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Article

Statistical Analysis of Student's Tracing Rates in Undergraduate Higher Education with Different Time Windows

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Abstract: Students' retention rates (RR), students' progression rates (PR), and students' graduation rates (GR) are statistical figures commonly used in higher education to monitor the performance of higher education institutions (HEI), academic degree programs, or their students. These rates can be demanded for internal quality assurance, third-party accreditation, or institutional ranking. Due to the lack of a universal definition of these quantitative metrics for quality assessment within higher education, their values should be interpreted carefully with a clear understanding of how they were computed to avoid misleading judgments and unfair comparisons. In the current study, we develop clearly defined benchmarking retention, progression, and graduation rates. In addition to developing overall benchmarking rates, we also derive discipline-specific retention and progression rates for nine broad academic specializations. This study contributes to policy or practice in higher education by (1) providing a large collection of benchmarking matrices customized for different time windows and different disciplines; (2) discussing the variability in defining these metrics, and how this can cause mistakes in their use or interpretation; and (3) proposing formulas for computing the students' progression rates, and the student's graduation rates such that they become robust metrics of efficiency, strictly bounded between 0% and 100%.

Keywords: statistical; extrapolation; relaxation; benchmarking; rates

1. Introduction

1.1. Quality Assurance and Benchmarking in Higher Education

Quality Education is the fourth goal among the 17 Sustainable Development Goals (SDGs), or the Global Goals, adopted by the United Nations in 2015 with the broad aim to address the three dimensions of sustainable development (namely; environment dimension, economic dimension, and social dimension) [1]. These integrated Global Goals were designed to end poverty, to protect the Earth's planet, and to reach a universal state of prosperity by 2030 [2,3]. Undergraduate higher education (postsecondary or tertiary education), is an important stage of the qualifications framework, where many students are being prepared for starting their career and professional life, rather than for a subsequent stage of formal education [4–7]. Quality assurance in this stage involves a continuous improvement process, where several performance elements (qualitative indicators and quantitative metrics) are regularly evaluated and monitored against target levels or benchmarked with local peers, international peers, or reference standards [8–11].

By “benchmarking”, we mean that a higher education institution compares its metric value or indicator situation with either the metric value or the indicator situation at another peer higher education institution (local, regional, or international), or specified norms (such as aspirational targets suggested by national authorities). Such benchmarking process guides in deciding the relative position of the higher education institution when compared to outside points of reference. By “benchmarking”, we do not mean comparing the institutions' own targets with the current situations,

because such internally set targets are intended to be reached. Failure to achieve these targets is a sign of unsatisfactory performance and a need for corrective actions. On the other hand, benchmarking is less strict, and being below peers does not necessarily demand a corrective action. For example, a higher education institution may set (based on self-assessment) a target of being ranked nationally in the 3rd place in the next ranking edition according to their selected university ranking service. If that institution is ranked in the 4th place when the ranking edition is released, it is clear that the institution failed to achieve its target. This is a regular internal strategic planning process, rather than a benchmarking process. On the other hand, if that institution finds that its peer institution in the same state or municipality is ranked in the 5th place within the released national ranking edition, then comparing the two received ranking positions shows that the intuition is actually performing relatively well in terms of this educational quality element (the national ranking). This is a benchmarking process. It is an additional process of receiving inputs from outside the institution with regard to the institution’s performance.

Examples of quality assurance monitoring metrics in higher education are listed in Table 1.

Table 1. Some quality assurance performance elements in higher education.

Performance element	Supporting references
Students-faculty ratio (SFR)	[12]
Academic accreditation (institutional or programmatic)	[13,14]
Students’ satisfaction (with either academic elements or non-academic elements)	[15]
Post-graduation job satisfaction (satisfaction of either working alumni or their employers)	[16]
Community engagement	[17,18]
Institutional ranking	[19,20]
Institutional or programmatic affiliations	[21,22]
Industrial collaboration	[23]
Interaction with professional bodies	[24]
Alignment with professional licensure	[25,26]
Students’ scores on third-party standardized tests	[27]
Practicum/fieldwork and other experiential learning modes	[28,29]
Entrepreneurial support	[30,31]
Participation in competitions or innovation exhibitions	[32–34]
Internationalization and student’s academic mobility	[35–41]
Diversity and students’ support	[42,43]
Attractive students’ activities and campus life	[44]
Focus on sustainability	[45–54]
Innovation	[55–65]
Addressing global and real challenges	[66–79]
Digitalization and inclusive educational technology	[80,81]

Retention rates (RR)	[82,83]
Attrition rates (AR) – also known as dropout rates (DR) or non-continuation rates (NCR)	[84,85]
Progression rates (PR) – also known as persistence rates	[86]
Graduation rates (GR) – also known as completion rates (CR)	[87]

1.2. Student Tracking Rates

The last four quality assurance metrics that appear in the previous list are the focus of the current study. Namely, these are the students’ retention rates (RR), students’ progression rates (PR), and students’ graduation rates (GR). The students’ attrition rates (AR) are the complementary value of the retention rates (RR); and due to their one-to-one relationship, we do not need to consider them separately as a fourth quality assurance metric. Instead, we utilize the retention rates (RR) here in lieu of the attrition rates (AR) or the non-continuation rates (NCR), while admitting that the attrition rates remain a valid candidate to be used instead of the retention rates. The reason for preferring the attrition rates over the attrition rates in the current study is that while the attrition rates are optimized through minimization (lower values are better than higher values), retention rates are optimized through maximization (higher values are better than lower values); which is the same behavior of the progression rates and the graduation rates. Thus, by selecting the retention rates instead of the attrition rates to express the same quality assurance aspect, we ensure that all three quality assurance metrics covered in the current study have coherent behavior. All these quantitative metrics are expressed in a percentage form, and they serve as three quantitative quality metrics for tracking students and assessing their success from the entry/admission point until the completion/graduation point, or for compliance with accreditation requirements. In the current article, these three rates are collectively referred to as students’ tracking rates” or TR.

1.3. Student Retention Rates

Retention rates express the ability of an HEI to retain its students; such that after a specified duration (one year for example), if a student remains enrolled (maintaining their active ID number) in the same HEI or program or earns a credential from it, then that student is retained. They show the attractiveness of the HEI or program, its stability, reputation, financial well-being, and a healthy relationship with its students that suggests a sense of belonging and an atmosphere of inclusion [88–91]. Mathematically

$$RR = \frac{\text{number of retained students}}{\text{number of initial students}} \quad (1)$$

If all initial students are retained, RR reaches its upper limit of 100%. With this expression, RR is guaranteed to lie exactly within the normalized range from 0% to 100% as an inclusive interval of all possibilities, making it straightforward to interpret as any efficiency figure adopted for convenient performance characterization in energy systems or industrial processes [92–97].

1.4. Student Attrition Rates (Dropout Rates)

The opposite (or complement) of retention is attrition (also called dropout, drop-out, or non-continuation), which refers to students who do not remain in their HEI or academic program, because of transferring out, withdrawal, or dismissal [98–101]. Thus, AR or DR is 100% minus RR as expressed in Equation (2). For example, a retention rate of 60% corresponds to an attrition rate (or a dropout rate) of 40%.

$$AR = 100\% - RR \quad (2)$$

or

$$AR = \frac{\text{number of dropout students}}{\text{number of initial students}} \quad (3)$$

1.5. Student Progression Rates (Persistence Rates)

Progression rates (or persistence rates or progress rates) commonly refer to the ability of the students to advance through their academic program with a satisfactory rate that enables them to graduate within the normal duration of study (such as four years in a bachelor’s degree program) [102–105]. The portion of students who maintain a satisfactory pace of passing courses or earning credit hours over a specified period gives the progression rate (PR). Mathematically, the progression rate can be described as

$$\widehat{PR} = \frac{\text{number of students maintaining a satisfactory pace of advancement in the degree program}}{\text{number of initial students}} \quad (4)$$

The circumflex (hat) notation is intentionally added to the above acronym of the progression (persistence) rate to emphasize that it is just one form of multiple forms according to how this rate is defined in the literature.

There is an alternative way to define the progression (persistence) rate, making it the result of augmenting the retention rate by including those students who transfer out to other institutions or complete a credential there (in this definition, a student is persistent or progressing if she or he continues studying, regardless of where). Mathematically, this alternative definition of the progression (persistence) rate can be expressed as

$$PR = \frac{\text{number of retained students in the same or another place}}{\text{number of initial students}} \quad (5)$$

In fact, this alternative definition was adopted by the source of raw progression (persistence) rates we used here. This alternative definition of the progression (persistence) rate makes it less interesting to an individual higher education institution or academic program (it remains interesting at a country level), and such a rate in this case does not qualify for institutional-level or program-level benchmarking and quality assessment, while the definition we expressed is much more useful and practicable. In addition, this definition requires a data collection process that extends beyond the institution’s records, because the actual destination of the student who left the institution should be monitored, even if this student has transferred to an institution in another country. Despite this, all the progression (persistence) rates in our study refer to the alternative definition of being an “expanded retention rate” as per Equation (5), rather than being a “within-institution/program study advancement” as per Equation (4).

We imagine here a situation where a two-year degree (associate degree or diploma) student transfers out to continue their study in another four-year institution (as an upgraded bachelor’s degree) without completing their original associate degree. According to the above alternative definition of the progression rate, this is an instance where a desirable outcome is achieved (the student is classified as progressing) although this instance does not directly yield the measurable attainment of an associate degree.

We also notice that some sources use the term “persistence rate” or “progression rate” with a similar meaning to what we call “retention rate”; but for the purpose of this study, these terms are different [106–108]. One study defined the progression rate during a college study in a different way as the duration of time to graduate following an anticipated progression pattern until graduation (for example, being a sophomore “second-year” student, then a junior “third-year” student, and then a senior “fourth-year” student) [109]. We understand that the term “progression” is easier to delineate in a school system with uniformly set sequential grades as compared to a college system where students have more freedom in deciding the sequence of courses they complete [110–113]. We also notice that there are higher education institutions or academic programs that do not monitor progression rates, but monitor retention rates and graduation rates; considering them sufficient for the tracking process [114–116].

1.6. Student Graduation Rates (Completion Rates)

Graduation rates (GR) or completion rates (CR) represent the portion of those students who successfully complete their graduation requirements within a specified period of time, which is commonly taken as 150% (one and a half) times the nominal program’s completion period (normal

or expected period for graduation); and this extension in the graduation window allows accommodating for students who have responsibilities beyond their education. This intentional time extension allows for accommodating such cases that otherwise penalize the HEI or program through low graduation rates [117–120]. Thus, for a four-year bachelor's degree program, the graduation rate is the portion of students who complete the program within six years. On the other hand, for a three-year undergraduate advanced diploma program, the graduation rate is the portion of students who complete the program within 54 months. For a two-year diploma (associate degree) program, the graduation rate is the portion of students who complete the program within three years. For a one-year undergraduate certificate program, the graduation rate is the portion of students who complete the program within 18 months. Other students who fail to graduate within that extended graduation window represent "non-completion" cases, and their portion is the complementary non-completion rate (NCR), defined as [121–126]

$$\text{NCR} = 100\% - \text{GR (or CR)} \quad (6)$$

Mathematically, the graduation (completion) rate can be expressed as

$$\text{GR (or CR)} = \frac{\text{number of students graduated within an extended period}}{\text{number of initial students}} \quad (7)$$

where the term "extended period" refers here to 150% of the nominal period for completion.

Several approaches can improve students' retention, progression, or graduation rates; such as advising and mentorship, customized educational environment, and student-centered learning [127–133]. For example, one study suggested innovative teaching techniques; such as project-based learning, peer teaching, and retrieval practice (which improves memory retention through 'active' recall of information in response to a question, as compared to 'passive' review methods); and such active learning strategies through systemic educational reforms boost an equitable and inclusive learner-centered environment and address learning barriers [134]. Another study found, through empirical research and hypotheses testing, that disparity in graduation rates among different higher education institutions is linked to the variations in institutional resources; and suggested that policy interventions can be adopted to remedy this issue where many higher education students are unable to earn a degree after enrolling in a four-year college [135]. In another study, offering a for-credit course titled "Psychology of Success" about positive psychology to academically-warned students after their first semester was found to foster retention, progression, and graduation; based on results analyzed after four years of implementing this methodology [136].

1.7. Study Objective

This study is partly made as a result of a lack of a broadly applicable lookup database for retention, progression, and graduation rates in undergraduate higher education. By "broadly applicable", we mean the definitions and data behind the database are clearly explained, and the reported rates are customized to different ways for defining how these rates can be interpreted by different higher education institutions. These three students' tracking rates (for retention, progression, and graduation rates) can be mandatory to compute or report regularly for a particular degree program or a higher education institution, in order to comply with accreditation or ranking requirements. While the computing of these rates can be automated through digital information systems, the evaluation of these rates remains a source of subjectiveness and perplexity if no clear targets or benchmarking standards exist.

