Analyzing time-to-degree for transfer students at Michigan State University

Alyssa C. Waterson
Department of Physics & Astronomy, Michigan State University, East Lansing, MI, 48824

Marcos D. Caballero
Department of Physics & Astronomy, Michigan State University, East Lansing, MI, 48824
Department of Computational Mathematics, Science, and Engineering, Michigan State University, East Lansing, MI, 48824
CREATE for STEM Institute, Michigan State University, East Lansing, MI 48824 and
Department of Physics and Center for Computing in Science Education, University of Oslo, 0315 Oslo, Norway

Rachel Henderson
Department of Physics & Astronomy, Michigan State University, East Lansing, MI, 48824 and
CREATE for STEM Institute, Michigan State University, East Lansing, MI 48824

Earning a bachelor's degree is expensive and time-consuming. Many undergraduate students pursue Advanced Placement (AP) courses in high school or transfer coursework from degree-granting institutions. However, the effect of those transfer credits on the time that it takes students to graduate (time-to-degree) is currently not well understood. We have investigated how incoming transfer credit impacts students' time-to-degree by defining three independent groups of transfer students: (1) those entering with College-level transfer credit, (2) those with only AP-level transfer credit, and (3) those without any transfer credit. The time-to-degree has been shown to be statistically different for each of these groups, with students who enter with college-level transfer credit graduating with the fewest semesters. We have explored differences in time-to-degree for students majoring in Physics and specifically for those who are traditionally underrepresented in the field. Cohen's d results suggest large negative effects on the time-to-degree for Physics students without any transfer credit, especially for female students and underrepresented ethnic or racial minority students. These results provide implications toward how universities support graduation in four years, as well as other impacts toward student financial aid such as four-year scholarships. This work was supported by Michigan State University's College of Natural Science and the National Science Foundation (DUE-1725520).

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I. INTRODUCTION

Deciding to enroll in a university degree program is a complex process; students apply, prepare funding, organize living situations, and prepare to live in a new context altogether. The whole process involved with moving into higher education has sparked interest, as some students have an extra weight of responsibility to bear concerning transfer courses.

Research efforts on the impact of transfer credit on time to graduation have only just begun. At Michigan State University (MSU), there have been university-wide conversations about graduation *rates* [1], but research supported efforts appear to be few and far between. For example, some studies have focused on graduation rates and the impact that the preparation between high school and college has on those rates [2–5]. However, there are limited studies focusing on the time a student spends at a particular institution working toward their earned degree [6–8] and even fewer within the Science, Technology, Engineering, and Mathematics (STEM) fields. In addition, research within the two-year college environment has recently become a large point of interest in STEM [9–15], so investigating the longitudinal impact of that transfer credit at a 4-year institution seems more important than ever.

The work presented in this paper focuses on identifying and distinguishing between types of transfer credit that a student brings into a university and how that might impact a student's time-to-degree, which we define as the time spent at MSU that it takes to graduate. We explore time-to-degree for students who chose to major in Physics and specifically for those who are traditionally underrepresented in the field. We aim to address the following two research questions:

RQ1: *What is the impact of transfer credit on a student's time-to-degree at MSU and how are those effects different for Physics majors?*

RQ2: *For women and underrepresented ethnic or racial minority (UERM) students in Physics, what is the impact of transfer credit on their time-to-degree?*

The research was conducted using registrar data collected over several years at MSU [16]. The dataset includes information on the courses transferred from other institutions (college-level or otherwise) and students' demographic information. This paper is organized as follows: in Sec. II, we discuss the methods we applied in the categorization of the type of transfer credit and demographic features, as well as the data reduction prior to performing our analysis. We then present the analysis and results that demonstrate the different time-to-degree outcomes in Sec. III. Finally, in Sec. IV we discuss those results, the limitations of our study, and the future research we plan to conduct.

II. METHODS

This research was conducted at MSU, a large, Midwestern, land-grant university in the United States serving approximately 50,000 students. MSU has a Carnegie classification as "Very High Research Activity" (R1) [17]. In 2016, the undergraduate enrollment of MSU is 51% women, 77% White, 14% International, 8% Black/African-American, 6% Asian, 4% Hispanic/Latino, and fewer than 4% for other student populations [18]. These statistics support framing MSU as a Primarily White Institution (PWI).

