enrollment when taking a hiatus.

Similar to overall drop-out percentages, a large fraction of hiatuses are also taken relatively early in a student's degree progress: 17% after only a single semester, 20% after two semesters, and 16% after three, meaning that 53% of all hiatuses occur after a year or less of enrollment.

Using these data, we may theoretically start to estimate future reenrollment rates for students identified as having dropped-out in recent matriculating classes. For example, 529 of the 1885 students who matriculated in Spring 2020 are presently identified as having dropped out, meaning that they dropped out after one, two, or three semesters of enrollment. 4% (741 out of 18,936) of all students who enrolled prior to that semester are observed to have taken a hiatus starting after one of their first three semesters, meaning that we might expect 4% of the current Spring 2020 drop-outs to reenroll. In practice, however, these numbers represent small fractions of total enrollment: such a reenrollment rate would amount to 21 returning students from the Spring 2020 matriculating class, a number likely to be dwarfed by future dropouts from that class. Thus, while the frequency, duration, and timing of hiatuses contribute to our overall understanding of retention, the possibility that students currently labeled as having dropped out might one day reenroll does not dramatically alter the overall numbers.

6 Course-Level Retention

As noted previously, when comparing a MOOC-based degree to both MOOCs and traditional degree programs, it becomes quickly evident that retention and completion hold different definitions in the different contexts. For degrees, we are most concerned with retention in the degree program as a whole: that a student drops a single class but still finishes a degree barely registers as a blip in a discussion of retention. For MOOCs, however, we mostly discuss completion of individual courses. It may thus be useful to examine retention and completion at the level of individual courses in the degree program as well.

It is worth noting that this comparison is still uneven: that we discuss completion rates in MOOCs rather than grades suggests that we somewhat passively assume that a MOOC can always be completed, and any failure to complete represents a deliberate decision by the student to cease progress. In the for-credit space, final grades affect our interpretation of completion: a withdrawal is obviously a failure to complete, and a letter grade of A or B is a successful completion, but what about C, D, and F? Even if D and F represent a failure to make degree progress, they are not necessarily analogous to a failure to complete a MOOC, as the student could have completed all coursework and simply failed to secure a satisfactory grade. This wrinkle will come up throughout these analyses, and there is no clear way to map completion rates in MOOCs to letter grades in for-credit courses.

That caveat aside, there are many ways we may analyze completion rates at the level of individual courses. For this work, we ask three questions:

RQ5: What is the overall course completion rate among courses in the program?

RQ6: How do course completion rates differ course-by-course?

RQ7: To what extent do students who withdraw from a course later reenroll in the same course?

6.1 Overall Course Completion Rate

To compute overall course completions, we excluded from the 149,808 total enrollments any enrollment that ended with a grade of I, S, U, V, or no grade as uninformative of completion status: an I grade represents an Incomplete which has not yet been resolved (due typically either to a personal emergency or an unresolved misconduct case), while S, U, V, and no grade come seminars, research credit, and other non-traditional course experiences. These five categories add to 420 total enrollments, 80% of which come from Incomplete grades. This brings the total number of enrollments in the dataset to 149,388.

Figure 6 represents the overall fraction of each remaining outcome: letter grades of A, B, C, D, or F, or withdrawals from the

class. Slightly over half of all enrollments end in a grade of A; of the remaining grades, withdrawals are the next largest fraction at 22%, followed by a grade of B at 19%. Cs, Ds, and Fs together add to 7%.

Depending on how we define course completion, this means that between 71% (B or above) and 76% (D or above) of students who enroll in a class complete the class; between 24% and 29% fail to do so, most by withdrawing from the class.

Fraction of Enrollments Ending in Each Letter Grade



Figure 6. Overall fraction of enrollments ending in each possible letter grade as well as W for course withdrawals.

6.2 Completion Rate by Course

To better understand these course completion ratios, however, we need to understand how they differ course-by-course: is it the case that courses in the program generally assign As to 52% of students, are dropped by 22%, etc.? Likely not, but what *are* the trends? To examine this question, we computed the grade distribution for every letter-grade class to appear in the dataset: this results in 66 total classes. For the sake of brevity we exclude any class taken by fewer than 100 students; this excludes 20 classes, 12 of which have been taken by fewer than 10 students.

The final list then contains 46 classes each taken by at least 100 students: they range from 158 students in the smallest to 10,611 in the largest. Figure 7 shows the grade distributions for each of these 46 classes, shown in ascending order of withdrawal rate. For anonymity, class names are replaced with numeric identifiers; the number in parentheses indicates the total enrollment in that class over time.