For example, the Organisation for Economic Co-operation and Development (OECD) book/report series "Education at a Glance" does not address undergraduate retention rates or undergraduate progression rates [137]. The OECD graduation rate there was defined as "First-time graduation rate represents the expected probability of graduating for the first time at a given level of education before the age threshold (25 for upper secondary education and 30 for post-secondary non-tertiary education) if current patterns are maintained." This definition concerns a conditional probability given a level of education and an age threshold, and it is very different from how higher education institutions may interpret the term "graduation rate", as being a portion of a particular cohort that graduates from the institution within a certain period. OECD also publishes values for its

“tertiary graduation rate”, which is defined as “the expected probability of graduating for the first time from tertiary education before the age threshold if current patterns are maintained” [138]. Again, this probabilistic metric is not suitable for higher education institutions or academic programs for benchmarking how fast their students complete their degree study. For example, the published OECD tertiary graduation rate for (Doctoral or equivalent level, women, Percentage, 2020) ranges from 1.5% in Germany to 0.07% in Chile. Such percentages are not relevant to the context of students’ tracking within a higher education institution. As another example, the “Higher Education Global Data Report” of UNESCO (United Nations Educational, Scientific and Cultural Organization) does not include these students’ tracking rates [139]. UNESCO’s “Higher education: figures at a glance” document includes several education metrics (such as gender parity and international student mobility), but none of the three students’ tracking rates investigated in this study are included [140]. As another example, the Higher Education Statistics Agency in the United Kingdom (UK) provides statistical data about non-continuation (a term that is equivalent to “attrition” in our study) for undergraduate students in each higher education provider (HEP) [141]. This “non-continuation” refers to undergraduate full-time students who do not continue their higher education study following one year of entry (following two years of entry in the case of part-time students). While these are useful and comprehensive data, they include two types of non-continuation rates; namely, (1) regarding students who transfer to another HEP in the UK, (2) regarding students no longer in higher education. Thus, the term “non-continuation rate” or NCR by itself is not uniquely specified, and care is needed when interpreting or reporting such a rate to avoid confusion or misuse of one form in place of the other. Furthermore, for higher education institutions that compute their attrition rate over a larger time window (for example, four years from entry to degree completion of a four-year bachelor’s degree program), the published HESA rates become in need for extrapolation, which is proposed in our study.

When attempting to compare the obtained students’ tracking rates (retention, progression, and graduation) with peer values, one can get highly misleading outcomes due to the variability in how these rates are computed. The problem becomes more pronounced in a higher education system that is based on credits (credit hours or credit points), rather than sequential semesters; because terms like “first year of study” and “second year of study” become not uniquely defined [142–145]. A student may be taking a course from the third year of the nominal study plan at the same time as taking a course from the second or even the third year, as long as the prerequisites are satisfied. Furthermore, undergraduate programs that involve a non-credit preparatory year (to be called here a ‘foundation year’) as a transition stage (a bridging step) between high school (secondary school) and the degree program in colleges need careful treatment when the student’s tracking rates are either computed or interpreted [146–149].

In the current study, we primarily aim at presenting general benchmarking value for the three students’ tracking rates (retention, progression, and graduation) based on selected and processed values, such that they may suit a wide range of higher education institutions as benchmarking standards for their particular situation.

The research gap that this study aims to address is a lack of a comprehensive database of the retention, progression, and graduation rates in undergraduate education that can be used conveniently as external benchmarking reference points (without a single geographic or institutional focus) while catering for diverse definitions of these rates by different institutions. By being external (not local), these benchmarking values target higher education institutions in any part of the world (except the United States), which aim to compare their performance with other external (overseas) higher education institutions. For higher education institutions in the United States, the benchmarking values provided here are useful local “national” levels. The use of the provided quantitative benchmarking values here is similar to when a higher education institution performs benchmarking with another higher education institution in a different country or the same country when developing a new academic program or revising an existing one. This analogous program-to-program benchmarking (such as by comparing the courses “subjects” offered or the student

outcomes “program learning outcomes”) does not mean that exact equality is the optimum condition and should be strictly achieved. Instead, such program-to-program benchmarking provides general guidelines about favorable similarity and lack of extreme divergence. For example, a higher education institution may have multiple options regarding the internship “work placement” component in a degree program, such as being compulsory or elective. Through the external or local program-to-program benchmarking process, the higher education institution can be able to make an informed decision based on identifying what the norm is. Similarly, in the lack of a universal threshold for student tracking rates (retention rates, progression rates, and graduation rates), external or local benchmarking serves as a valuable guide.

The current study provides a large set of synthesized student tracking rates corresponding to (1) different time windows and calculations, (2) whether or not a non-credit foundation program exists, and (3) different disciplines.

The methodology of the current study and how it achieves its goal are outlined in the following section (3 Research Methodology).

1.8. Research Questions

The following research questions are addressed in the current study:

- What are common examples of quality assurance elements in higher education?
- Is there a wide agreement on the definition of the retention rate?
- Is there a wide agreement on the definition of the progression rate?
- Is there a wide agreement on the definition of the graduation rate?
- What is a representative overall (not discipline-specific) undergraduate benchmarking retention rate?
- What is a representative discipline-specific undergraduate benchmarking retention rate?
- What is a representative overall (not discipline-specific) undergraduate progression rate?
- What is a representative discipline-specific undergraduate progression rate?
- What is a representative overall (not discipline-specific) undergraduate graduation rate?
- How can the progression rate be defined to ensure that it meaningfully lies within the normalized range of 0-100%?
- How can the graduation rate be defined to ensure that it meaningfully lies within the normalized range of 0-100%?

Overall student tracking rates in the current study may be used at the institution level, rather than at the program level. They may also be used at the program level when viewed as an approximation when no better program-specific rates are available.

2. Research Methodology

2.1. Data Sources

The present study is based on descriptive statistical analysis. All the raw data used here are from open-access databases with anonymized records. No sensitive data were collected. No human or animal subjects were involved. No biohazardous materials were handled. These conditions eliminate potential and ethical considerations.

The data are from NCES (National Center for Education Statistics), and NSC-RC (National Student Clearinghouse – Research Center).

NCES is one of the four centers belonging to the IES (Institute of Education Sciences) of ED (U.S. Department of Education) [150,151]. The other three centers are NCSEI (National Center for Special

Education Research), NCER (National Center for Education Research), and NCEE (National Center for Education Evaluation and Regional Assistance) [152,153]. NCES is the main federal entity in the USA for collecting and analyzing data related to higher education. This data system is IPEDS (Integrated Postsecondary Education Data System) [154–156]. College Navigator is a free online portal by NCES [157,158].

NSC-RC (National Student Clearinghouse – Research Center) is the branch of NSC (National Student Clearinghouse) in the United States of America [159,160].

Table 2 lists the data we curated in the current study and their sources.

Table 2. Curated raw data used in the current study.

Data type	Source	Reference
Graduation	NCES	[161]
Retention	NCES	[162]
Progression* * The name of this metric in the source is “Persistence Rate”. Progression rates* (discipline-specific: Architecture, Business/Management, Computer/Information Science, Education, Engineering, Engineering Technology, Health/Clinical, Humanities, Law) * The name of this metric in the source is “Persistence Rate”. Retention rates (all undergraduate degrees combined) Retention rates (discipline-specific: Architecture, Business/Management, Computer/Information Science, Education, Engineering, Engineering Technology, Health/Clinical, Humanities, Law)	NSC-RC	[163]

2.2. Selected Disciplines and CIP Classification

The nine disciplines selected here for additional discipline-specific analysis are not exhaustive. These selected disciplines allow diversity in the coverage (rather than being focused only on STEM “Science, Technology, Engineering, and Mathematics”, health care, or humanities), with less priority given to disciplines with smaller numbers of enrolled students (like Theology). Examples of additional available disciplines in the NSC-RC data are Agriculture, Biological/Biomedical Sciences, Communication/Journalism, English Language, History, Liberal Arts, Mathematics/Statistics, Military Technologies, Parks/Recreation/Leisure/Fitness Studies, Philosophy and Religious Studies, Physical Sciences, Psychology, and Public Administration.

The CIP (Classification of Institutional Programs) is a US-based classifying code for academic disciplines, The CIP codes for the selected nine disciplines are listed in Table 3.

Table 3. CIP classification of disciplines selected for further discipline-specific analysis.

Broad academic discipline	Reference
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Our assigned brief title	Full (official) title	CIP (for USA use)	
Architecture	Architecture and Related Services	04	[164]
Business/Management	Business, Management, Marketing, and Related Support Services	52	[165]
Computer/Information Science	Computer and Information Sciences and Support Services	11	[166]
Education	Education	13	[167]
Engineering	Engineering	14	[168]
Engineering Technology	Engineering/Engineering-Related Technologies/Technicians	15	[169]
Health/Clinical	Health Professions and Related Programs	51	[170]
Humanities	Liberal Arts and Sciences, General Studies and Humanities	24	[171]
Law	Legal Professions and Studies	22	[172]

2.3. Retention and Progression Extrapolation

The reported retention rates in both sources and the progression rates by NSC-RC are based on the first year of college study. HEIs adopting larger time windows should not compare their retention or progression rates with those reported by NSC-RC or NCES. We suggest a nonlinear extrapolation where the first-year retention rate or progression rate is penalized when estimated for a multi-year period with a multiplicative discount factor (λ) that is the average of the square roots of the first-year retention rates (or the first-year progression rates) in the last four years. The rationale for our choice of this extrapolation mechanism combines both simplicity and reasonableness. Thus, instead of multiplying with the first-year rate, taking the square root increases the multiplicative factor toward 1.0, thereby weakening the expected decline. Then, taking an average over 4 years smoothens the computation and reduces the likelihood of short-term irregularity due to exceptional rates in a particular year, such as COVID-19 [173–177].

Mathematically, if the first-year retention rates for the last four consecutive cohorts are RR_1 (oldest: corresponding to Fall 2019-20 in our study), RR_2 , RR_3 , and RR_4 (latest: corresponding to Fall 2022-23 in our study); then the discount factor for extrapolating the retention rate (λ_{RR}) is

$$\lambda_{RR} = 0.25 \left(\sqrt{RR_1} + \sqrt{RR_2} + \sqrt{RR_3} + \sqrt{RR_4} \right) \quad (8)$$

If the mean retention rate is

$$\overline{RR} = 0.25 (RR_1 + RR_2 + RR_3 + RR_4) \quad (9)$$

then, the first-year retention rate is extrapolated as

$$RR(\text{one year}) = \overline{RR} \quad (10)$$

$$RR(\text{two years}) = \lambda_{RR} \overline{RR} \quad (11)$$

$$RR(\text{three years}) = \lambda_{RR}^2 \overline{RR} \quad (12)$$

$$RR(\text{four years}) = \lambda_{RR}^3 \overline{RR} \quad (13)$$

$$RR(\text{five years}) = \lambda_{RR}^4 \overline{RR} \quad (14)$$

Similarly, if the first-year progression rates for the last four consecutive cohorts are PR_1 , PR_2 , PR_3 , and PR_4 (latest); then the discount factor (λ_{PR}) is

$$\lambda_{PR} = 0.25 \left(\sqrt{PR_1} + \sqrt{PR_2} + \sqrt{PR_3} + \sqrt{PR_4} \right) \quad (15)$$

and the mean progression rate is

$$\overline{PR} = 0.25 (PR_1 + PR_2 + PR_3 + PR_4) \quad (16)$$

The extrapolation of the first-year progression rate is

$$PR(\text{one year}) = \overline{PR} \quad (17)$$

$$PR(\text{two years}) = \lambda_{PR} \overline{PR} \quad (18)$$

$$PR(\text{three years}) = \lambda_{PR}^2 \overline{PR} \quad (19)$$

$$PR(\text{four years}) = \lambda_{PR}^3 \overline{PR} \quad (20)$$

2.4. Progression Adjustment for Foundation Year

If the progression rate ($\widehat{PR}$) is a measure of the satisfactory pace of students' advancement in their study, then when it is computed for an academic program that offers a non-credit foundation year, the computation becomes difficult because to the college is not necessarily happening concurrently at a single point [178,179]. A foundation year does not impact the retention rates. However, it worsens the progression rates. We propose an adjustment for proper benchmarking by scaling down reference progression rates using a penalty factor between 0 and 1 (taken as 0.5) in the first-year progression rate. Thus, if the foundation-free benchmarking value or target for the first-year progression rate is 70%, the program may expect to achieve 35%. Because this foundation year is not considered when the progression in the degree program is quantified, the penalty factor of 0.5 appears reasonable. We suggest that this penalty factor (is relaxed if the first-year progression rates are extrapolated, with a relaxation factor of ($\Lambda=1/0.9$). This relaxation is the decay of the interruption by the foundation year. This numerical relaxation technique (also called the successive relaxation technique) is borrowed from a numerical method for iteratively solving a system of coupled equations that can arise when describing certain problems in physics or engineering [180–196]. A relaxation factor (also called an under-relaxation factor) of 0.9 is a representative value that is used to progressively reach a final solution that combines the solutions belonging to two sequential iterations [197–206].

