D.I.S.T.L.

PLAN

August 2022

UMD

UNIVERSITY OF MINNESOTA DULUTH

Driven to Discover℠

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EXECUTIVE SUMMARY

UMD is falling short of its mission for nearly one half of its student population. Low first and second year retention numbers and a paltry four year graduation rate [redacted]%) directly show a lack of commitment to half of its core values including learning, inclusiveness, sustainability, and integrity. UMD students boast some of the highest student-loan debt aided by a six-year graduation rate that is still several percentage points lower than its most direct competitor's four-year rate. This shortfall is exacerbated when we consider data for our students from BIPOC and Pell eligible student groups, all sporting four-year graduation equity gaps over [redacted]% with some groups as high as [redacted]%. New white and private high school graduates in Minnesota will begin to decline, but every other race/ethnicity subgroup is expected to grow. The status quo is unsustainable.

By tackling these issues we have the opportunity to meet the challenge and simultaneously help UMD realign with its core values. To be more sustainable, increase equity and generate a workforce that has the skills to help us solve the problems of the 21st century. This proposal is grounded in well-established research in Science, Technology, Engineering and Mathematics, (STEM) education that has proven to slow the lost potential that UMD experiences when students do not persist to graduation and abrogate achievement gaps for students from diverse backgrounds. UMD has engaged thus far in a shotgun approach. Disjoint efforts have made improvement in isolated sections but any gains typically stop there. Instead we are laying out the blueprint for a wholesale change that will compound many positive effects and be a force multiplier in terms of student retention. Upfront investments of under $2 million include support for an additional sixteen faculty and academic professionals. Costs are redeemed in 2-3 years, with an expected net gain of over $1.1 million after year three thanks solely to retained tuition revenue.

This proposal fundamentally connects many of the aspects of a student's experience in their first two years that are not working together. By housing together experts in curriculum, advising, research related to teaching and learning, and continually monitoring the data we break down the barriers preventing us from optimizing our full teaching potential. While the proposal is evidence based it also fulfills a more holistic mission to build a foundational experience for students that we believe will help them see the links between their core courses in STEM and feel a stronger connection to UMD. One that allows students not only to persist but thrive in an environment they know is built with their success in mind.

While the scholarships of teaching intensive faculty from a variety of departments form the basis of these proposed actions, please direct questions or comments to the principal author Aaron Shepanik (shepa107@d.umn.edu), and [redacted]).

INTRODUCTION

distill (/dəˈstil/)

verb: Extract the essential meaning or most important aspects of.

We live in a state with one of the greatest achievement gaps and have a duty to address this issue and be part of the solution.[1] We aspire to eliminate the gaps and improve success for all students. What we have created here is an initial plan to not only revitalize SCSE and UMD but also a proactive strategy to address the upcoming challenges facing higher education in the Midwest and specifically, the state of Minnesota. This full-scale plan is meant to be an outline of the infrastructure for the Duluth Institute of STEM Teaching and Learning (DISTL). While aspirational, everything here is grounded in research and data-driven. We envision this document like a recipe or blue-print. All the necessary pieces to come up with an acceptable finished product are here, but as with any blue-print, some details are modified in the construction process, and the finished project will be an accurate but varied depiction of the initial plan.

[1] Grunewald, R., & Nath, A. (2019, October 11). A statewide crisis: Minnesota's education achievement gaps. Retrieved August 18, 2022, from https://www.minneapolisfed.org/~/media/assets/pages/education-acheivement-gaps/achievement-gaps-mn-report.pdf?la=en

OVERVIEW OF UMD AND SCSE

A System and College Perspective

According to the Institutional Data and Research (IDR)[2] reports there were 42,212 undergraduate students enrolled in the U of M system in fall semester 2021, of which 72.8% were at the Twin Cities campus (UMTC) and 19.2% at the Duluth campus (UMD). The largest college at UMD in terms of enrollment numbers was the Swenson College of Science and Engineering (SCSE) with 2787 students. The College of Liberal Arts had 12,911 students enrolled making it the largest on the Twin Cities campus (the College of Science and Engineering (CSE) had 5,602).

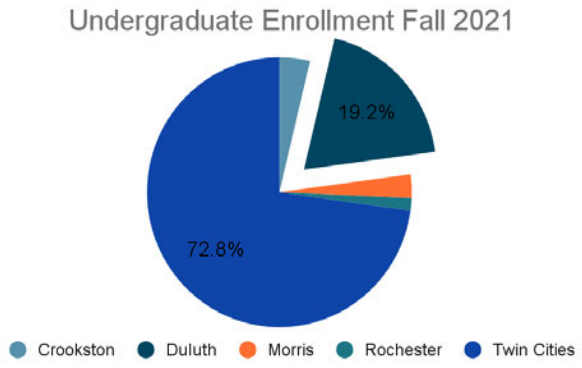

Figure 1: Undergrad Enrollment by Campus

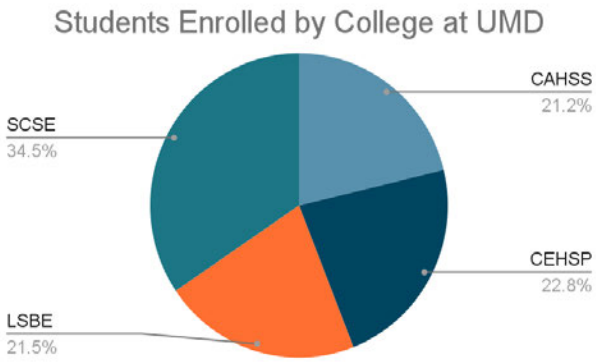

Figure 2: Undergrad Enrollment by College at UMD, Fall 21

An institution's 4-year graduation rate is still commonly used as a metric for evaluating programs since, to no one's surprise, most programs at a 4-year institution are intended to be completed in 4 years. The 4-year timeline also has implications for common funding/financial

[2] Data and Reports are available at idr.umn.edu

aid options for undergraduates. The good news is that at a system level the 4-year graduation rate has been steadily increasing, up to a new high of 66.8% for new freshmen starting in 2017. The Twin Cities campus is responsible for carrying this average with the highest rate within the system at 74.3%. This is great for the campus that is responsible for most of the enrollment, but it's not so great when the second largest campus, UMD, is underperforming with a 4-year graduation rate of just 50.9% for new freshmen in 2017. The sad part is that the 6-year graduation rate at UMD is just 71.5%, which is still less than the Twin Cities 4-year rate! Clearly, to say that students are just taking longer to graduate at UMD is false. Students are leaving UMD before they graduate. Stark evidence of this is provided by looking at the most recent one and two year retention statistics for new freshmen, shown below.

	1 Year Retention	2 Year Retention	4 Year Graduation Rate
SCSE	80.50%	80.10%	52.50%
CSE	94.00%	91.90%	76.40%
UMD	81.50%	76.90%	50.90%
UMTC	91.70%	89.50%	74.30%
System	**88.60%**	**85.00%**	**66.80%**

With numbers like these—if you were a science student, why would you ever choose SCSE over the twin cities' College of Science and Engineering? There is almost a 50% better chance you graduate in 4-years if you go to CSE versus SCSE. This begs the question "Why UMD?" and more specifically why UMD instead of UMTC? This is a comparison worth making; the Twin Cities campus is hands-down Duluth's biggest competitor, enrolling more UMD-admitted students than the combined total of our next six biggest competitors.[3] For fall 2021, 41% of new high school applicants admitted to UMD were also admitted to UMTC, of which UMD only secured 11%.

So why UMD? UMTC must be really expensive, right? Bigger, better, and higher quality things usually do cost more. Sadly, Twin Cities Undergraduate Resident Tuition was $13,520 for the 21-22 academic year, and the Duluth Undergraduate Resident Tuition was $12,376, a difference of just $1,144.

[3] UMD SEM Plan 2022-2026, January 2022

You can save about 8% in tuition at UMD vs. UMTC if you want your chances of graduating on time to be about a coin-flip.