There is a wide distribution of withdrawal percentages, from a minimum of 5% for Course 01 to 40% for Course 46. There is a moderate negative correlation (R = -0.5279) between withdrawal fraction and the fraction of non-withdrawing students who receive an A. This correlation means classes with high withdrawal rates tend to also give lower grades overall, suggesting that some of these withdrawals may be "defensive" against a bad course grade.

There is, however, no correlation between withdrawal rate and course enrollment (R = -0.0171). We might have expected fewer enrollments in classes with high withdrawal rates as students avoid classes they will not succeed in anyway: however, is it also possible that high withdrawal rates drive more students to retake the class, inflating the course's enrollment numbers. To investigate this, we turn to the final element of our analysis, an examination of reenrollment in courses based on prior grades in the course.

All-Time Grade Distribution per Class



Figure 7. Per-course completion rates along with actual letter grade distributions, sorted by withdrawal rate.

6.3 Course Reenrollment Rate

The final question we ask is: to what extent do students who withdraw from a course later reenroll in the same course? This may influence our perception of course-level retention as we would likely interpret a student who withdraws and reattempts a course later differently from one never reattempts the course. We may ask similar questions about other letter grades as well: how often do students reattempt courses after earning grades of F, D, C, or B? Of course, as this dataset contains many students who have not yet completed their studies, it is unclear to what extent a student who has withdrawn may retake the course in the future: we would again likely interpret a student who does not reenroll in a particular class because they graduated or dropped out left the program altogether from one that did not reenroll but continued to take other courses.

To answer this question, we computed "enrollment strings" for every student and class enrollment in the program. An enrollment string is the sequence of grades a student earned in a single class: for example, if a student withdrew from a class twice, then earned an A, their enrollment string would be "WWA". This summarization does not capture the time between enrollments, but it shows the sequence of enrollments.

Through this analysis, we identified 172 unique enrollment strings covering 138,682 student-course enrollment histories; only 48 of these strings occur more than 10 times, and only 16 more than 100. Most are straightforward: the most common enrollment strings are simply "A", "B", "W", and "C", representing a single attempt at each course resulting in each grade. These four enrollment strings cover 91.5% of all student-course enrollment histories; adding in "F" raises this to 92.9%. More common than "F" however is "WA", representing a single withdrawal followed by a grade of A; this occurs for 1.6% of all student-course enrollment histories. Then, in order to account for whether the student may retake a class in the future, we break these enrollment strings down by the student's current status: graduated, enrolled, or dropped-out.

Because our focus here is withdrawals, we include in our subsequent analysis only those instances where a withdrawal is part of the enrollment string. There are 131 unique enrollment strings with at least one withdrawal covering 28,620 studentcourse enrollment histories; 101 of these unique enrollment strings occur fewer than 10 times, covering only 243 of the 28,620 studentcourse enrollment histories. For brevity, we include here only the 23 most common unique enrollment strings that together cover 99% of student-course enrollment histories. Table 1 shows these histories broken down by current student status.

Table 1. The 23 most common enrollment strings that include a withdrawal.

String	Graduated	Enrolled	Dropped	Total
W	3103	8441	9249	20793
WA	1135	985	159	2279
WW	195	838	732	1765
WB	808	653	172	1633
WWW	35	192	126	353
WC	69	155	80	304
WWB	105	93	15	213
WWA	102	84	13	199
WF	9	67	107	183
WD	6	42	46	94
WWWW	3	55	17	75
FW	5	22	42	69
CW	17	28	23	68
WWWA	26	14	3	43
WCB	29	3	2	34
WWC	10	19	5	34
DW	4	9	18	31
WWWB	13	17	1	31
wwwww	2	14	15	31
WCA	17	8	2	27
WWF	4	8	11	23
CWB	13	4	2	19
WWD	1	4	9	14
Total	5711	11755	10849	28315
Total (all strings)	5808	11885	10927	28620

Combining all enrollment strings with withdrawals, there are 28,620 student-course enrollment histories. 72.7% of these are

simply "W", indicating after withdrawal there is approximately a one-in-four chance that the student will reenroll in the same class. As expected, these numbers differ significantly based on student degree progress: among the 5,808 program graduates to have previously withdrawn from a course, 47.6% would later reattempt the course; among program drop-outs, only 15.6% would. Currently enrolled students are in between at 29.0%.

Looking specifically at the 7,827 student-course enrollment histories to include both a withdrawal and a reenrollment (that is, those students who reattempted a class from which they had previously withdrawn), 82.3% reattempt the class only once; 13.6% attempt the course three times; and the remaining 4.1% attempt the course four times or more.