If the progression rate adjustment factor is μ , and the adjusted progression rate is $\widehat{PR}_{FY}$, the following expression describes our correction:

$$\widehat{PR}_{FY}(\text{one year}) = \mu(\text{one year}) \widehat{PR}(\text{one year}) \quad (21a)$$

$$\mu(\text{one year}) = 0.5 \quad (21b)$$

$$\widehat{PR}_{FY}(\text{two years}) = \mu(\text{two years}) \widehat{PR}(\text{two years}) \quad (22a)$$

$$\mu(\text{two years}) = \mu(\text{one year}) \Lambda = 0.5/0.9 = 0.55556 \quad (22b)$$

$$\widehat{PR}_{FY}(\text{three years}) = \mu(\text{three years}) \widehat{PR}(\text{three years}) \quad (23a)$$

$$\mu(\text{three years}) = \mu(\text{two years}) \Lambda = \mu(\text{one year}) \Lambda^2 = 0.5/0.9^2 = 0.61728 \quad (23b)$$

$$\widehat{PR}_{FY}(\text{four years}) = \mu(\text{four years}) \widehat{PR}(\text{four years}) \quad (24a)$$

$$\mu(\text{four years}) = \mu(\text{three years}) \Lambda = \mu(\text{one year}) \Lambda^3 = 0.5/0.9^3 = 0.68587 \quad (24b)$$

Figure 1 visualizes this adjustment factor.

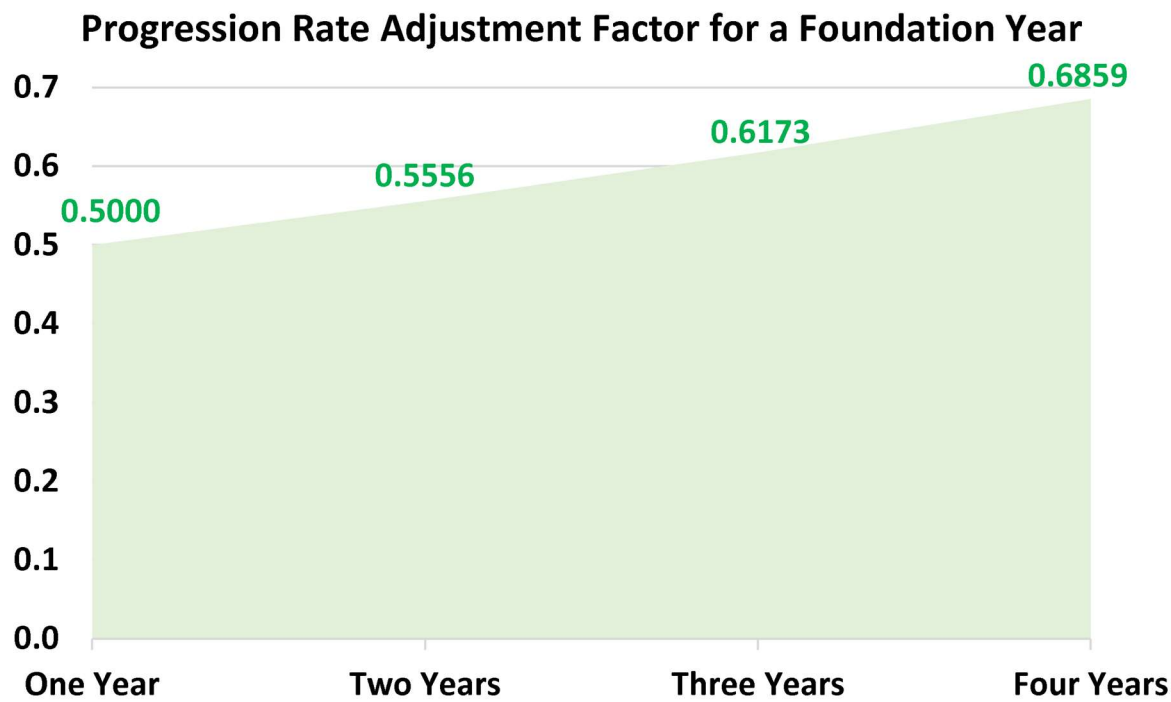


Figure 1. Profile μ .

3. Results

3.1. Overall Full-Time Bachelor's Degree Retention Rates

Our results start with the overall retention rates for bachelor's degree students. These estimates are based on NCES data. The average first-year retention rate is 75.93%. Programs report their retention rates over an entire study period should note that the extrapolated benchmarking retention rate becomes 50.23%.

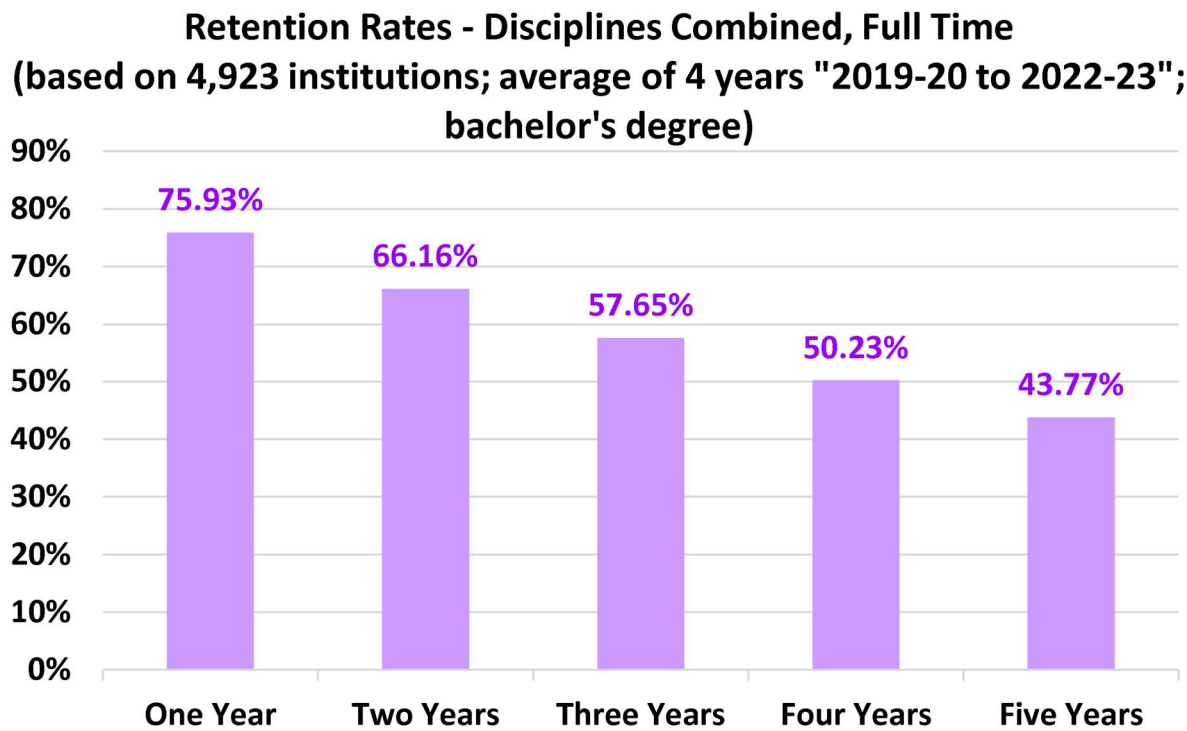


Figure 2. Overall retention rates.

3.2. Discipline-Specific Retention Rates

For the selected nine broad disciplines, NSC-RC allows for estimating specific undergraduate retention rates. These are presented in Figures 3–11.

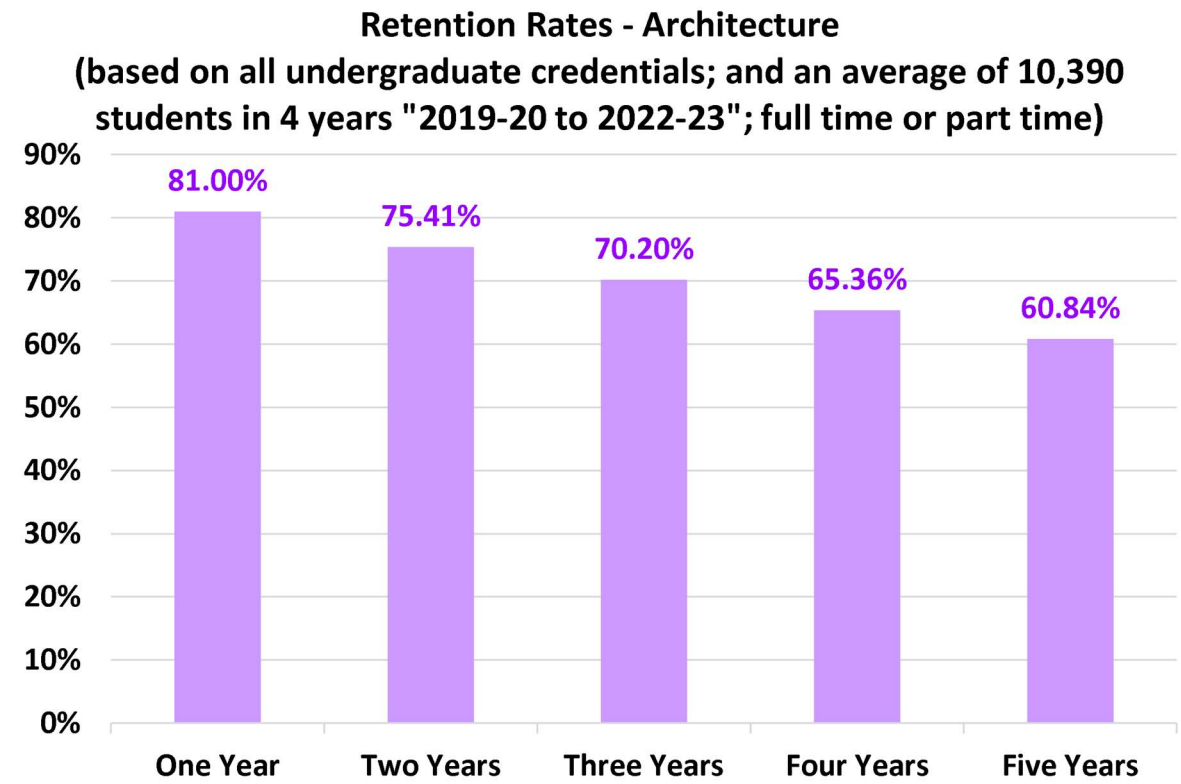


Figure 3. Architecture retention rates.

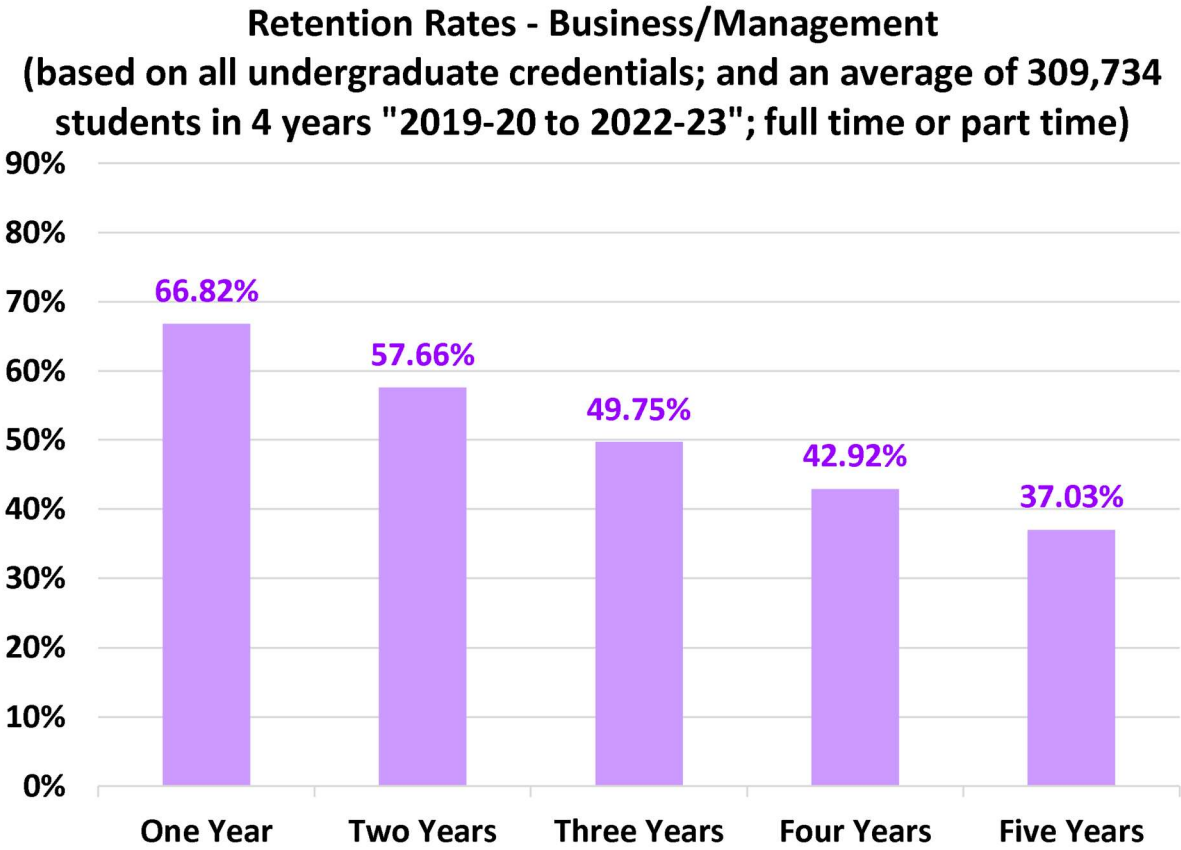


Figure 4. Business/Management retention rates.