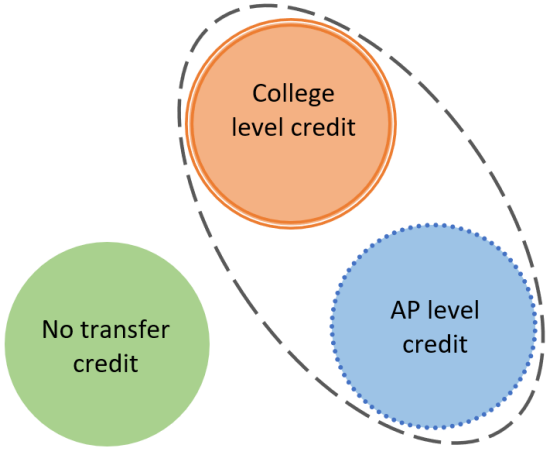

FIG. 1. Students can come into MSU with AP level credit from high school (blue, dotted outline, $n = 18,472$), at least one college-level credit from other institutions (orange, double outline, $n = 73,752$), or no transfer credit (green, no outline, $n = 38,961$). Both bubbles within the dashed line are categories of students that are considered to have transfer credit.

The time frame of enrollment we considered for this work was from 1992-2015, just over twenty years worth of data. MSU's transition from quarters to semesters in 1992 motivated the lower limit, while the upper limit of Fall 2015 allowed for students to graduate within 6 years.

A. Type of Transfer Credit

Transferring various course credit is an experience that can significantly shape a student's post-high school academic career. In order to explore our research questions, classifying the type of transfer credit that a student can hold is critical. We distinguish three different types of transfer credit for the purposes of this work (Fig. 1):

- A student has transfer credit, but only from their high school – Advanced Placement or "AP level credit"
- A student has transfer credit with at least one credit from a college-level institution – "College level credit"
- A student has no transfer credit – "No transfer credit"

The most notable distinction in defining these three categories is the separation of transfer credit holders into 'College level credit' and 'AP level credit' (as noted with the dashed line in Fig. 1). Motivating this is the reflection that a student having transfer credit from another college means that they went through applying to/attending a different institution in

some capacity, suggesting a different experience than a student who transferred only AP level credit from high school. Students with AP level credit are then binned into their own category so long as they do not *also* have at least one College-level transfer credit from a different institution.

B. Social Demographic Features

In addition to investigating the type of transfer credit, we wanted to explore how these effects compared for folks that are traditionally underrepresented in the field of Physics. It is well-documented that women and students of color have different experiences at universities and certainly within the field of Physics compared to their white-male counterparts [19–21]. However, comparing students to their white-male classmates emphasizes white males as the model to which other students should conform [22]. As such, in this work we intentionally chose to not compare directly to white men. Rather, within a demographic group (specifically, folks who are traditionally underrepresented in the field of Physics), we investigated the impact of the type of transfer credit on time-to-degree between students majoring in Physics and the MSU population more broadly.

At MSU, the registrar data has a variety of demographic information listed for each student. This includes gender, race/ethnicity, major, high school preparation metrics such as high school GPA and ACT/SAT scores, and additional factors. For the analysis centered around folks who are traditionally underrepresented in Physics, we are limited to the gender binary representation and the IPEDs definitions for racial/ethnic groups. As such, we performed the analysis for students recorded as female as well as students who identified as an underrepresented ethnic or racial minority (UERM) within the field of Physics. Students were coded as UERM status if they identified as American Indian/Alaska Native, Black/African-American, Hawaiian/Pacific Islander, or Latinx, which are the historic identifiers for racial/ethnic groups at MSU. We acknowledge the limiting nature of this binary view of gender as it does not provide a full representation of any one student's identity [23]. There are also limitations to the binary view of race/ethnicity as this averaging can mask differences among groups; we will investigate the individuality of these groups in future publication. It is important to note that we did not analyze the intersection of gender and UERM status due to the small number of female students and UERM students within the field of Physics; however, we encourage the overall Physics community to further investigate the impact of transfer credit on time-to-degree for students with intersecting identities.