It's worth considering that paying higher tuition to attend UMD is justified if it was one of the best in its own category, that is, among other campuses more similar to UMD outside of the U of M system. When compared to other peer institutions, however, UMD is not outperforming its peers. Quite frankly, it's mediocre at best. Figure 3 below shows UMD in red compared to 11 other peer institutions used by IDR. Bringing UMD's numbers closer to 70% would be a meaningful improvement while being completely reasonable based on its peers (note this plot is showing 6-year graduation rates).

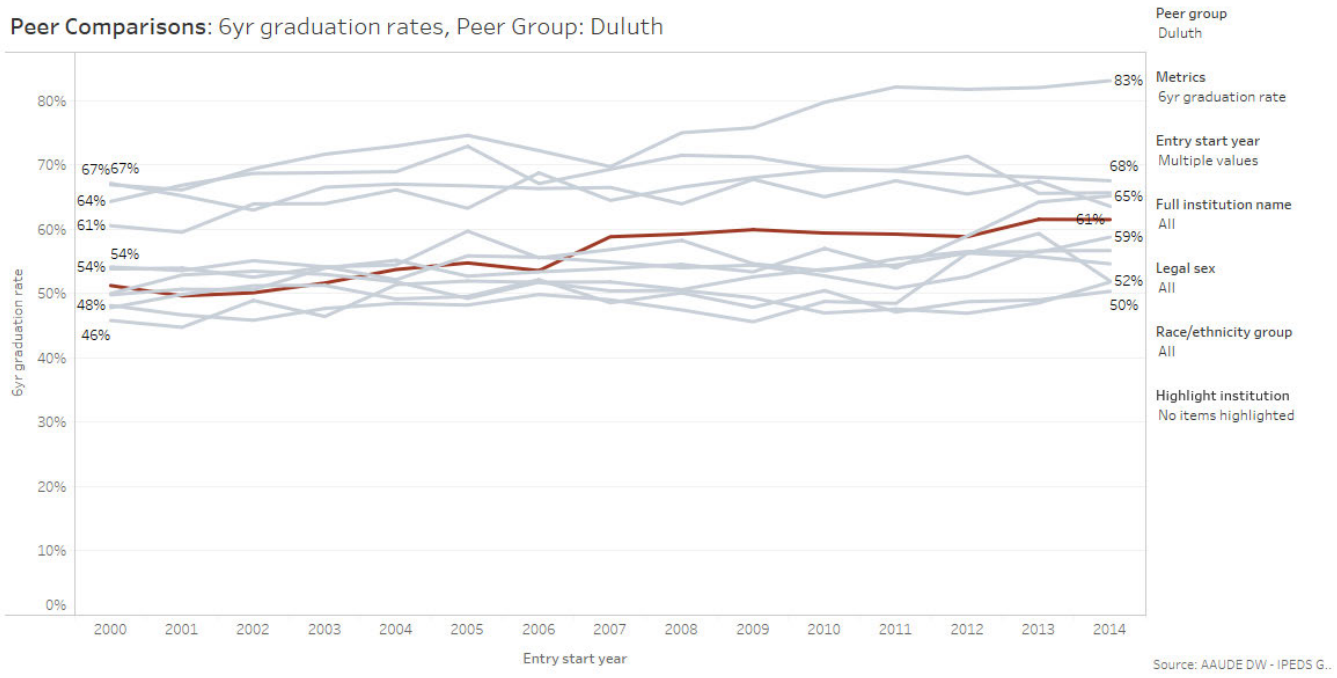

Figure 3: Peer Group Comparison 6-Year Graduation Rates

SCSE: The Area of Opportunity

The silver lining is SCSE is a college of opportunity. Clearly, retention and graduation numbers are nowhere near a maximum. In fact, this is not an isolated occurrence and is a national concern. On September 28th, 2021, the President's Council of Advisors on Science and Technology held a meeting on "STRENGTHENING U.S. SCIENCE & TECHNOLOGY GLOBAL LEADERSHIP FOR THE 21ST CENTURY" where it was stated that "the United States is losing ground with regard to the education of its citizens: In 2000, the United States

generated twice as many STEM graduates as did China; in 2007, the two countries were about even; and now China generates twice as many STEM graduates as the United States."[4]

We can and need to do a lot better. And it is possible as evidenced by the UMTC persistence and 4-year graduation rates. The current Strategic Enrollment Management (SEM) plan for UMD wants to increase first year retention, maintain graduation rates, develop a consistent brand promise, and (among other things) grow undergraduate enrollment seven percent by fall 2026. It also acknowledges that "significant opportunities remain to refine UMD's brand-identity, to further evidence our strong commitment to student access, success, and timely progress to degree completion, and to remove roadblocks within student processes and progress." If UMD wants a real chance at achieving any of these goals then SCSE must be a part of the solution.

Other facets of this campus may be wounding UMD as well, but a remedy is available now to heal SCSE. An abundance of research in STEM education outlines already proven strategies. What's now needed is to reduce and eliminate barriers that prevent us from implementing and propagating these strategies at UMD.

[4] https://www.whitehouse.gov/wp-content/uploads/2021/12/PCAST_Minutes_9-28-29-2021_FINAL.pdf

DULUTH INSTITUTE OF STEM TEACHING AND LEARNING

Description

We propose the creation of the Duluth Institute of STEM (Science Technology Engineering and Mathematics) Teaching and Learning (DISTL) housed in the Swensen College of Science and Engineering (SCSE) on the Duluth campus of the University of Minnesota (UMD). The Institute will create and manage:

- **an SCSE GTA/LA program (tutoring),**
- **a foundations of learning program and bridge courses,**
- **a restructured core advising center (academics and mental-health),**
- **first-year research experiences, and**
- **share, research, and promote scholarship of teaching and learning.**

Figure 4: The Six Pillars of DISTL

This, accompanied with course coordination, constitutes the six pillars of DISTL. These six aspects of DISTL work not individually but together to break down barriers of student success

and narrow the achievement gap[5]. It is the joint nature of this effort that leads to a resilient and sustainable design of STEM education. One that can adapt fluidly, one that can actually learn from itself, and one that can continually improve. Without this comprehensive approach, improvements and developments in any one of the six pillars remain isolated. Unnecessary barriers, large or small, remain in the way. Knocking down these barriers and weaving together the job of educating STEM students across disciplines and between academic professionals are necessary steps for higher education to reach its full potential. Due to the projected demographic changes, the fact that known strategies exist that improve outcomes for all students while creating a more equitable playing field for BIPOC students is critically important.

We've already acknowledged as a campus (in the current SEM plan) that student success best practices are implemented at varying, inconsistent levels as resources dictate, and that students would further benefit from a more cohesive plan and strategic investment in areas that prioritize strategies that are core to the UMD undergraduate experience. DISTL is the embodiment of that type of strategic investment. None of the individual pillars are that novel in and of itself. Aspects of DISTL and smaller versions of "STEM Centers" are in use or being tested across the country[6], but nothing appears to be as full-scale as this.

Part of the comprehensive approach of DISTL is its organizational structure. Much like how the success of individual departments or programs within SCSE rely on the success of their counterparts, all facets of DISTL should be in harmony to abrogate learning barriers. As such, a "top-down" approach like a typical chair and vice-chair (as is typical in most departments) will be avoided. DISTL will be governed by a board of fellows with one or, in some cases, several fellows from each of the six pillars outlined above. Most of the costs of DISTL will be the human resources used to fulfill these roles. These increased costs are easily recovered by mitigating tuition loss from current unsustainable student retention rates (see *Table 5: Expected Return on Investment*). What follows are brief descriptions of each of the pillars that also outline the creation of the necessary fellow positions.