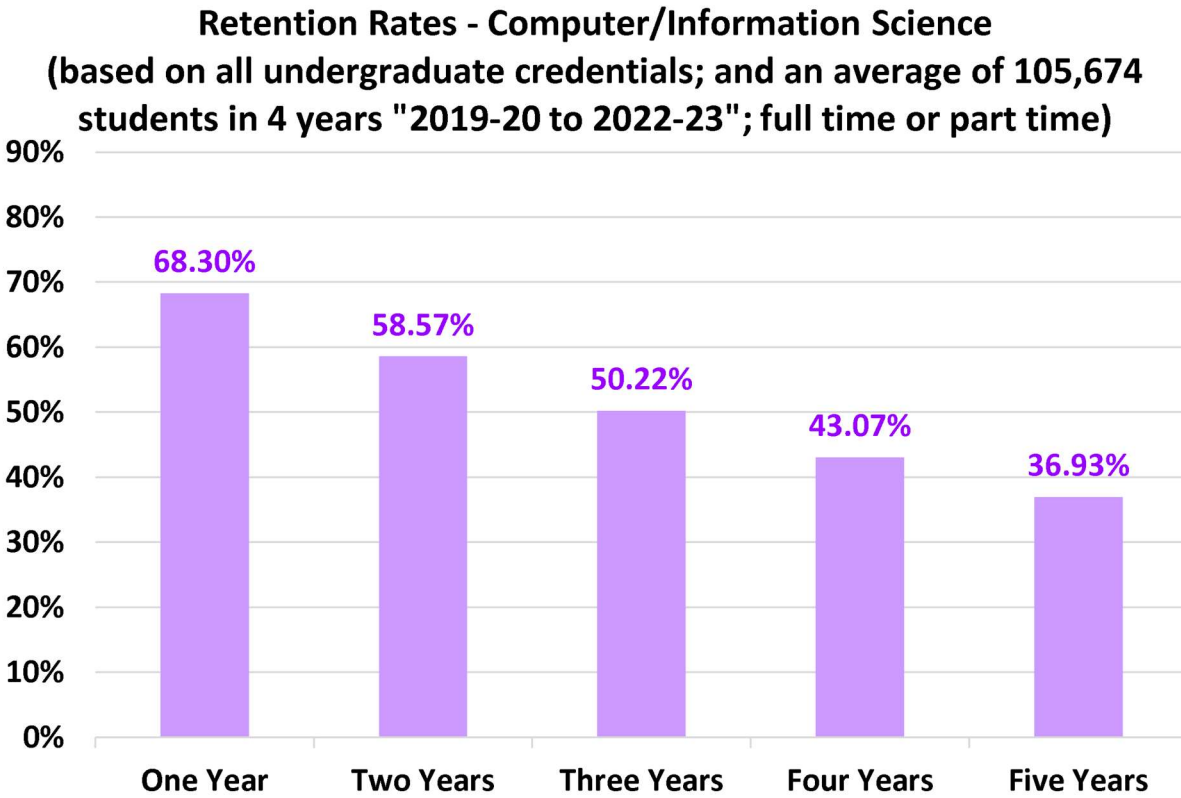


Figure 5. Suggested "Computer/Information Science" benchmarking retention rates at five durations (from one year to five years after admission).

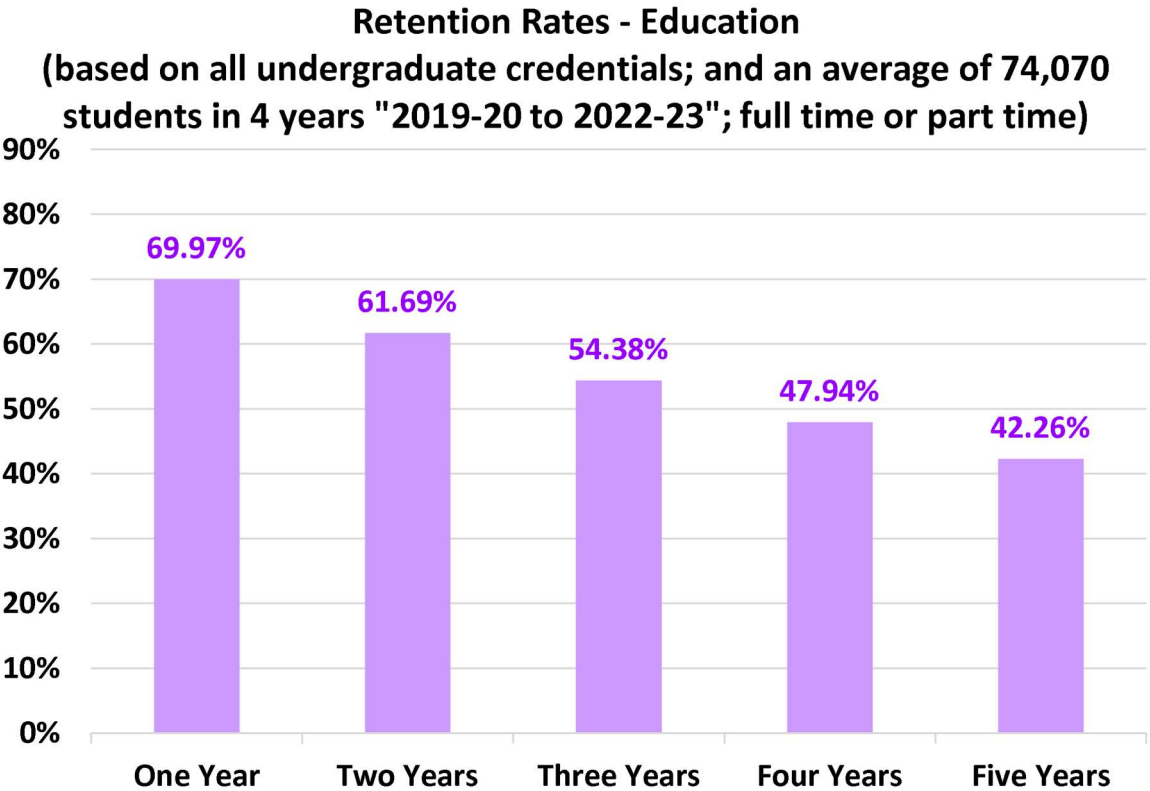


Figure 6. Education retention rates.

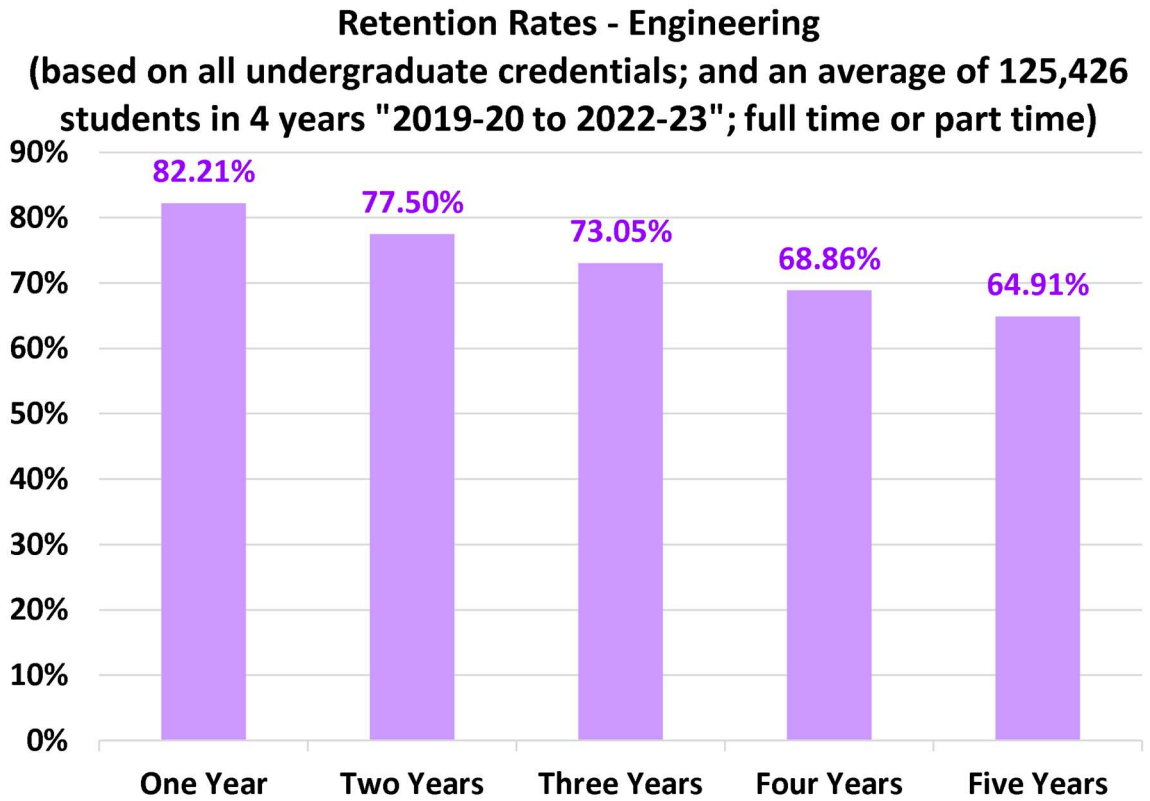


Figure 7. Engineering retention rates.

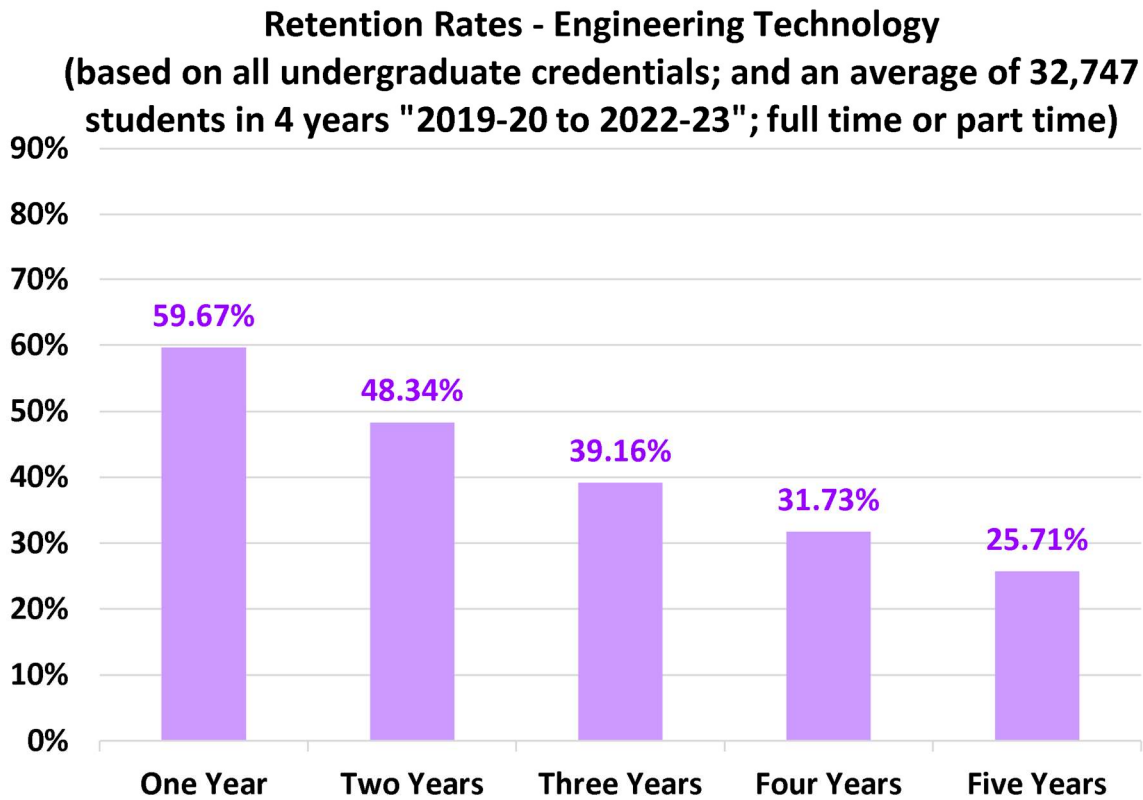


Figure 8. Engineering Technology retention rates.