C. Other data features

In order to solidify our definition of time-to-degree, we use 'number of semesters' as the metric to represent the time spent at MSU, including Summer semesters. We found this important to keep in the total count because Summer semesters are usually financially supported out of pocket. In the future we also intend to explore the potential effect of average credit hours per semester on time-to-degree. The final semester count also does not include semesters spent at previous institutions, as our dataset does not provide this information and we want to keep the definition related to semesters spent at MSU.

As mentioned above, the registrar data has millions of individual data elements that include features such as major, high school GPA, and SAT/ACT scores. In investigating the student's time-to-degree, we only kept students who have earned their conferred degree and had one primary major. We did not use high school preparation data here; this decision was made due to much missing data, as these fields do not apply to every incoming student, especially if attending from abroad. We intend to investigate this missing data in future work [24].

III. RESULTS

RQ1 and RQ2 are each explored using various methods. To address RQ1 in Sec. III A, cumulative distribution plots are used and compared via Kolmogorov-Smirnov (KS) tests. Cumulative distribution plots show the percentage of the target population that graduate after each semester, rising gradually until all students in the population have graduated. KS tests were performed when there was a noticeable separation between lines. We approximate these data as continuous distributions, such that we are justifying the use of KS tests. The results of the test will tell us the likelihood that two distributions could be pulled from the same (larger) population. If our samples are statistically distinguishable, then we can claim that the time-to-degree is veritably different depending on what type of transfer credit one holds.

To address RQ2 in Sec. III B, Cohen's d was used to discern differences in average time-to-degree. If certain groups of students have different average times-to-degree, Cohen's d can characterize the size of that effect. We use Cohen's d for its efficiency of measuring effect size when comparing the means of two samples (adjusted by their pooled standard deviations). Cohen identified $d = 0.2$ as a small effect, $d = 0.5$ as a medium effect, and $d = 0.8$ as a large effect [25].

A. Impacts of transfer course status

In exploring RQ1, Fig. 2 describes the relationship between time-to-degree and transfer credit type. The plots represent the overall population at MSU (Fig. 2a) and MSU Physics majors only (Fig. 2b). Focusing on the total MSU population, each line has clear space between them, giving us a distinct "rising order": we infer that students transferring at least one college-level credit (orange dotted line) are, on average, those who graduate in the fewest semesters. Then fol-