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[5] Active learning narrows achievement gaps for underrepresented students in undergraduate science, technology, engineering, and math. https://doi.org/10.1073/pnas.1916903117

[6] A comprehensive Model for Improving the Success of STEM Majors through the STEM Center. Sam Houston State University. Abstract retrieved May 2022. https://www.nsf.gov/awardsearch/showAward?AWD_ID=1725674&HistoricalAwards=false

Pillars One and Two: Course Coordination and CUREs

A major aspect of DISTL is breaking down barriers between departments, allowing coordination across core courses to increase academic success. The lowest level typically considered a success is when a student earns a C- grade; a D grade, a Fail (F), and withdrawing from a course (W) are often pooled together (DFW) quantifying a lack of success. It is already well understood that "Academic success in the first year, as measured by first-term and first-year grade point averages, is associated with persistence and graduation. Gateway course DFW rates can guide opportunities to consider alternative learning formats, reduced class sizes, or supplemental learning interventions to intentionally support early academic success."[7] Among a myriad of majors in STEM are common courses that students in the college matriculate through prior to entering their major courses. Based on the DFW analysis conducted (see *SCSE DFW Analysis*) we've identified 15 individual courses across 5 departments. These 15 courses are taken mostly by first and second year students and make up almost [redacted]% of the DWFs for 3000-level courses and lower. DISTL will award a "fellowship" for each of these core areas. These fellows will be responsible for coordinating course design across the different disciplines that align with best practices and disseminating these courses to faculty across their respective departments to aid in successfully teaching multiple sections.

This mapping will facilitate the implementation of Course based Undergraduate Research Experiences (CUREs) that cut across different courses. A simple example is learning basic Python commands in Computer Science, collecting data in a lab course like Chemistry, and applying statistical methods from Statistics to analyze the data in Python. These early hands-on experiences for undergraduate students allow them to develop self-confidence and see the big-picture of doing science. This, in conjunction with other interventions, have been shown to increase retention in STEM education.[8]

[7] UMD SEM Plan 2022-2026, January 2022

[8] Journal of STEM Education. Volume 16, Number 2, Jul 17, 2015 ISSN 1557-5284 Publisher: Laboratory for Innovative Technology in Engineering Education (LITEE)

Pillar Three: Advising

An often undervalued, yet critically important aspect of retaining students and promoting healthy learning is advising. It was reported in 2020 that young adults aged 18-25 had the highest prevalence (30.6%) of a diagnosed mental, behavioral, or emotional disorder of any age group.[9] In 2021, more than [redacted] of surveyed UMD students reported that they were unable to manage their stress level.[10] Unfortunately, in many cases, advisor roles come in many different flavors from academic advising (which courses to take and when) to mental health advising or counseling. These are usually very disconnected in both a functional sense (academic advisors are often not trained to deal with issues outside the scope of academic/professional questions) and in a literal physical sense (mental health counseling is usually isolated on campuses within their medical clinics and possibly even off-campus all together). This disconnect is present at UMD, and DISTL will recognize and aim to remove these barriers as mental health and learning cannot be treated as separate issues anymore.

Coordination across academic advising will also run in parallel to that of the course coordination. Advisors for entry level students will benefit from being well versed in core course offerings. Instructors will absorb feedback from advisors about common challenges students are facing. This feedback mechanism would allow nimble mid-semester interventions as needed. DISTL will award one fellowship each for academic advising and mental-health management.

Pillar Four: Scholarship of Teaching and Learning

The Institute will be the hub for scholarship of teaching and learning for the UMD campus including research and dissemination of knowledge. Despite teaching one-sixth of all student credit hours in the whole University of Minnesota system, none of the twenty plus Center for Educational Innovation (CEI) professionals are housed at the Duluth campus. The lack of any permanent physical CEI presence is an egregious oversight. Given the current existence of CEI, but the disconnected nature of its location, simply adding a point person on site will be a

[9] National Institute of Mental Health. (2020). Prevalence of Any Mental Illness. Retrieved August 2022 at https://www.nimh.nih.gov/health/statistics/mental-illness.

[10] UMNTC Boynton Health Service *College Student Health Survey* administered 2021

"plug and play" solution leveling up the teaching knowledge and skills of the faculty as a whole. A member of the University's Center for Educational Innovation will be housed on campus, full-time, and be a fellow of the Institute. Furthermore, this enables a true home for seminars and colloquia about the scholarship of teaching, a place to gather, track, and report on data about these teaching efforts, and a place to champion the task of evaluating faculty's teaching. Course fellows will be required to give a teaching seminar as part of their duties.

Pillar Five: Bridge Programs

Summer Bridge programs are implemented at various universities across the U.S. as a way of allowing students to get a jump-start on their academic career. A Bridge program can serve two purposes, allowing students to refresh their core STEM skills and to build confidence in their ability to see themselves succeed at the university level (this has been shown to have a larger impact on first generation students[11]). Currently UMD has a small summer Bridge program with an online and an in person (summer camp) component that has shown a net positive impact on first generation students. We envision housing this program in DISTL and connecting the program to the other components discussed above, specifically advising incoming students and retention. Earlier intervention for students that need more remediation in core content areas (foundational courses) could be recognized at this time thus ensuring students are better placed in the course that meets their readiness level. Having a strong relationship with these foundational courses (Algebra for example) would be mission critical to increasing outcomes for the overall program and student retention. Data collected from these would help the Institute target students at a higher risk of dropping out and improve our ability to test and apply interventions that reduce the risk of losing students. The institute will award one fellowship for the summer Bridge coordinator.

Pillar Six: GTA/LA Experiences

Graduate teaching assistant (GTA) experiences vary widely across departments with varied levels of onboarding and training left to individual departments. There are also a smaller number of departments currently utilizing undergraduate learning assistants (LAs) to assist with large enrollment courses. We propose that DISTL will be a natural home for ongoing GTA

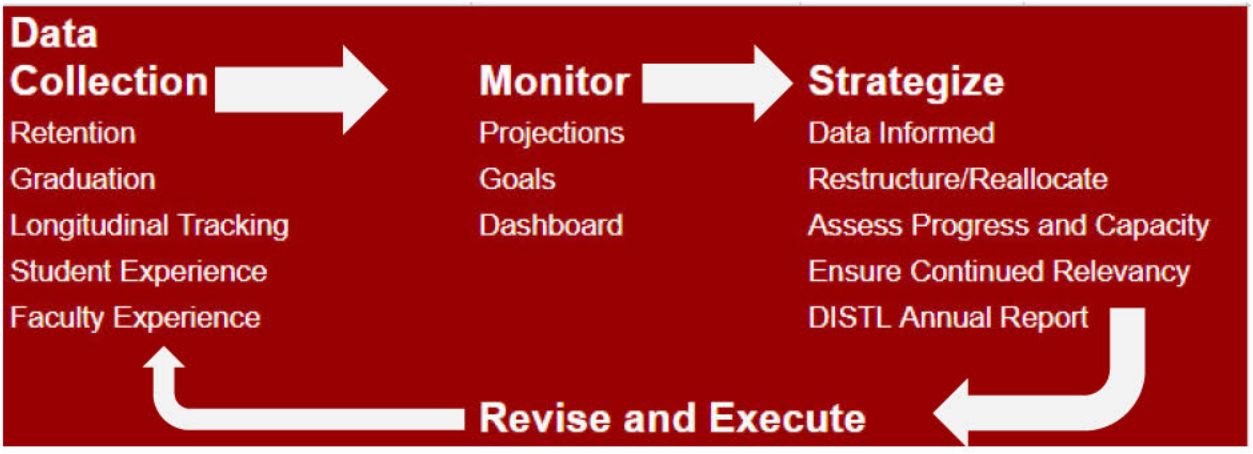
[11]Journal of STEM Education. Volume 16, Number 2, Jul 17, 2015 ISSN 1557-5284 Publisher: Laboratory for Innovative Technology in Engineering Education (LITEE)

and LA training, supervision, performance evaluation, and teaching interventions across all departments. DISTL faculty can provide general training and supervision for assistants in all disciplines as well as having discipline specific expertise for assistants within the content areas. Exposing the assistants in the DISTL culture of cross discipline STEM education will have positive impacts on the student experience. The GTA/LA training and coordination fellow will have involvement with staffing and organizing tutoring, resulting in a multi-faceted fellowship.