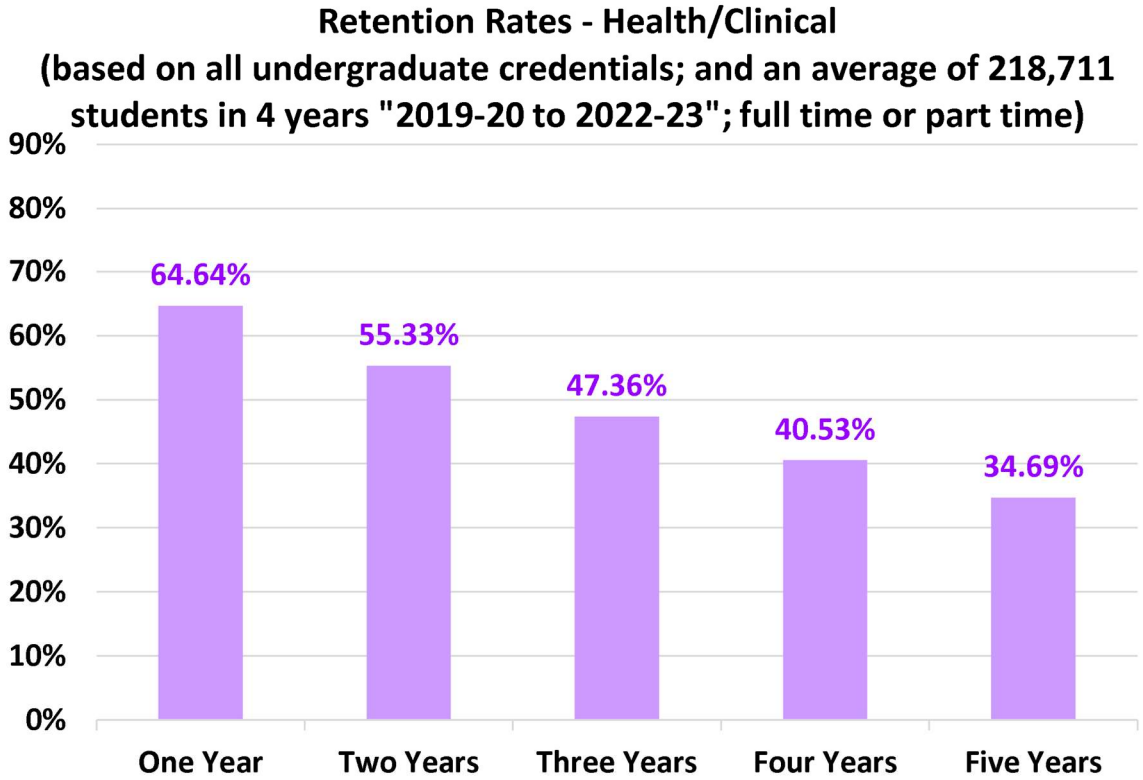


Figure 9. Health/Clinical retention rates.

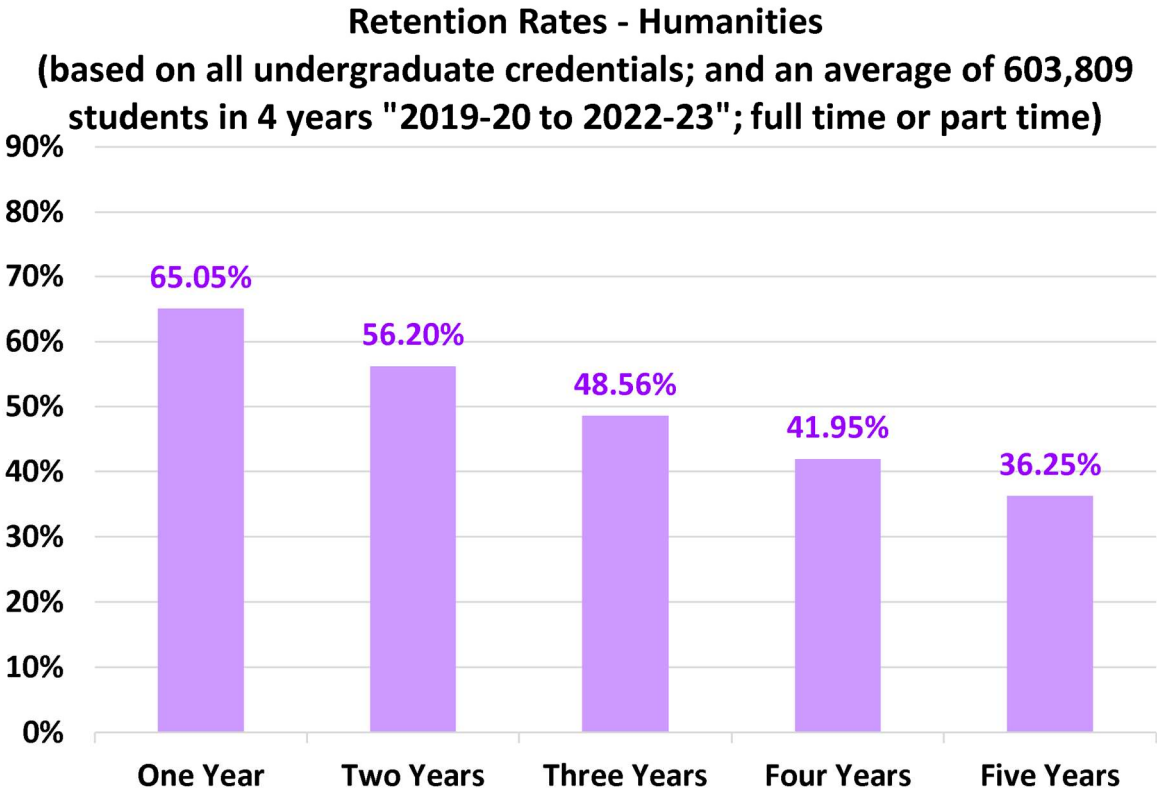


Figure 10. Humanities retention rates.

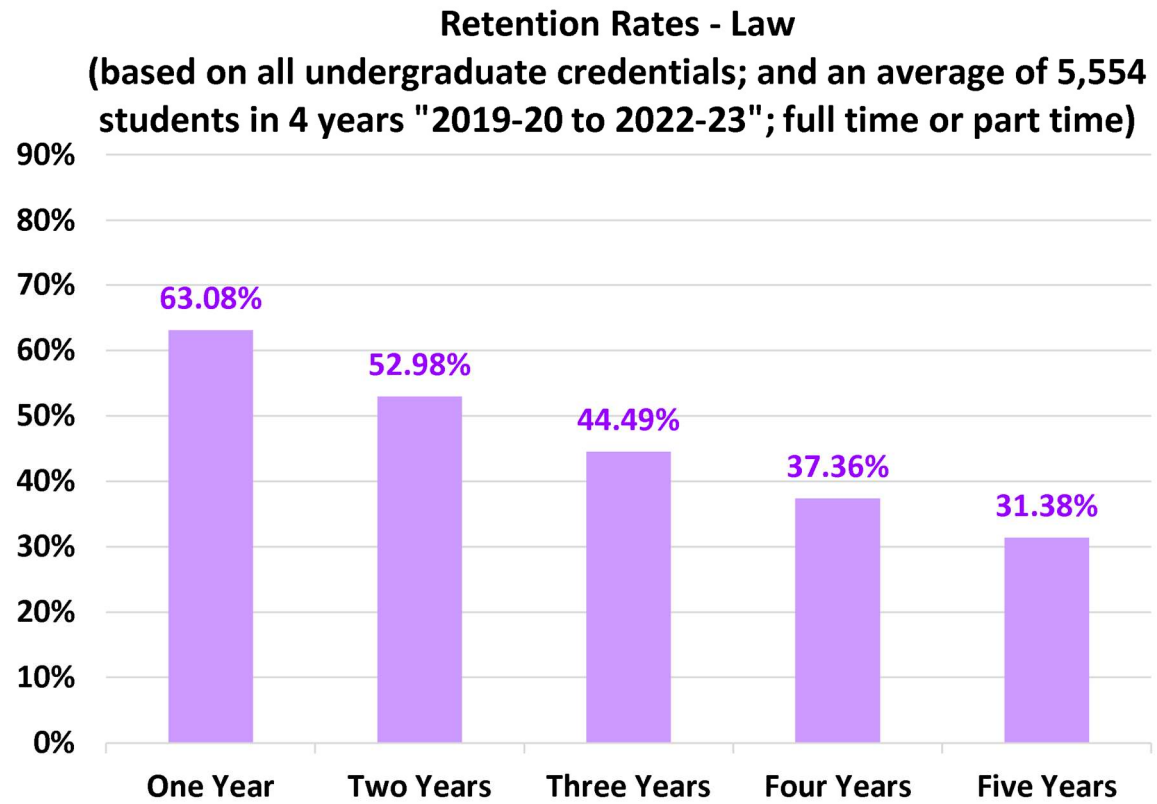


Figure 11. Law retention rates.

3.3. Overall Progression Rates

Figure 12 shows the overall undergraduate graduation rates. These are based on NSC-RC data.

The mean first-year progression rate non-foundation-year is 75.22%. The value of 75.22% for $\overline{PR}$ is computed according to Equation (16) as $\overline{PR} = 0.25 (PR_1 + PR_2 + PR_3 + PR_4)$, where the raw first-year progression rates (directly from the NSC-RC database) for the four consecutive cohorts (Fall admission) of 2019-20, 2020-21, 2021-22, and 2022-23 are $PR_1 = 0.738072192$, $PR_2 = 0.748297756$, $PR_3 = 0.757355268$, and $PR_4 = 0.765102937$; respectively. Then, our proposed discount factor for extrapolating the progression rate (λ_{PR}) is computed according to Equation (15) as $\lambda_{PR} = 0.25 (\sqrt{PR_1} + \sqrt{PR_2} + \sqrt{PR_3} + \sqrt{PR_4})$, which gives $\lambda_{PR} = 0.86728$. Finally, the extrapolated progression rate (for institutions that adopt this time window for defining their progression rate) is computed according to Equation (20) as $PR(\text{four years}) = \lambda_{PR}^3 \overline{PR}$, which gives the value of 49.07% displayed in the figure.

For higher education institutions or academic programs that adopt a non-credit bridging foundation program, if this progression rate is of the “within-institution/program study advancement” type (this is $\widehat{PR}(\text{one year})$), then its adjusted average first-year value is 37.61%. This is $\widehat{PR}_{FY}(\text{one year})$, which in our model is approximated according to Equation (21) as $\mu(\text{one year}) \widehat{PR}(\text{one year}) = 0.5 \widehat{PR}(\text{one year})$; where $\widehat{PR}(\text{one year})$ is 75.22%, and its value is computed following the same method as $\overline{PR}$.