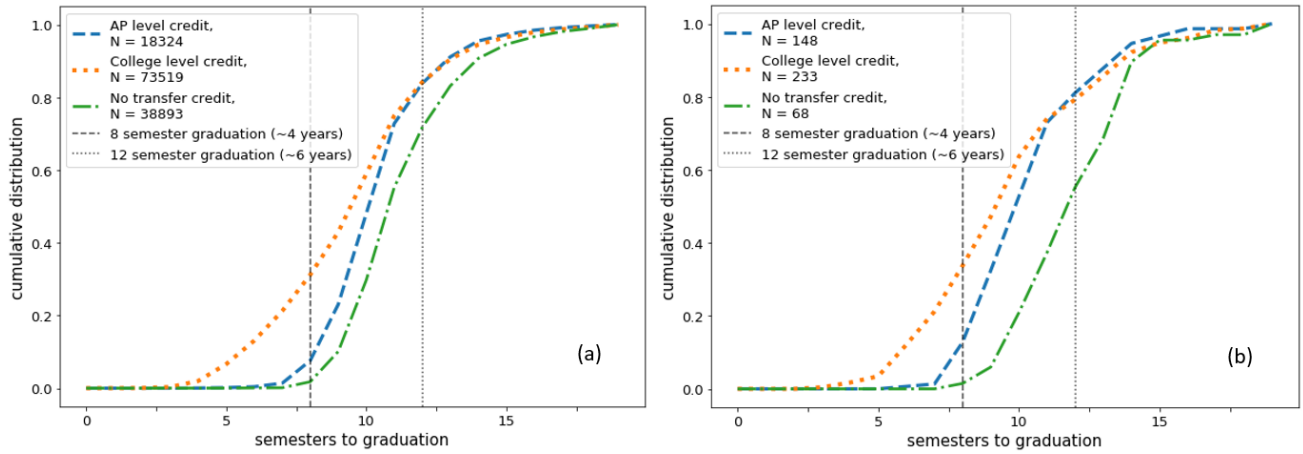

FIG. 2. Cumulative distributions recording the fraction of the population that have earned their degree for each transfer credit type. Plot (a) represents the general population at MSU aside from Physics majors and plot (b) is for all Physics degree earners at MSU. A dashed line is placed at the 8 semester mark (4 years) and a dotted line is placed at the 12 semester mark (6 years).

lows students with only AP transfer credit (blue dashed line) and finally students holding no transfer credit (green dotted-dashed line). At the '8-semester norm', which we approximate to a '4-year degree', less than 50% percent of any student population have graduated and less than 5% of students without transfer credits have graduated. By 10 semesters, both populations with transfer credit see at least 50% of their students graduating, but students without transfer credits are barely above 20%. For students majoring in Physics at MSU, the story is similar. At a '6-year degree' (12 semesters), approximately 75% of the general population at MSU without transfer credits graduate compared to around 60% of Physics students.

From Fig. 2, the visual distinction between lines is evident, but we determined the significance of these differences using KS tests. If significant, we can claim that having transfer credit, whether it's College level credit or AP level credit, are likely to have a distinct effect on a student's time-to-degree. As reported in Table I, the small p-values suggest that the distributions are dissimilar. In terms of time-to-degree, we conclude that, in general, those with transfer credit tend to graduate in fewer semesters from MSU than students without transfer credit. Further, those with college level transfer credit tend to graduate with fewer semesters than students with AP level transfer credit. This effect is observed in the full population at MSU as well as for the students majoring in Physics.

TABLE I. KS tests were performed between each pairwise distribution. We report the KS statistic and p-value. Each distribution was determined to be statistically different from the others with $p < 0.001$ for all tests.

	Overall Pop.		Physics Pop.	
Difference between:	*KS*	*p*	*KS*	*p*
College/AP lines	0.24	< 0.001	0.22	< 0.001
AP/No transfer lines	0.17	< 0.001	0.36	< 0.001
No transfer/College lines	0.33	< 0.001	0.42	< 0.001

B. Impacts of demographic analysis

While the type of credit a student holds when they enter at MSU appears to affect a student's time-to-degree, we want to view these implications for students who are traditionally underrepresented in the field of Physics. Table II presents the mean time-to-degree by type of transfer credit for female students and UERM students. Again, we present this for the general female or UERM population at MSU as well as for female or UERM students who are majoring in Physics.

To investigate RQ2, we focus within a given demographic group to determine if Physics majors' time-to-degree significantly differs from their classmates across MSU. For example, if we compare the average time-to-degree of female Physics students without transfer credit to the average time-to-degree of the *overall* female population without transfer credit, the former's mean is 13.1 semesters and the latter's is 11.6 semesters. As the sample sizes of these population are vastly different, we've calculated the effect size using Cohen's d. Here, negative Cohen's d values will indicate higher time-to-degree for Physics majors and positive values indicate higher time-to-degree for the overall MSU population.

Examining the relative effect sizes of the results in Table II, it is evident that not having transfer credit impacts both female and UERM Physics students negatively; Cohen's d represents a medium to large effect. Conversely, having AP level transfer credit positively impacts female and UERM Physics students' time-to-degree (i.e. graduating earlier than the general female and UERM population at MSU). For this analysis, we cannot discern *why* such a large impact is shown from this data, but it is important to highlight that the impact exists.