Summary

The primary goal of the institute will be to coordinate teaching and learning not just within, but across STEM disciplines. We recognize that individual faculty in each department are incorporating high impact practices as best they can; we also have come to the conclusion that best instructional practices for a typical first year chemistry, biology or mathematics course have more in common with each other than the disciplines necessarily do individually. Students also face challenges that cut across individual courses as they transition into their undergraduate STEM career that can be best handled with a comprehensive approach managed by the Institute. While a major and direct focus of the Institute will be implementing proven high impact practices this is not the sole function. A more robust and comprehensive structure will be used to promote a successful transition into college, increase academic readiness, persistence, social integration and remove historical barriers to student success from marginalized communities. The collaborative nature of the institute, by design, will generate a climate that promotes resilience and sustainability by maximizing student success in STEM education.

Monthly fellow meetings along with a larger annual gathering and report will help maintain collaboration and continued progress. The figure below depicts the management plan to ensure a resilient and sustainable STEM education center.



STRATEGY, COSTS, AND ROI

An important aspect is to strategically identify courses that are common points of attrition. These are the places where coordination and innovation can most align with the mission of the Institute. Based on experience, many experts will have the same opinion on which courses fit this description. For example, it's relatively reasonable to assume almost any SCSE major has to filter through Calculus 2 and Computer Science 1. But in order to provide a reliable estimate of a return on investment, we need to know what kind of teaching power we need, and we won't know that until we decide exactly which courses we should be looking at. What follows is a data driven approach to investigate and answer what courses the Institute should consider focusing on.

SCSE DFW Analysis

The following is based on data from the most recent six semesters, beginning with fall 2019 up through spring 2022. These last three years encompass information that is pre, peak, and post-pandemic. Special instructional sessions like May or summer classes are not included in this data. Further, since our focus is on early interventions in gateway courses we restrict to 3000-level and lower number courses across SCSE.

Q1: How is enrollment spread in SCSE? What areas are showing the highest DFW numbers?

There were [redacted] enrolled seats in total, with the majority being in Chemistry (~[redacted]%), Math (~[redacted]%), Biology (~[redacted]%) and Physics (~[redacted]%). Unfortunately, the number of seats enrolled is trending downward, beginning with [redacted] in fall of 2019 followed by [redacted], and [redacted] in spring 2022.

There were a total of [redacted] DFWs, for an overall proportion of about [redacted]%. Even with the pandemic, this is relatively consistent across the last 6 semesters, with rates of [redacted]% in fall 2019 followed

Subject	SUM of Enrollee#	SUM of DFW#
Aerospace Studies Total	[redacted]	[redacted]
Astronomy Total	[redacted]	[redacted]
Biology Total	[redacted]	[redacted]
Chemical Engineering Total	[redacted]	[redacted]
Chemistry Total	[redacted]	[redacted]
Civil Engineering Total	[redacted]	[redacted]
Computer Science Total	[redacted]	[redacted]
Electrical Engineering Total	[redacted]	[redacted]
Engineering Total	[redacted]	[redacted]
Environmental Science Total	[redacted]	[redacted]
Geology Total	[redacted]	[redacted]
Industrial Engineering Total	[redacted]	[redacted]
Mathematics Total	[redacted]	[redacted]
Mechanical Engineering Total	[redacted]	[redacted]
Physics Total	[redacted]	[redacted]
Statistics Total	[redacted]	[redacted]
Grand Total	[redacted]	[redacted]

Table 1: Data for fall 2019 to spring 2022

by [redacted]% in spring 2022. However, Math, Chemistry, Biology, Computer Science, and Physics make up [redacted]%, and [redacted]%, relatively speaking, or [redacted] of all the DFW's for this time period (the next highest subject is Statistics at [redacted]%). These numbers along with the other subjects are shown in Table 1.

Q2: What subjects have a high number of first and second year students? Are these the same subjects with high DFW numbers?

Not surprisingly, the short answer is "Yes." As stated above, Chemistry, Math, Biology, and Physics are the most widely taken subjects overall, and these, along with Computer Science have the highest DFW numbers as well. It turns out that in all of these subjects more than [redacted] of the enrollment in 3XXX level and lower courses are first and second year students.

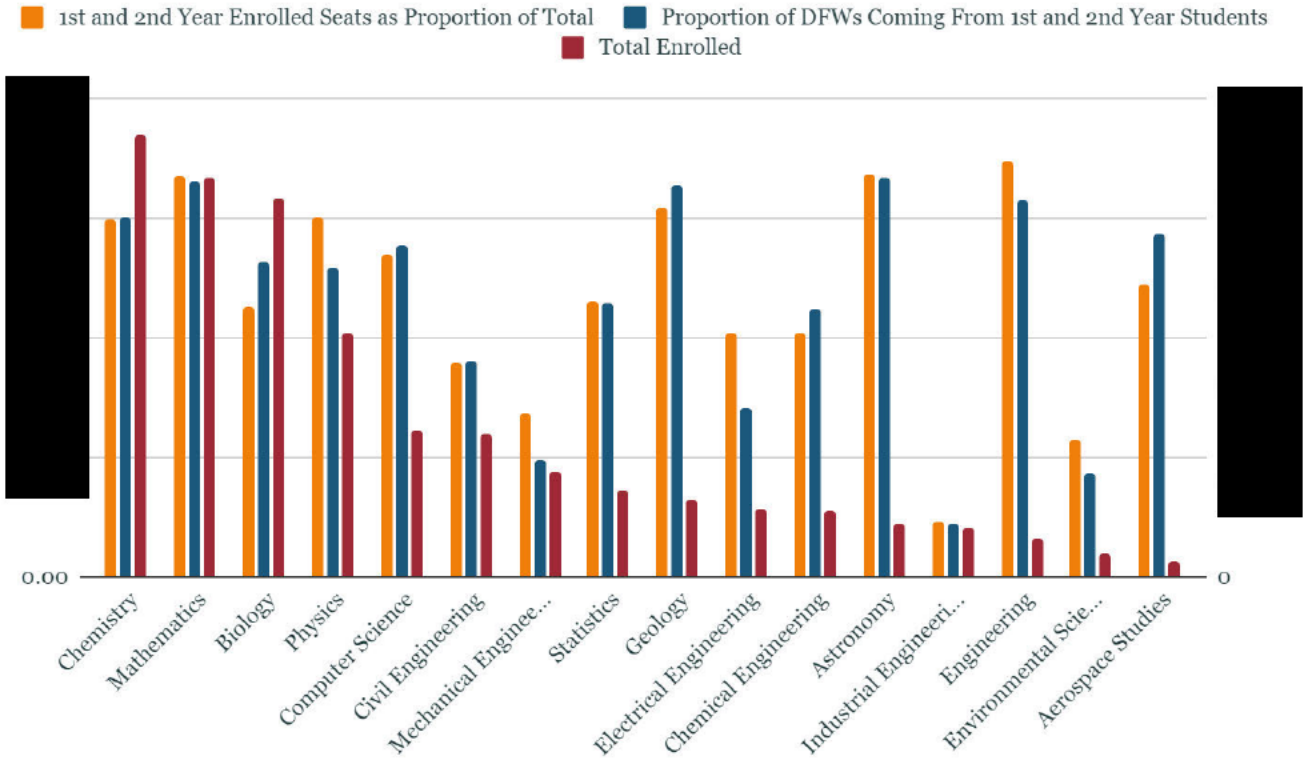


Figure 5: First and Second Year Proportions of Totals from fall 2019 to spring 2022

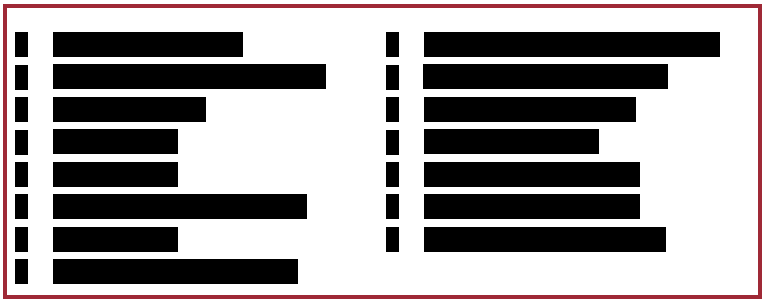
Above we see the total enrolled corresponds to the vertical axis on the right. Of the total number, the proportion of first and second year students in the subject is given as well as the proportion of total DFWs that came from those first and second year students. In most cases with larger enrollments, the two proportions are quite similar. This seems somewhat expected. Take Chemistry, for example. About [redacted]% of the enrollment is first and second year students

and they account for about [redacted]% of the DFWs as well. Based on the overall enrollment, DFWs, and proportion of first and second year students, we need to intervene in the following areas:

- Math (and possibly Statistics since they are the same department)
- Chemistry
- Biology
- Physics
- Computer Science

Q3: What are the specific courses in SCSE that we can improve the most?