Progression "Persistence" Rates - Disciplines Combined
(based on all undergraduate credentials; and an average of 2,439,729
students in 4 years "2019-20 to 2022-23"; full or part time)

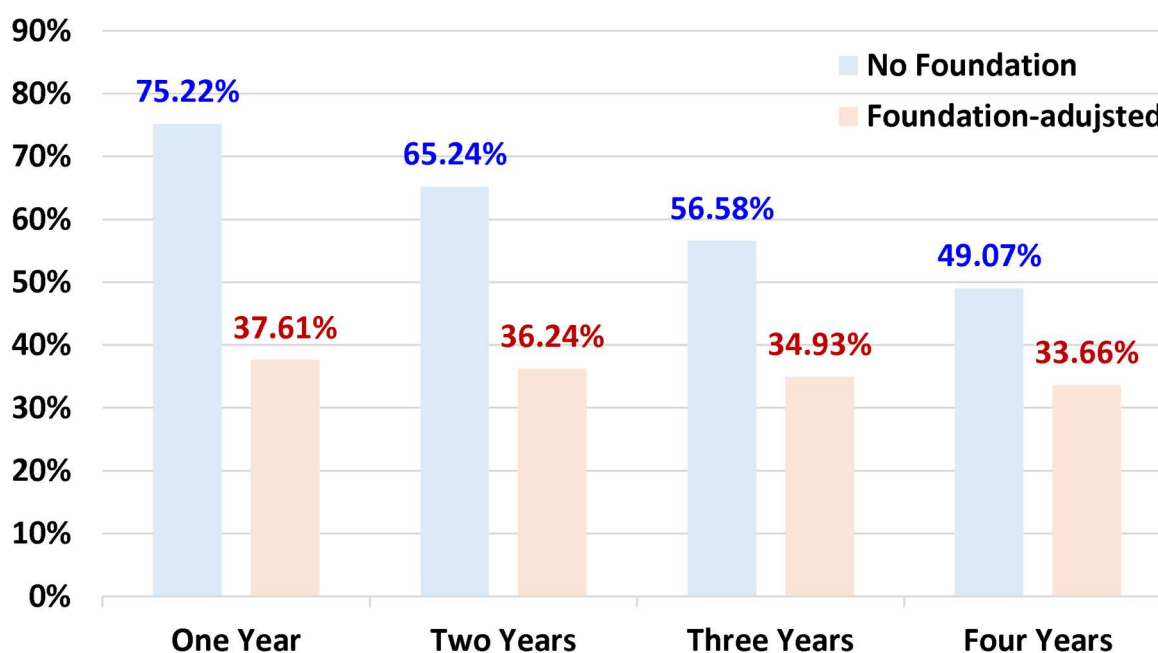


Figure 12. Overall progression rates.

3.4. Discipline-Specific Progression Rates

For the selected nine disciplines, and based on NSC-RC data, we present discipline-specific progression rates in Figures 13–21.

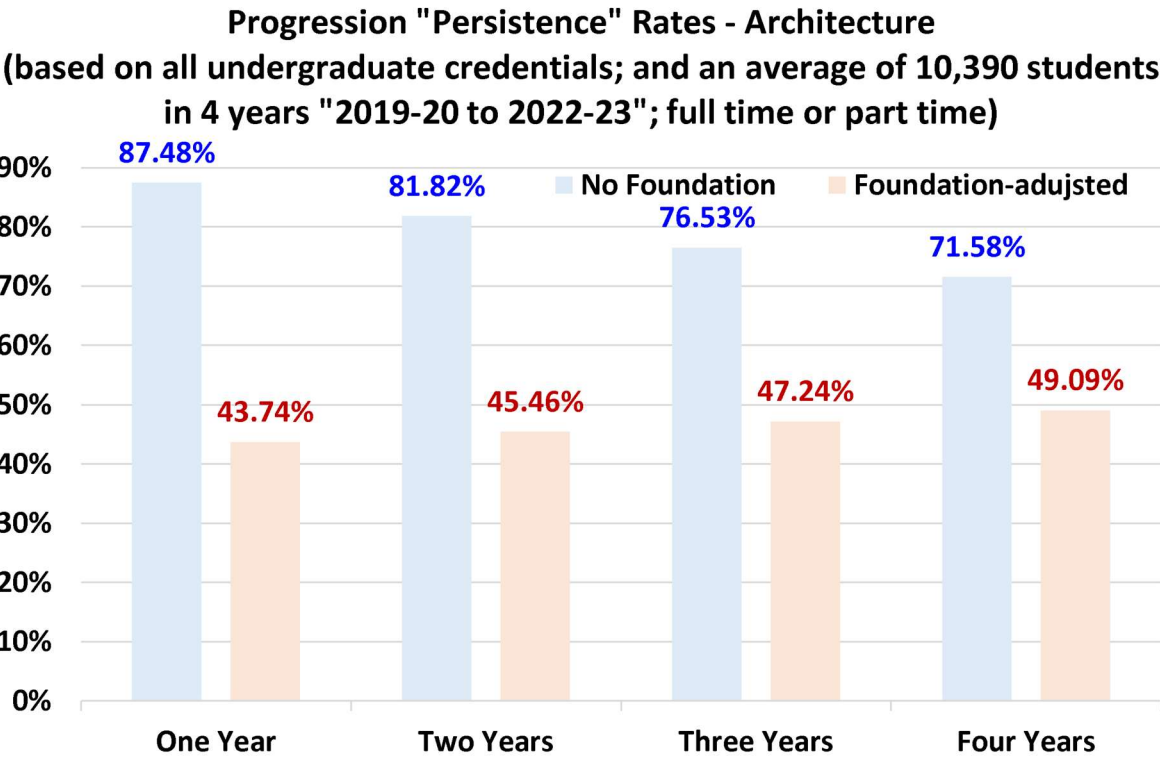


Figure 13. Architecture progression rates.

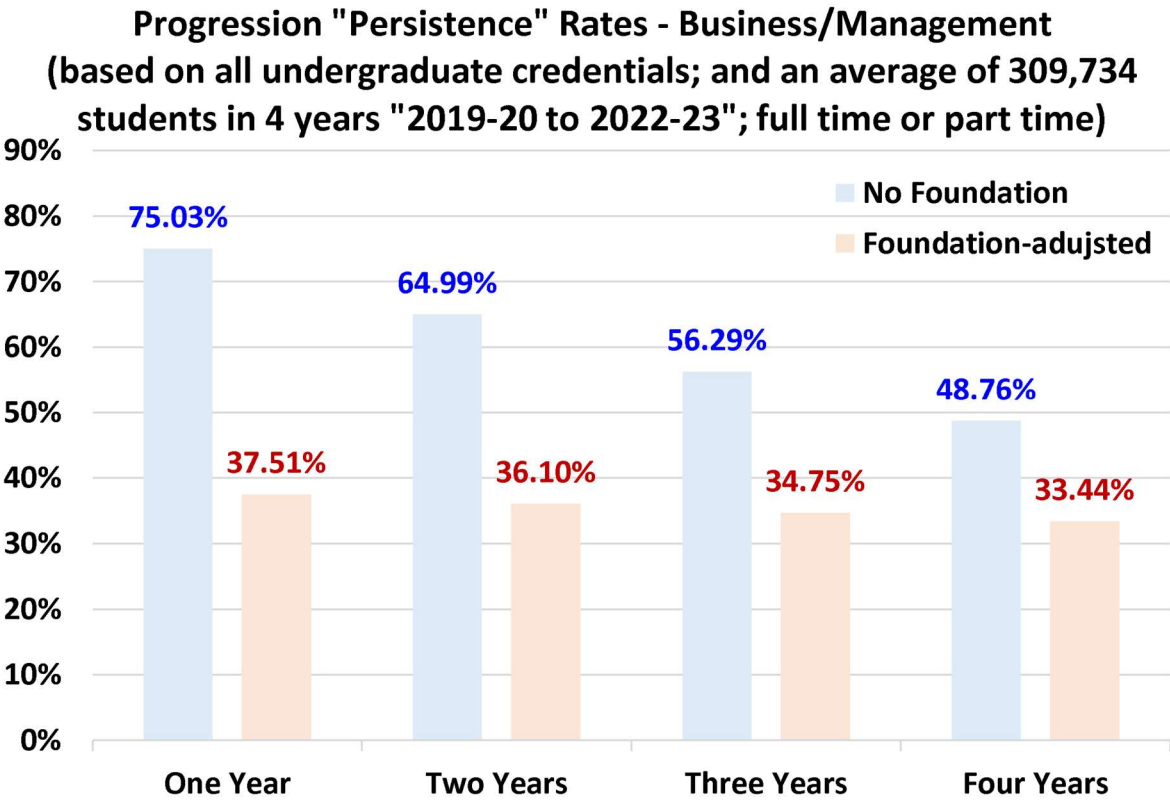


Figure 14. Business/Management progression rates.

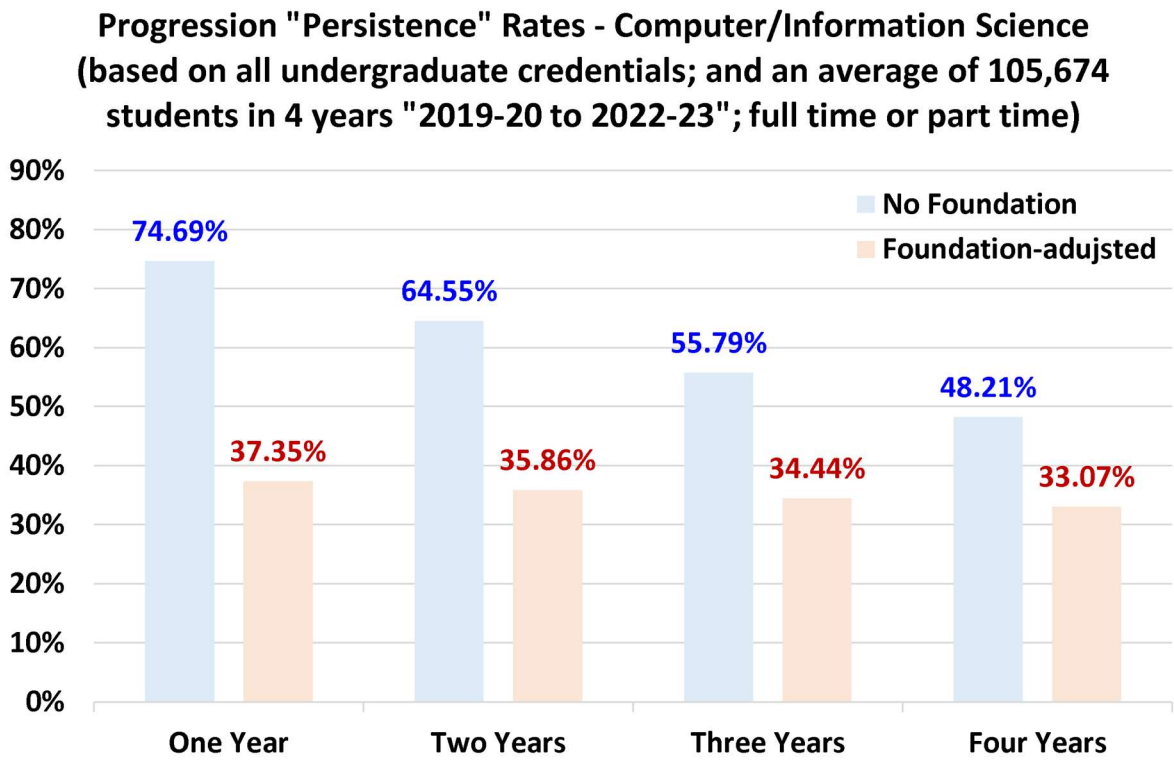


Figure 15. Computer/Information progression rates.

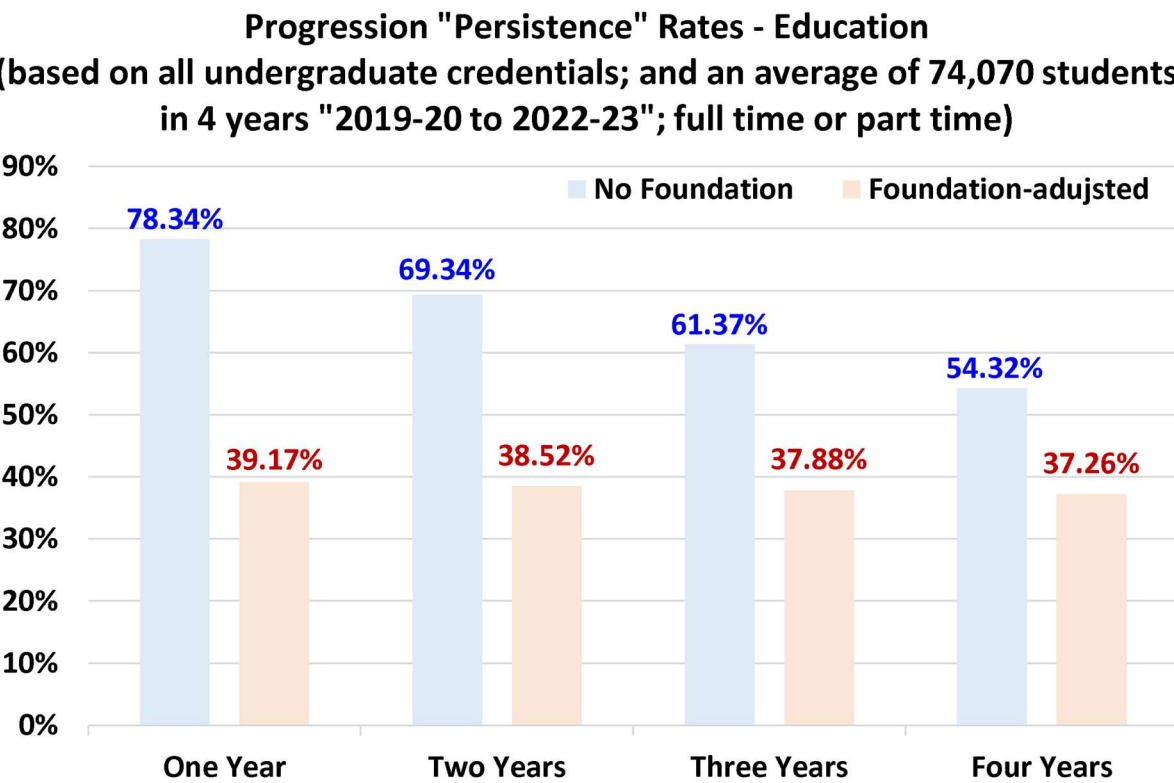


Figure 16. Education progression rates.