The most common pattern is to earn an A on the second try: 29.1%–2,279 of the 7,827 reenrolling students—earn an A on their next attempt. 22.6% withdraw twice and do not reattempt the course a third time; 20.9% earn a B on their second attempt; and a combined 7.4% earn a C, D, or F on their second attempt and never reattempt the class. Students who reattempt are generally eventually successful: 33.4% of students who reattempt a course eventually receive an A and 25.7% eventually receive a B. 6.0% eventually receive a C, although many of these—20.9%, 98 out of 469—reattempt the course after earning a C, suggesting their goal was to score higher.

The likelihood of eventually earning a good grade decreases with added reattempts. Among students who attempt a class only twice, 35.5% receive an A and 25.5% receive a B. On the third attempt, 24.5% receive an A and 28.1% receive a B. With four or more attempts, 21.6% receive an A and 21.9% receive a B.

7 Discussion

The above analyses provide several lenses through which to look at retention in a MOOC-based degree program. In this section, we summarize these trends, discuss their positioning compared to other programs, and share some implications for program evaluation and course design that arise from these data.

7.1 Summary of Trends

There are two ways of investigating retention in a MOOCbased degree program. On the one hand, we may examine retention at the individual course level: what fraction of students who enroll in a course complete it? This is akin to MOOC-style retention. On the other hand, we may investigate retention at the program level: what fraction of students who enroll in the program as a whole complete the program? This is more akin to how retention is measured in degree programs, where a student withdrawing from a single class is largely inconsequential if they complete the degree as a whole.

At the program level, 84.5% of students who have met the program's foundational requirement (a B or above in two courses) either have graduated or remain enrolled; among all students who have matriculated, this percentage is 67.9%. Thus, most students who drop out do so early: 45% never completed a single class with a grade of B or above, and 64% failed to complete half of the courses they attempt. At the program level, it is generally the case

that students who succeed in the first couple semesters are highly likely to complete the program. This ratio puts the program on par with other online graduate programs despite the scalable structure [2].

At the course level, withdrawals are common: 22% of all student-course enrollments have ended with a withdrawal. Withdrawal rates differ wildly by course, from 5% to 40%, suggesting that the nature and difficulty of the course itself is a significant determinant of its withdraw rate. Similarly, classes with high withdrawal rates also see lower overall grades, suggesting that students may at times withdraw in order to prevent a bad grade. In a quarter of cases, students reattempt the class in a future semester, at which time most will get As. In some cases, students continue to try the same course over and over, semester after semester, though the likelihood of earning a good grade decreases as more attempts are made at the class.

7.2 Comparisons to MOOCs and Degrees

This analysis situates this MOOC-based degree between MOOCs and traditional degree programs, aiming to compare to both. However, two observations are apparent: one, defining these comparisons specifically is difficult, and two, regardless of how they might be defined, the differences are enormous.

First, comparing to MOOCs, do we compare at the course level or the program level? Most analysis on MOOC completion rates looks at the completion of individual courses, yet in the world of for-credit classes, we are usually more concerned with degree progress and program-level retention. Rates of withdrawal and failure are relevant, but usually in what implications they carry for students' overall likelihood of finishing the program. However, this difference is ultimately unimportant: regardless of what we choose to compare, retention and completion in this MOOC-based degree are far, far higher than MOOCs. Early analysis of MOOCs positioned their completion rates between 2% and 12% [20, 27, 36]; some more recent analyses find typical rates between 8% and 18% while some individual courses may reach far higher [39]; innovative interventions and more nuanced measurements of engagement may increase perceived success as well [6, 18, 39], but none as high as the retention and completion numbers observed here. It is thus clear that retention in this MOOC-based degree program far exceeds retention in MOOCs themselves. Some hypothesized explanations for this are: the incentive to complete the degree is greater in an accredited program than in an unaccredited MOOC; the admissions process filters out students who would not have succeeded either due to lack of readiness or due to lack of dedication necessary to complete the application process; and the higher tuition (relative to a MOOC) deters students from enrolling who lack the commitment to see the program through.

Comparing to for-credit on-campus programs—or at least this university's own on-campus program—is theoretically more straightforward, as both enrollment systems and accreditation are identical. The dataset under analysis here, however, covers only the online program, and we cannot perform an identical analysis. A straightforward comparison to publicly available data quickly reveals stark differences, though. From 2014 to 2021, 1,363 students matriculated to the on-campus program, and during the same time period, 1,500 degrees were awarded—a student may receive the degree without ever "matriculating" if they transfer campuses or change their major after initially matriculating in a different program. While this does not show the exact retention rate, it suggests it is likely very high.