We consider the following 15 courses as those with the most opportunity.



These courses were selected as they all have a large proportion of first and second year students, a large overall enrollment, and they top out DFW numbers within their department (Table 2). The "Select 15" courses account for about [redacted]% of the total enrolled seats in 3000-level courses and lower in SCSE for the last 6 semesters but also almost [redacted]% of the total DFWs (~[redacted]%). A more detailed breakdown of all the courses and each department can be found in the appendix (***DFW Analysis in Select Departments***). A reasonable achievement would be to have the two proportions similar; that is, DFWs spread out evenly across the courses.

With a current DFW rate of about [redacted]%, SCSE's 4-year graduation rate is at about 52.5%. Certainly the relationship between DFWs and 4-year graduation rates isn't quite as simple as this, but for arguments sake, let's assume this relationship holds. Then, improving the DFWs in the "Select 15" to be proportionate with their enrollment (from [redacted]% to [redacted]%) reduces the total [redacted] (shown in Table 1) down to [redacted]. This is about a [redacted]% reduction. A [redacted]% reduction in students not graduating in 4-years would bring SCSE's 4-year rate up to [redacted]%. Since SCSE accounts for about [redacted]% of the enrollment at UMD, then in a similar fashion this would improve UMDs 4-year rate from [redacted]% to a projected [redacted]%. A second goal of looking for a [redacted]% DFW rate in the "Select 15" would improve SCSE's 4-year rate to [redacted]% and UMD's up to a projected [redacted]%. These, along with the retention rates, are shown in Table 3 below. With focus, effort, coordination, funding and support, experts in these subject areas agree the above goals, if not better, are certainly feasible. In fact, there's no reason not to aim to make these courses our

most successful courses for our incoming students. Why not try to have 95% of students passing General Chemistry 1 on their first try?

Table 2

Subject	*Course Name*	SUM of Total Enrollment All Students	SUM of Total DFW All students
Biol	[redacted]	[redacted]	[redacted]
Biol Total			
Chem	[redacted]		
Chem Total			
CS	[redacted]		
CS Total			
Math	[redacted]		
Math Total			
Phys	[redacted]		
Phys Total			
Grand Total			

Table 3

	1 Year Retention	2 Year Retention	4 Year Graduation Rate
UMD	81.50%	76.90%	50.90%
UMD After Goal 1	82.60%	78.00%	54.00%
UMD After Goal 2	84.00%	79.00%	56.00%

Necessary Human Resources

DISTL					
Course Coordination	**1st Year Research Experience**	**Foundations of Learning and Bridge**	**Core Advising**	**GTA & LA/ Tutoring**	**Scholarship of Teaching & Learning**
Coordinators					
Bio, Chem, CS, Math (x3) Phys, Chem at 33% time each[12]		Bridge	Academic Advising Mental Health	Training and Tutoring	CEI
FTE					
2.33		**1**	**2**	**1**	**1**
+ 1 Executive Administrator					

In order to implement high-impact practices and improve the student experience, existing class sizes and the number of sections offered need to change. In almost all cases, this is a reduction in class size and an increase in the number of sections, requiring additional teaching power. Where possible, existing faculty with experience focusing on increasing student success were consulted for discipline specific norms on appropriate class sizes, etc. Table 4 summarizes additional estimates needed to offer the "Select 15" courses in settings that promote the use of these strategies. A more detailed table with a breakdown by course is in the appendix (*Estimating Additional Teaching Power Tables*).

Based on these estimates, a total of about 16 additional full time faculty/professionals are needed.

[12] FTE estimates are assuming a 90/10 teaching/service workload

Return on Investment

Table 4: Summary of additional instructional power needed as a result of Coordinator workload and decreased class sizes

Department	Current Estimated Instructional Power Used (in FTE's)	Additional Instructional Power Needed
Biology	[redacted]	1.50
Chemistry		2.3
Math		2.5856
Stat		0
CS		1
Physics		0.333
Total		7.72

The most likely results are shown in Table 5, with both more and less optimistic tables shown in the appendix (*Return on Investment Scenarios*). Considering several different cases, a break-even point is estimated to occur around years 2-3, even with pessimistic outcomes. Naturally, several assumptions need to be made in order to come up with such projections. Because of this, conservative numbers were used where possible. For example, we used a static, recent, and modest net tuition per student value for all years, but we assumed a 3% annual increase on human resource costs. Estimated new initial enrollment is also conservative and remains below the projected 7% increase over the next 5 years as planned in the SEM.

Fiscal Year 0 (FY0) would indicate the initial year of operation. We are ignoring any potential new enrollment bumps that may occur at start-up. Thus, the initial year is all up front cost but comparative gains are realized quickly in following years. It's worth noting initial up-front costs possibly associated with equipment or facilities are left blank at this time.

The mathematical and financial assumptions were used to try to develop a data-driven, quantifiable, justifiable, and a realistic return-on-investment. The resulting ratios, proportions, and ensuing calculations end up being much more complicated than assuming a simple "84%" retention rate, for example (although you'll find 1-year retention rates are expected to be near 84% and 2-year rates near 78% across the plan—which is actually all still significantly lower than system averages!).

As a sanity check, let's just consider the number of additional students we're expecting to retain after the first and second iterations. In FY1 we expect to realize an increase of 86 students that make it to the second year. In other words, we need the 16 additional faculty/professionals to be responsible for retaining just an additional 5-6 students each. In the following year we expect to realize gains from students that make it to year three finally (81

more compared to pre-strategy), as well an additional projected 120 second year students, or about 12.5 students for each of the 16 additional hires.

Sanity check passed ✓.

Table 5: Expected Return on Investment

Initiative: DISTL

Expected Outlook (Estimated Most Likely)		Plan Year				
VARIABLES/STRATEGIES	Pre-Strat	FY0	FY1	FY2	FY3	FY4
Enrollment (Undergraduate Freshman)	2649	2649	2,689	2,728	2,768	2,808
Persisted to 2nd year /Soph	2183	2183	2269	2303	2337	2371
Persisted to 3rd year/Juniors	2058	2058	2058	2139	2170	2202
Persisted to 4th year/Seniors	2000	2000	2000	2000	2079	2109
Total Enrollment	6241	6241	6327	6442	6586	6682
SEM Initiative Costs						
Instruction # FTE (faculty FTE: salary+fringe+3% annual)	16	$ 1,227,120	$ 1,263,934	$ 1,301,852	$ 1,340,907	$ 1,381,134
Equipment/space - one-time investment		$ -	$ -	$ -	$ -	$ -
Total Costs		$ 1,227,120	$ 1,263,934	$ 1,301,852	$ 1,340,907	$ 1,381,134
RETURN ON INVESTMENT ANALYSIS						
est. FY21 Net Tuition Revenue per resident UGD	$ 12,000	$ 12,000	$ 12,000	$ 12,000	$ 12,000	$ 12,000
Pre-Strategy Tuition Revenue	$ 74,896,512	$ 74,896,512	$ 74,896,512	$ 74,896,512	$ 74,896,512	$ 74,896,512
Post-Strategy Tuition Revenue		$ 74,896,512	$ 75,928,512	$ 77,305,752	$ 79,033,685	$ 80,187,166
Post-Strategy Tuition Revenue Gain (loss)		$ -	$ 1,032,000	$ 2,409,240	$ 4,137,173	$ 5,290,654
Less Total SEM Costs		$ 1,227,120	$ 1,263,934	$ 1,301,852	$ 1,340,907	$ 1,381,134
Net New Revenue Gain (loss)		$ (1,227,120)	$ (231,934)	$ 1,107,388	$ 2,796,266	$ 3,909,520

Model assump ion: DFW rate is reduced in Select Courses to [redacted] college wide, as discussed in Goal 1 of DFW Analysis.