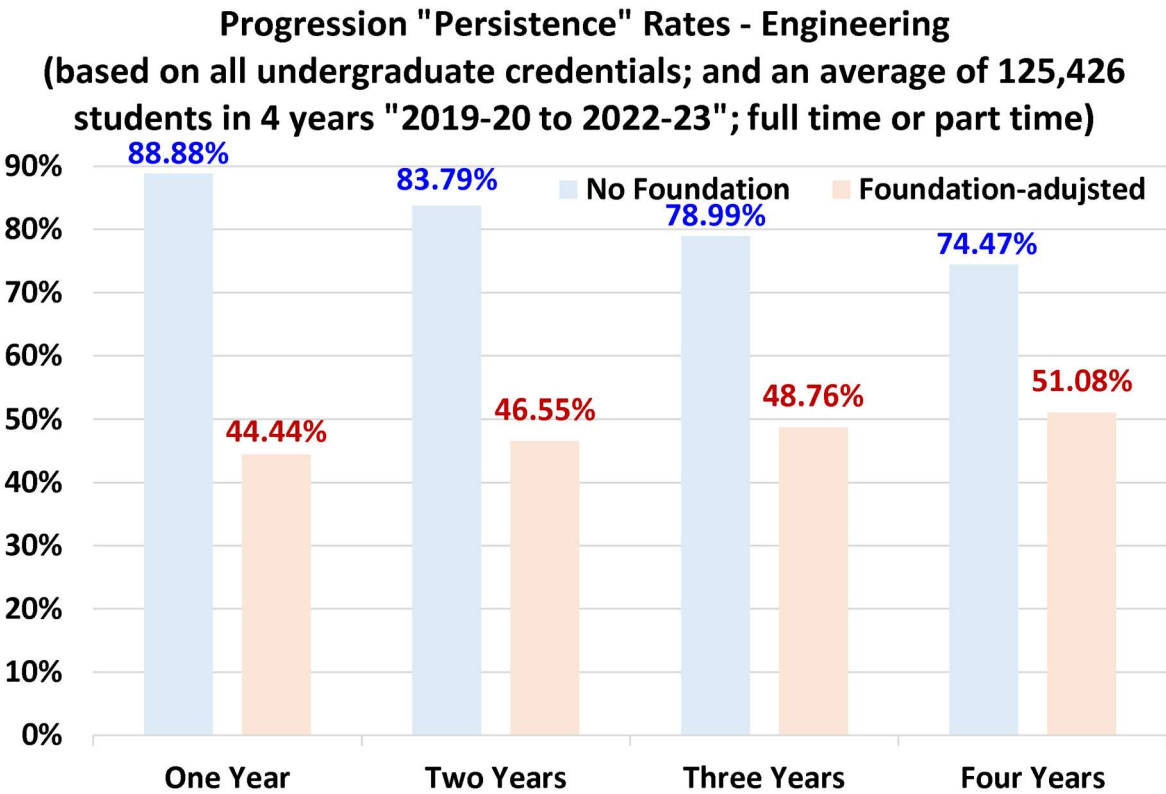


Figure 17. Engineering progression rates.

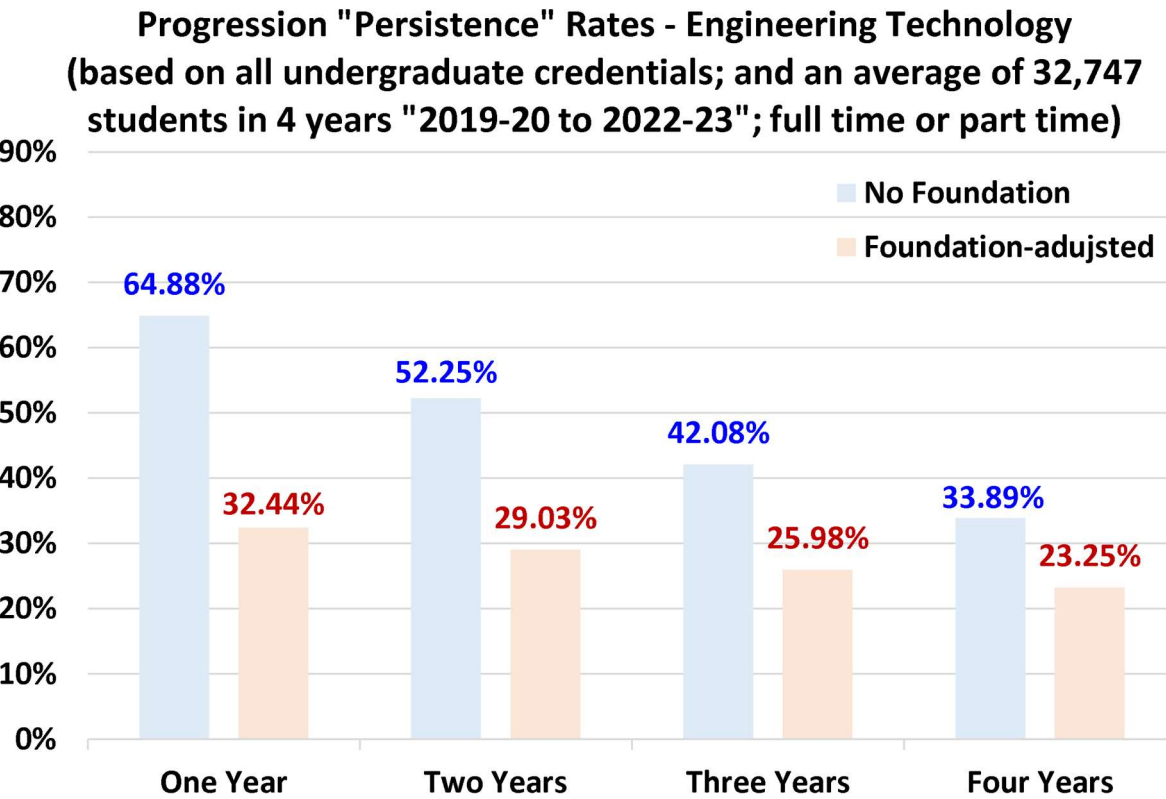


Figure 18. Engineering Technology progression rates.

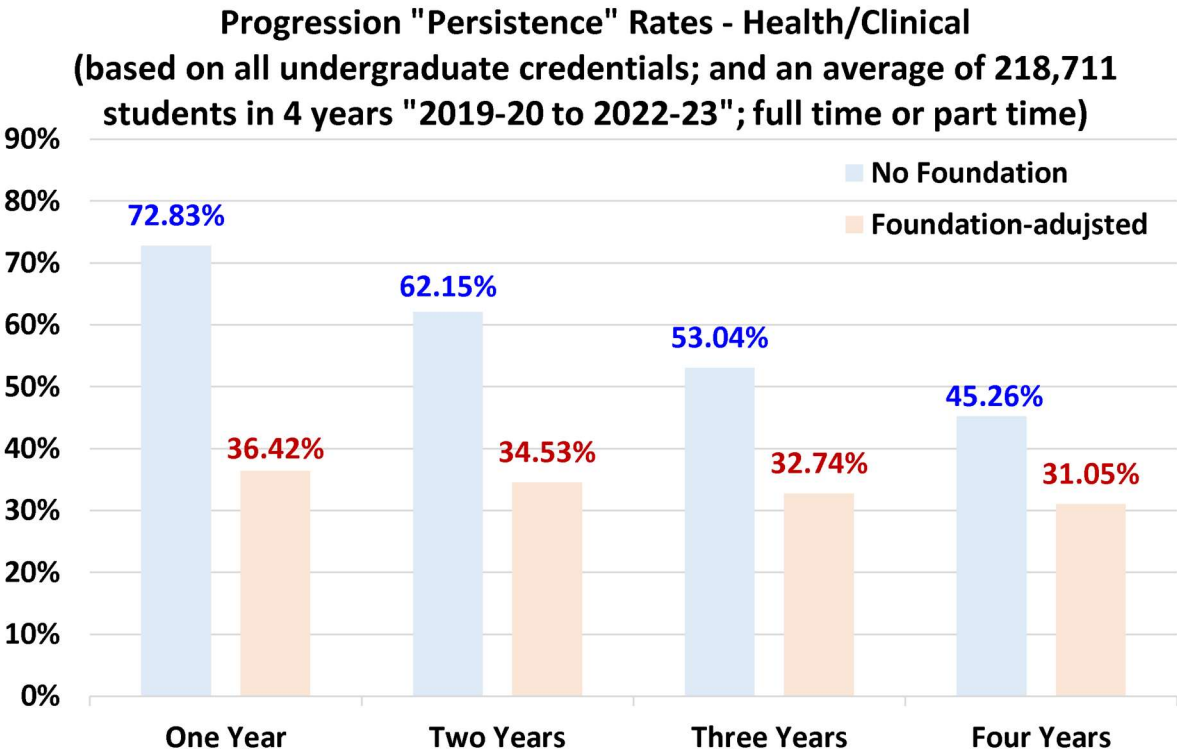


Figure 19. Health/Clinical progression rates.

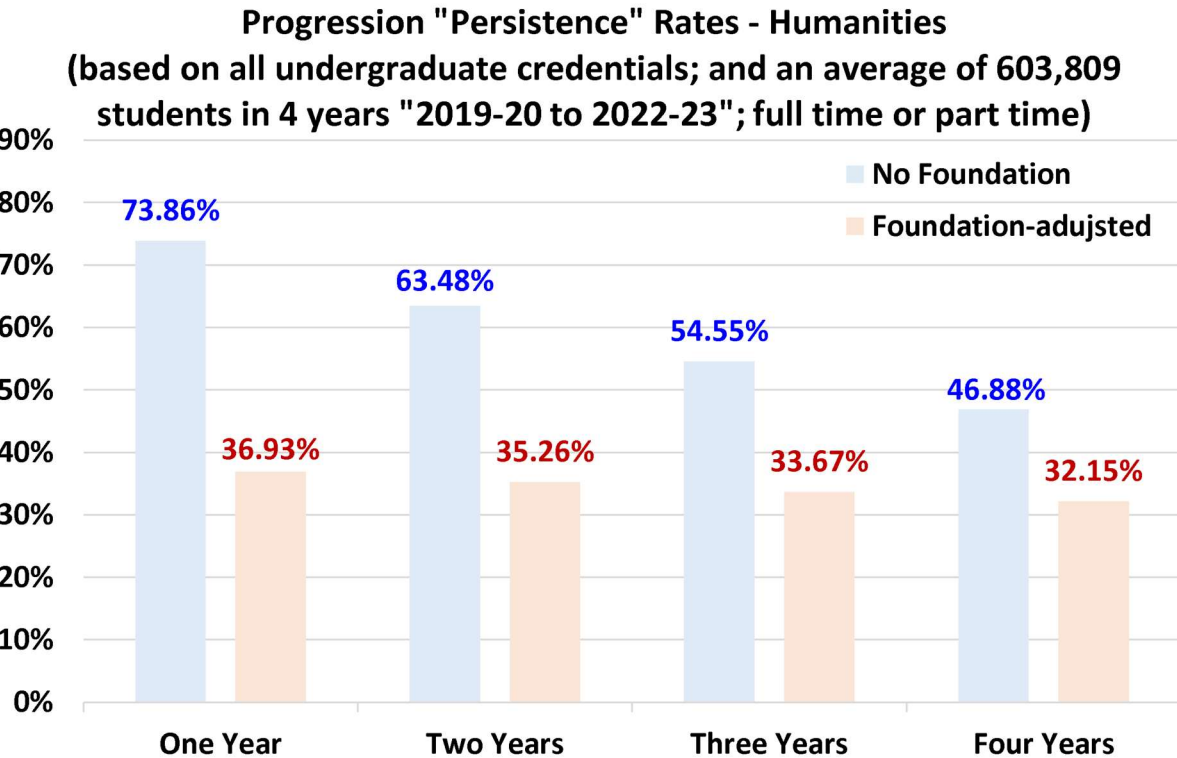


Figure 20. Humanities progression rates.