TABLE II. The average time-to-degree (in semesters) for female students and students who are traditionally underrepresented in Physics. The average time-to-degree are presented by the type of transfer credit: Advanced Placement, College-level, and None. Cohen's *d* effect sizes for the differences in mean time-to-degree between all students at MSU and Physics Majors are calculated. Small to large effect sizes are indicated with an asterisks (*). N is Number of students, M $\pm$ SE is Mean semesters $\pm$ Standard Error.

	Type of Transfer Credit	**Population**	**N**	**M $\pm$ SE**	**Cohen's *d***
Female	Advanced Placement	All Students	9463	$10.75 \pm .02$	0.30^*
		Physics Students	26	$10.15 \pm .31$	
	College-level	All Students	41505	10.00 ± 0.01	-0.04
		Physics Students	40	10.13 ± 0.60	
	None	All Students	20303	11.60 ± 0.02	-0.68^*
		Physics Students	11	13.09 ± 0.88	
UERM	Advanced Placement	All Students	1692	11.32 ± 0.06	0.43^*
		Physics Students	12	10.33 ± 0.36	
	College-level	All Students	13358	10.64 ± 0.03	0.00
		Physics Students	39	10.64 ± 0.56	
	None	All Students	7258	12.90 ± 0.03	-0.89^*
		Physics Students	15	15.40 ± 2.66	

IV. DISCUSSION AND FUTURE IMPLICATIONS

Students at MSU, depending on the type of transfer credit they have, earn their degrees over different lengths of time. Those with transfer credit earn their degree within fewer semesters than those without any transfer credits. This trend is also true for students majoring in Physics. In particular, the Physics student population with no transfer courses graduate approximately 15% less of its students than the general population by the 12 semester mark. This effect is large for students who are traditionally underrepresented in the field of Physics – female and UERM students. In addition, only about 15% of physics graduates do not have transfer credits, which could be an inquiry to explore attrition.

These results imply there is much to discuss around the concepts of 'preparation for college' and 'graduating on time'. In general, students are *not* graduating 'on time', if 'on time' (as defined by MSU's metric) is 8 semesters. Students without transfer credits will be greatly impacted by this result, especially students majoring in Physics without transfer credits. We secondarily acknowledge the existing stigma around students with transfer credit in that they "should" graduate "earlier" than other students, but this work demonstrates a *huge* portion of MSU students taking far longer than 8 semesters to graduate, regardless of the type of transfer credit they have. Consider, as an example of this effect, that a significant portion of scholarships are only offered for 8 total semesters. With many populations in our dataset showing averages of 10 semesters upon graduation, this leaves questions in regards to finances and resources for those extra semesters.

While this work has led to some initial claims, there are some limitations to the analysis presented here. In the study itself, the vastly different sizes in population between the overall population and only the Physics majors creates an interesting dialogue about the results; the large effects seen may be impacted partly by the fact that the Physics population has much fewer students, and therefore could contribute a significant impact on the data results. For the Cohen's d calculation, the pooled standard deviation was used to take this into account, but such vastly different population values may not be balanced by *only* this consideration. Furthermore, the KS test assumes that our data is continuous, so we will look toward other statistical tests to solidify our claims. Additionally, we have limited our work to students who earned single degrees; there might be important effects for dual degree earners as well as students earning specific minors. This creates dialogue on how helpful their transfer courses are in application to all of those majors and/or minors. The study so far does not consider which courses are transferred or how many; the *type* of course that is transferred in should also be explored.

Future work will look deeper into the our limitations and other inquiries such as having minors or more than one conferred degree as well as the average number of credit hours brought in to MSU (including consideration of full-time, part-time, or Summer enrollment). It is also of interest to analyze the impact of bringing in courses relevant to their chosen major versus bringing in general transfer credits. As this work develops, there is also a need to build models around the time-to-degree variable, with efforts in predicting one's time-to-degree from transfer course status, student demographics, and prior preparation. Those models can then be explored for different majors and various groups of people at MSU.

There are many inquiries for future research; where are we lacking in support for students? How can we address students without transfer credit taking up to a semester longer to graduate? Seeing the large impact this has on women and underrepresented ethnic and racial minority students in Physics at MSU is indicative of a need to look further into these student experiences and to provide better support and advising.

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