Model assump ion: lost enrollment is a Poisson process; based on last two years of data it is most likely we lose [redacted] student for every [redacted] DFWs, and in two years we lose [redacted] student for every [redacted] DFWs total.

Over the last 2 years, SCSE averages [redacted] lost student for every [redacted] DFWS---this is used for Pre-Strat persistence to 2nd year. Model start (pre-strat) based on average of Fall 21/Spring 22 Enrollments.

Based on he most recent 2-year college retention rate, SCSE los [redacted] total student to every [redacted] DFWs----this is used for Pre-Strat persistence to 3rd year

Assumed 2.8% attrition based on historic 3-year retention data for persistence to 3rd year.

Average SCSE annual 9-month instructor (9404) salary [redacted] (Reporting Center Job Code Average Salary report 2018) used for all 16 positions.

Estimated Net Tui ion Revenue - equals gross tuition revenue minus expected ins itutional financial aid, scholarship, and waiver expenditures.

Anticipated o her revenue, e g. course fees, collegiate fee, auxiliary services, etc., not included.

Based on the model assumptions, we expect to lose about 380 students in the first year and 550 total over the first two years. An optimistic outlook (25% chance) we lose less than 368 and 537 students in the first and second years, and a weak outlook (90% chance) we lose less than 406 and 583 students, respectively. These losses are scaled linearly (1.5%) in subsequent years to coincide with projected enrollment increases from the SEM plan.

CALL TO ACTION

We live in a state with one of the greatest achievement gaps and have a duty to address this issue and be part of the solution. New white and private high school graduates in Minnesota will begin to decline, but every other race/ethnicity subgroup is expected to grow. An unacceptable four year graduation rate of (50.9%) directly contributes to the problem and shows a lack of commitment to half of UMD's core values including learning, inclusiveness, sustainability, and integrity. Now is the time to act.

If we do so, we can position ourselves to have a reliable and sustainable future. We estimate the return on investment will break-even after just a few years, at which point, we can reinvest resources to manage upcoming demographic concerns.

The comprehensive structure of DISTL can reposition not just SCSE but all of UMD on the regional and national map. Duluth can be the home and leading STEM center across the country. National attention and a fresh branding opportunity are just beneficial byproducts of such an endeavor.

But most importantly, this is finally a real, actionable answer, to "Why UMD?"

APPENDIX

DFW Analysis in Select Departments

MATH:

[redacted]

ENROLLMENT ANALYSIS	Sum of 1st and 2nd Year as a % of total	Total Enrollment All Students
College Algebra		
Precalc Analysis		
Finite, Intro Calculus		
Calculus I		
Math for Elementary Ed II		
Math for Elementary Ed I		
Calculus II		
Calculus for Natural Sciences		
Differential Equations		
Introduction to Game Theory		
Intro Contemporary Mathematics		
Calculus III		

Foundations Math, Geometry		[redacted]
Vectors and Matrices		
Discrete Math		
Algebra Review		
Numerical Methods		
Theory of Interest		

DFW Analysis	Sum of 1st and 2nd Year's DFW as a % of Total DFW in Course	Total DFW All students	As a % of Total DFW in Department	Ratio of DFW # over Enrollment # In Course
Calculus I		[redacted]		
Precalc Analysis				
College Algebra				
Calculus II				
Finite, Intro Calculus				
Differential Equations				
Calculus III				
Discrete Math				
Calculus for Natural Sciences				
Vectors and Matrices				
Math for Elementary Ed I				
Algebra Review				
Numerical Methods				
Theory of Interest				

Intro Contemporary Mathematics				
Math for Elementary Ed II				
Introduction to Game Theory				
Foundations Math, Geometry				

[redacted]

CHEMISTRY:

In Chemistry we have a pretty clear winner—or loser, depending on your perspective. In fact, if you're one of the few whose hobbies fall in the intersection on the Venn diagram of gambling and chemistry education, there's a pretty good chance you could nail the trifecta. [redacted]

ENROLLMENT ANALYSIS	Sum of 1st and 2nd Year as a % of total	Total Enrollment All Students
Gen Chem I Lab for Majors		
Gen Chem II Lab for Majors		
General Chem II for Majors		
General Chem I for Majors		
General Chem Lab I		
Organic Chem II Lab B.S. Chem		
General Chemistry I		
Gen,Organic, Biol Chemistry II		
Gen, Organic, Biol Chemistry I		
General Chem Lab II		
General Chemistry II		

[redacted]

Organic Chemistry I Lab	
Aspects of Chemistry Lab	
Organic Chemistry I	
Aspects of Chemistry	
Organic Chemistry II Lab	
Organic Chemistry II	
Quantitative Analysis Lab	
Quantitative Analysis	
Environmental Chemistry	
Biochemistry	
Descriptive Inorganic Chem	
Biochemistry Laboratory	

[redacted]

DFW Analysis	Sum of 1st and 2nd Year's DFW as a % of Total DFW in Course	Total DFW All students	As a % of Total DFW in Department	Ratio of DFW # over Enrollment # In Course
General Chemistry I				
General Chem Lab I				
General Chemistry II				
Organic Chemistry I				
General Chem Lab II				
Organic Chemistry II				
Quantitative Analysis				
Gen, Organic, Biol Chemistry I				
Aspects of Chemistry				
Organic Chemistry I Lab				

[redacted]

Organic Chemistry II Lab				
Biochemistry				
Gen Chem II Lab for Majors				
Gen Chem I Lab for Majors				
General Chem I for Majors				
Descriptive Inorganic Chem				
General Chem II for Majors				
Aspects of Chemistry Lab				
Quantitative Analysis Lab				
Biochemistry Laboratory				
Gen,Organic, Biol Chemistry II				
Environmental Chemistry				
Organic Chem II Lab B.S. Chem				

BIOLOGY:

Looking at the subject of Biology we see the nucleus is still [redacted] It is responsible for the largest enrollment, the largest number of first and second year students, and the largest DFW numbers. It alone accounts for just under [redacted]% of the DFW's in the department. A noticeable difference in the next highest course suggests, for Biology at least, we actively focus on this course and then everything else should be just fine.

ENROLLMENT ANALYSIS	Sum of 1st and 2nd Year as a % of total	Total Enrollment All Students
General Biology I		
Biology and Society		
General Biology II		
Human Biology		
Genetics		
Food Science and Production		
Cell Biology Laboratory		
General Ecology		
Microbiology for Human Health		
Cell Biology		
Genetics Laboratory		
Evolution		
Cell and Molecular Biology		
Ecology and Evolution		
Ecology Lab		
Marine Biology		
Human Anatomy		
Plant Taxonomy		
Freshwater Ecology		
Animal Physiology		
Human Physiology		
Animal Diversity		
Lab Teach Exp		
General Microbiol		
Communication in Biology		

DFW Analysis	Sum of 1st and 2nd Year's DFW as a % of Total DFW in Course	Total DFW All students	As a % of Total DFW in Department	Ratio of DFW # over Enrollment # In Course
General Biology I		[redacted]		
Biology and Society				
General Biology II				
Genetics				
Cell Biology				
General Ecology				
General Microbiol				
Human Anatomy				
Evolution				
Ecology Lab				
Marine Biology				
Genetics Laboratory				
Communication in Biology				
Ecology and Evolution				
Cell and Molecular Biology				
Cell Biology Laboratory				
Food Science and Production				
Animal Physiology				
Human Physiology				
Human Biology				
Freshwater Ecology				
Plant Taxonomy				
Animal Diversity				

Lab Teach Exp		[redacted]			%
Microbiology for Human Health					%

PHYSICS:

Venturing into the subject of Physics, we see something in the data that is a little unexpected. The course with the sheer largest number of DFWs is actually a course that falls somewhat low on the scale in terms of enrollment numbers, specifically when it comes to first and second year students. Let's take a look at the data tables:

ENROLLMENT ANALYSIS	Sum of 1st and 2nd Year as a % of total	Total Enrollment All Students
Honors: General Physics I		[redacted]
General Physics Lab I		
Conceptual Physics		
General Physics I		
Honors General Physics II		
Explor Current Topics Physics		
General Physics Lab II		
General Physics II		
Energy		
Classical Physics		
Classical, Quantum Physics Lab		
Intro to Physics I		
Rel, Quantum Phys		
Intro to Physics II		

DFW Analysis	Sum of 1st and 2nd Year's DFW as a % of Total DFW in Course	Total DFW All students	As a % of Total DFW in Department	Ratio of DFW # over Enrollment # In Course
Intro to Physics I		[redacted]		
General Physics I				
General Physics II				
General Physics Lab I				
General Physics Lab II				
Intro to Physics II				
Conceptual Physics				
Energy				
Rel, Quantum Phys				
Classical Physics				
Explor Current Topics Physics				
Honors: General Physics I				
Classical, Quantum Physics Lab				
Honors General Physics II				

While **Intro Physics 1** has quite a startling DFW rate of almost 30% over the last 6 semesters, **Gen Phys 1** and **Gen Phys 2** are of interest simply because of the enrollment numbers. Compared to other leaders in the clubhouse, DFW rates of about 11.5% isn't that bad. In fact, that would be a dramatic improvement over any of the discussed math courses above! But with the large enrollment numbers in these courses, even a small improvement, such as 1 percentage point, would result in meaningful change.

COMPUTER SCIENCE:

Yay for computers! Seriously, could you imagine trying to keep track of all this stuff on a classical spreadsheet ledger—I'd rather program in Assembly. Anywho, let's see what the data shows:

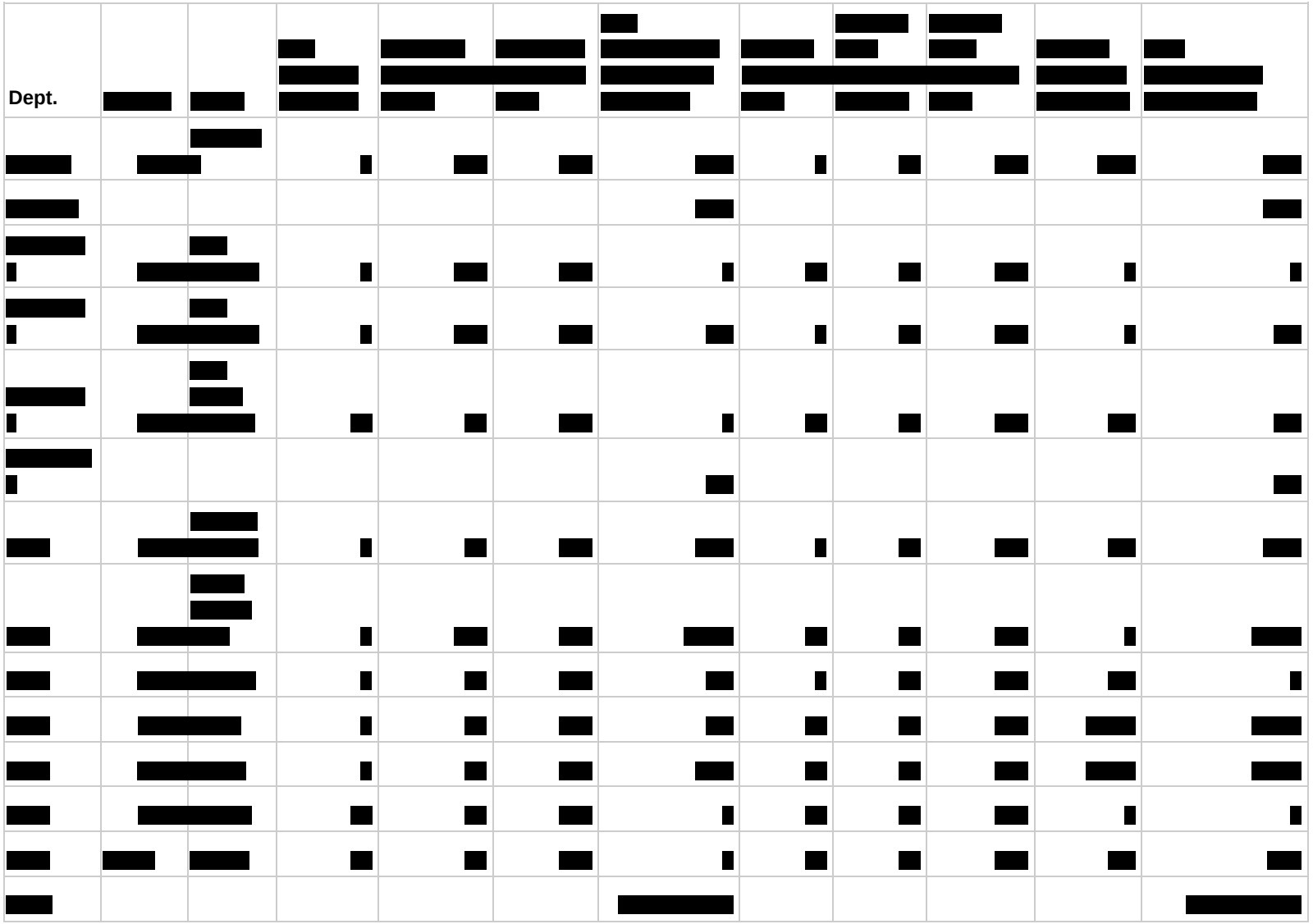
ENROLLMENT ANALYSIS	Sum of 1st and 2nd Year as a % of total	Total Enrollment All Students
Intro to Programming Matlab		[redacted]
Computer Science I		
Computer Science II		
Intro Visual BASIC.NET		
Computer Org and Architecture		
Software Analysis and Design		
Discrete Structures		
Intro to Programming in Python		
Automata and Formal Languages		
Software Engineering		
Computer Ethics		

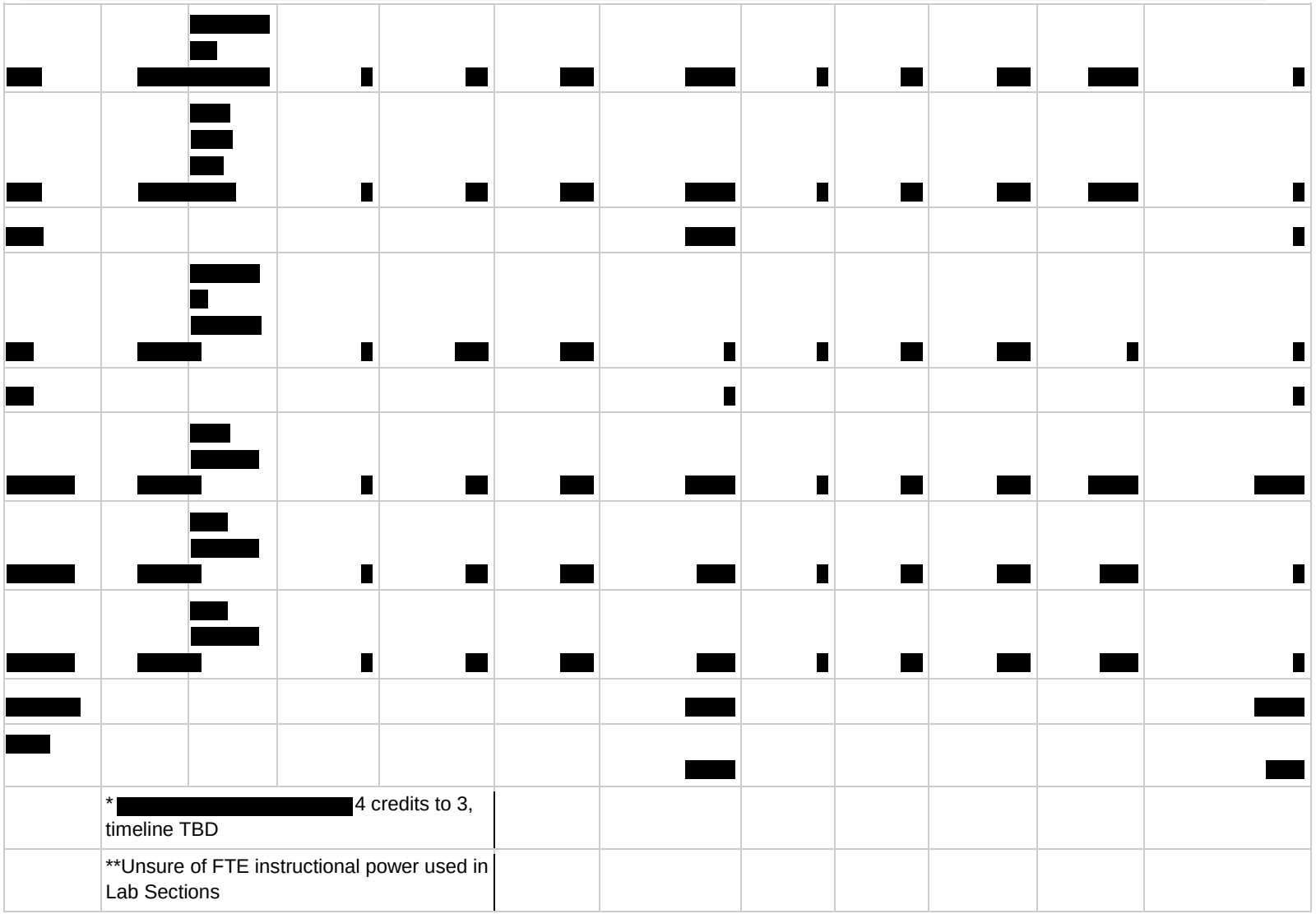
DFW Analysis	Sum of 1st and 2nd Year's DFW as a % of Total DFW in Course	Total DFW All students	As a % of Total DFW in Department	Ratio of DFW # over Enrollment # In Course
Computer Science I		[redacted]		
Intro to Programming Matlab				
Software Analysis and Design				
Computer Science II				