We can similarly compare course-by-course: in the 2020-2021 academic year, 35 times a course was offered both online and oncampus in the same semester, 14 times by the same professor in each. In every case, the withdrawal rate online exceeded that of inperson. The average withdrawal rate of these on-campus sections is 5.7%, while the average for online sections is 14.4% (6.6% and 18.3% looking only at sections with the same instructor online and in-person). Program-level drop-outs and course-level withdrawals are thus both more common online than in-person.

7.3 Implications for Program Evaluation

Given our earlier discussion about the desirability of high retention rates, we may ask how these numbers should be interpreted in evaluating such programs. It is notable that the factors we hypothesize cause higher completion rates in this degree program than in MOOCs are, in some ways, the exact mirror of factors that may cause lower completion rates in this program than its in-person analogue. First, tuition is lower online: total degree cost is ~\$7500 for any online student, compared to \$21,000 for in-state and \$40,000 for out-of-state in-person students. In-person attendance also includes structural obstacles like the costs of relocation and the opportunity costs of eschewing or structuring work to fit the needs of a synchronous in-person program. These obstacles likely deter all but the most committed students from matriculating in-person; online, students who are less committed may enroll anyway.

Secondly, it is a feature of the online program that it has no capacity restrictions, and thus that anyone who meets minimum qualifications will be admitted. On-campus, scarce classroom capacities limit how many students may matriculate. So, in addition to only enrolling students who may overcome these obstacles, the on-campus program selects only the best fraction of applicants. The online program accepts 75.4% of its applicants, while the in-person program accepts 14.5%¹. Thus, the online program has many students who would not have enrolled on-campus, but who still meet the programs' admission criteria; limited capacity renders the minimum criteria moot for an on-campus program that takes the best ~15% of applicants. Girves & Wemmerus found that selectivity is the chief determinant of retention [15], and this shows how these new programs with no enrollment caps must alter our thoughts on retention.

The takeaway here is neither an attack on nor a defense of online programs' retention rates; instead, the context surrounding these programs (despite their equal accreditation) makes it nearly meaningless to compare their retention rates. This echoes another finding about the program: applications to the on-campus program have tripled since the online program launched [25], suggesting the two draw from different audiences, each of which comes with its own caveats.

7.4 Implications for Course Design

What explains higher per-course withdrawal rates online? We propose two models: our online students have more reasons to withdraw, and our online students have fewer reasons *not* to withdraw. Observations about MOOCs and online courses justify the former model: students feel isolated and have trouble finding support. Online students are also more likely to be working professionals juggling jobs and families [23]. However, online students also have fewer reasons *not* to withdraw: online courses are offered several times a year rather than once, the cost of retaking a class is lower, and students are in less of a rush to graduate. Online students performing poorly can retry the course quickly; on-campus students must wait a year, which may delay graduation or prevent them from reattempting at all.

This phenomenon carries implications for course design. While an in-person class may assume most of its enrollees are there for the first time, an online class must contend with a segment of its students returning after a prior attempt. If the class reuses assignments—a common tactic as large enrollment incentivizes investment into sophisticated, reusable tools and frameworks [26]—then it must have formal policies for what students may reuse. Classes that grade on a curve must understand that a segment of students reattempting the class have an advantage, driving the class average higher and unfairly penalizing first-time enrollees. Overall, these patterns force a course design model similar to MOOCs where we might expect students to be at different places in the material.

7.5 Future Work

This work has investigated patterns of withdrawal in individual classes and the program as a whole, but it has not investigated the reasons for such decisions. We are separately investigating to what extent unforeseen obstacles—such as health crises, family issues, local disasters, or workplace demands interfere with students' progress. Early findings suggest many students have had their progress delayed by some such issue, causing them to withdraw or take a hiatus.

In addition to those sorts of obstacles, future work may separate willful drop-outs from academic dismissals to predict what students are most likely to elect to reenroll. Future work may also quantify the reasons for withdrawals: do withdrawals reflect students' performance in a course so far, their satisfaction with the course experience, and other external factors? Finally, the conclusion of this study has been that a MOOC-based degree is difficult to compare to either MOOCs or to traditional degrees, although the shift to scale has seemingly not negatively affected retention compared to other online programs [2]. There are now many other MOOC-based programs, though: how much do these numbers vary across different programs?

 $^{^1}$ Though interestingly, the online yield is higher as well: 84.9% of accepted online students enroll, compared to only 55.7% of on-campus acceptances.

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