Intro Visual BASIC.NET	
Automata and Formal Languages	
Computer Org and Architecture	
Discrete Structures	
Intro to Programming in Python	
Computer Ethics	
Software Engineering	

[redacted] is obviously in need of some debugging or an update. While some courses individually have high DFW rates, like [redacted] the enrollment numbers are getting low. If [redacted] was somehow under the Math designator, it wouldn't even make the top 5.

Estimating Additional Teaching Power Tables





* [redacted] 4 credits to 3, timeline TBD

**Unsure of FTE instructional power used in Lab Sections

Return on Investment Scenarios

Initiative: DISTL

Optimistic Outlook (Estimated 25% Chance)

VARIABLES/STRATEGIES	Pre-Strat	Plan Year FY0	FY1	FY2	FY3	FY4
Enrollment (Funnel=Undergraduate)	2649	2649	2,689	2,728	2,768	2,808
Persistence to 2nd year	2183	2183	2281	2315	2344	2378
Persistence to 3rd year	2058	2058	2058	2152	2175	2207
Persistence to 4th year	2000	2000	2000	2000	2091	2114
Total Enrollment (years 2-4)	6241	6241	6339	6467	6611	6700
SEM Initiative Costs						
Instruction # FTE (faculty FTE: salary+fringe+3% annual)	16	$ 1,227,120	$ 1,263,934	$ 1,301,852	$ 1,340,907	$ 1,381,134
Equipment/space - one-time investment		$ -	$ -	$ -	$ -	$ -
Total Costs		$ 1,227,120	$ 1,263,934	$ 1,301,852	$ 1,340,907	$ 1,381,134
RETURN ON INVESTMENT ANALYSIS						
est. FY21 Net Tuition Revenue per resident UGD	$ 12,000	$ 12,000	$ 12,000	$ 12,000	$ 12,000	$ 12,000
Pre-Strategy Tuition Revenue	$ 74,896,512	$ 74,896,512	$ 74,896,512	$ 74,896,512	$ 74,896,512	$ 74,896,512
Post-Strategy Tuition Revenue		$ 74,896,512	$ 76,072,512	$ 77,607,912	$ 79,329,077	$ 80,395,379
Post-Strategy Tuition Revenue Gain (loss)		$ -	$ 1,176,000	$ 2,711,400	$ 4,432,565	$ 5,498,867
Less Total SEM Costs		$ 1,227,120	$ 1,263,934	$ 1,301,852	$ 1,340,907	$ 1,381,134
Net New Revenue Gain (loss)		$ (1,227,120)	$ (87,934)	$ 1,409,548	$ 3,091,658	$ 4,117,733

Initiative: DISTL

Weak Outlook (90% Chance at This or Better)

VARIABLES/STRATEGIES	Pre-Strat	Plan Year FY0	FY1	FY2	FY3	FY4
Enrollment (Funnel=Undergraduate)	2649	2649	2,689	2,728	2,768	2,808
Persistence to 2nd year	2183	2183	2243	2277	2310	2344
Persistence to 3rd year	2058	2058	2058	2106	2137	2168
Persistence to 4th year	2000	2000	2000	2000	2047	2077
Total Enrollment	6241	6241	6301	6383	6494	6589
SEM Initiative Costs						
Instruction # FTE (faculty FTE: salary+fringe+3% annual)	16	$ 1,227,120	$ 1,263,934	$ 1,301,852	$ 1,340,907	$ 1,381,134
Equipment/space - one-time investment		$ -	$ -	$ -	$ -	$ -
Total Costs		$ 1,227,120	$ 1,263,934	$ 1,301,852	$ 1,340,907	$ 1,381,134
RETURN ON INVESTMENT ANALYSIS						
est. FY21 Net Tuition Revenue per resident UGD	$ 12,000	$ 12,000	$ 12,000	$ 12,000	$ 12,000	$ 12,000
Pre-Strategy Tuition Revenue	$ 74,896,512	$ 74,896,512	$ 74,896,512	$ 74,896,512	$ 74,896,512	$ 74,896,512
Post-Strategy Tuition Revenue		$ 74,896,512	$ 75,616,512	$ 76,593,072	$ 77,925,473	$ 79,062,560
Post-Strategy Tuition Revenue Gain (loss)		$ -	$ 720,000	$ 1,696,560	$ 3,028,961	$ 4,166,048
Less Total SEM Costs		$ 1,227,120	$ 1,263,934	$ 1,301,852	$ 1,340,907	$ 1,381,134
Net New Revenue Gain (loss)		$ (1,227,120)	$ (543,934)	$ 394,708	$ 1,688,054	$ 2,784,914

Poisson Process Estimations

Year	SCSE Enrollment (AVG of Fall and Spring Semesters for the year)	SCSE DFWs	SCSE 1 year Ret Rate	Enrollement Persistence to Next Year (based on 1 year ret)	Number NOT Retained in First Year	Ratio of Lost Students to DFWS		Average of Ratios Weighted on Enrollment	SCSE 2 Year Ret Rate	Number Students Lost in First Two Years Based on Two Year Retention Rate	Ratio of Lost Students to Sum DFWs for Two Years
19-20	[redacted]										
20-21											
21-22											
22-23											

[redacted]

Number of Students Lost	Probability of being beween N and N+10		
280	0.0000004741080153		
290	0.000006877446247		
300	0.00006966850056		
310	0.0005212073014		
320	0.002865073107		
330	0.01168067623		
340	0.03562907378		
350	0.08197966606	25th percentile at N=368	
360	0.1433896194		
370	0.1920379775		
380	0.1982817211		
390	0.1588579877		
400	0.09936235138		
410	0.04880235933	90th percentile at N = 406	
420			

Num Students Lost	Probability of being between N and N+10		
450	0.00001888492119		
460	0.0001152287403		
470	0.0005694900509		
480	0.002239786752		
490	0.00752157966		
500	0.02026620335		25th percentile at 537
510	0.04496312955		
520	0.08244505534		
530	0.1253821063		
540	0.1586894016		
550	0.1676963054		
560	0.1484330861		
570	0.1103793537		
580	0.06916174161		
590	0.0356177387		90th percentile at N = 583
600	0.01642666283		
610	0.006250147732		
620	0.002031913177		
630			