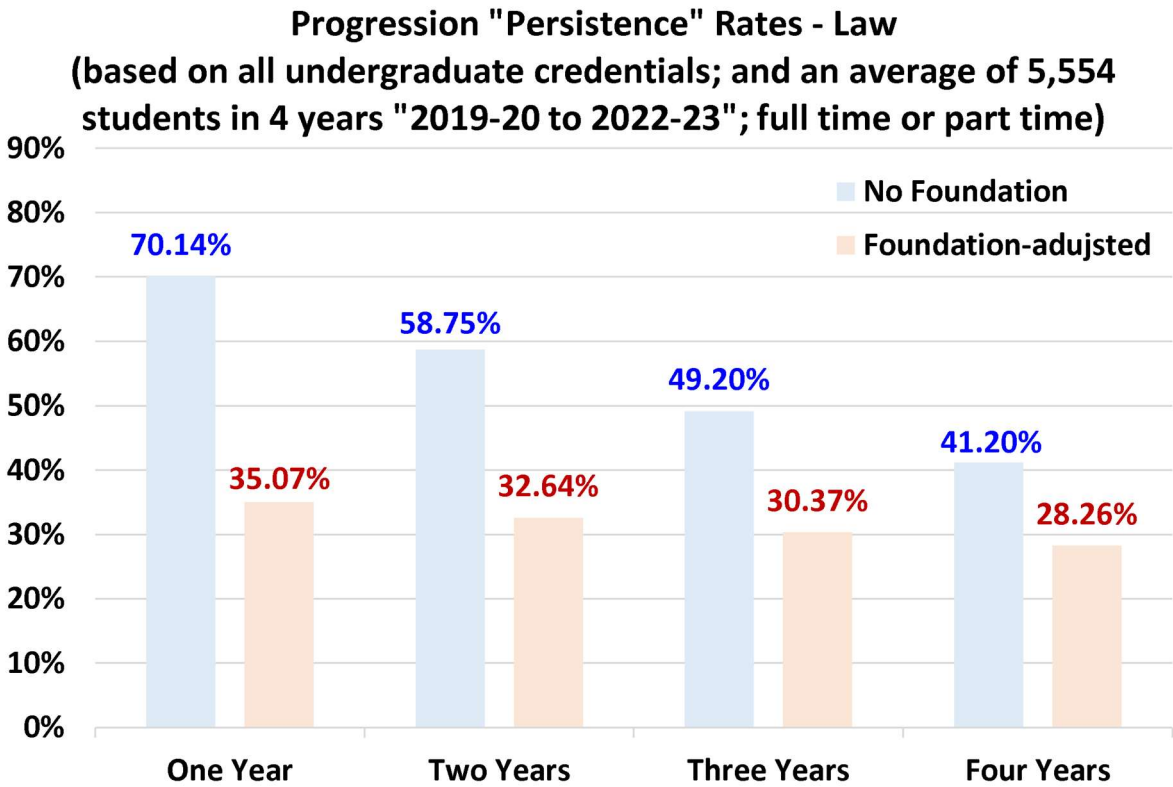


Figure 21. Law progression rates.

3.5. General Full-Time Bachelor’s Degree Graduation Rates

Our estimation for the benchmarking graduation rates (or completion rates) is shown in Figure 22. The graduation rate has been consistently from 63.4% to 64.6%.

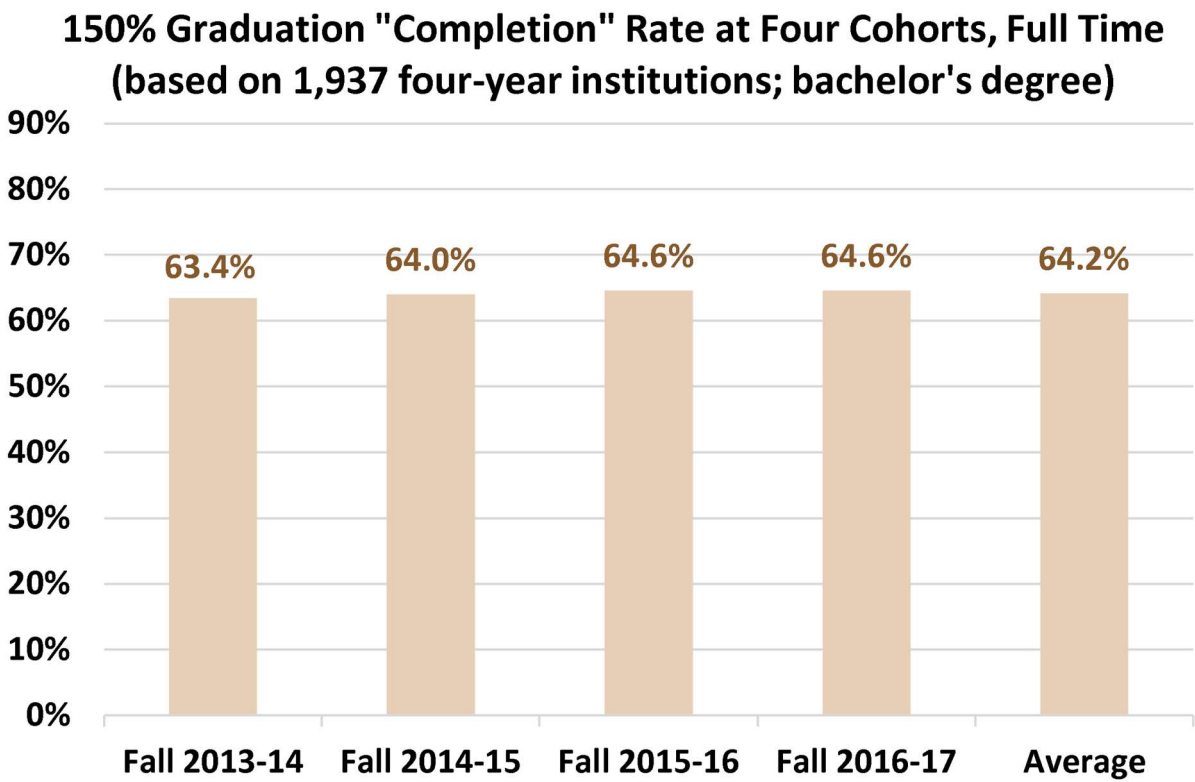


Figure 22. Overall graduation rates.

3.6. Retention-Progression Correlation

The observed matching of the disciplines having extremum retention rates and progression rates stimulates further investigation of the correlation between the retention rates and progression rates for the nine disciplines covered here. Through Figure 23, we show that there is nearly a linear correlation between the two tracking rates (the figure is based on the rates with a one-year time window, without extrapolation); where we obtained the following reduced-order model, with the coefficient of determination (or R-squared) being 0.9765, and its adjusted R-squared value being 0.9731; and both values are favorably close to 1.0, suggesting strong linear dependence [207–211]:

$$RR(\text{one year}) = 0.9918 PR(\text{one year}) - 6.64\% \quad (25)$$

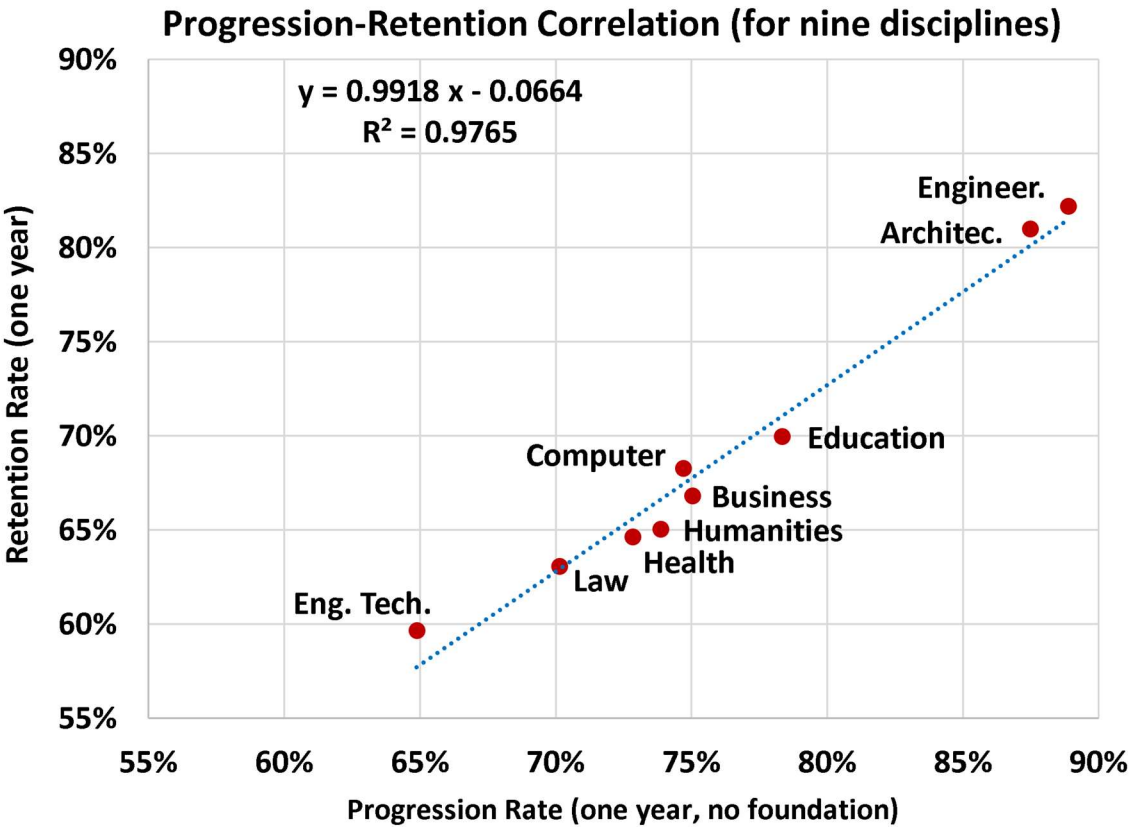


Figure 23. Relation between retention rates and progression rates for the nine selected disciplines.

Further statistical analysis (hypothesis testing) shows that this linear dependence is statistically significant, with a p-value of only 5.86×10^{-7} , which is much less than the typical threshold significance level of 0.05 [212–216]. Furthermore, the 95% confidence interval for the regression coefficient (0.9918) is (0.8480-1.1211), and the 99% confidence interval for it is (0.7825-1.1866); and both intervals are relatively far from the trivial zero value; therefore, that the null hypothesis that retention rates are not dependent on the progression rates can be rejected. The inferential statistical tool used here is the Analysis ToolPak’s Regression tool of Microsoft Excel [217].

It should be noted that the linear correlation obtained here is partly attributed to the inherent coupling mentioned earlier between the retention rate and progression rate, according to the way both are defined.

4. Further Remarks

In this section, we make seven supplementary comments, which are aimed primarily at providing brief standalone elements that extend the scope and value of the main part of this study.

4.1. Proposed Progression and Graduation Rate Formulas

First, it should be noted that according to the defining expression in Equation (4) for the “within-institution/program” progression rate ($\widehat{PR}$), this progression rate is actually influenced by the retention rate, where $\widehat{PR}$ cannot reach 100% if RR is below 100%. This feature mandates that $\widehat{PR}$ should not be interpreted independently of RR, due to the coupling between them. A preferred expression for a scaled “within-institution/program” progression rate ($\widehat{PR}'$) that is magnified for properly becoming an efficiency-like figure or a nondimensionalized (dimensionless) variable that lies exactly between 0 and 1.0 or 100% (as commonly done for describing or solving problems in physics and engineering), is [218–232]

$$\widehat{PR}' = \frac{\text{number of students maintaining a satisfactory pace}}{\text{number of retained students}} = \widehat{PR}/RR \quad (26)$$

Similarly, according to the defining expression in Equation (7) for the graduation rate (GR) or completion rate (CR), this graduation rate is actually influenced by the retention rate, where GR cannot reach 100% if RR is below 100%. This feature mandates that GR should not be interpreted independently of RR, due to the coupling between them. A preferred expression for a scaled graduation rate (GR') or a scaled completion rate (CR') that is magnified for properly becoming an efficiency figure (exactly bounded between 0% and 100%) [233–239] is

$$GR' = \frac{\text{students graduated within an extended period}}{\text{retained students}} = GR/RR \quad (27)$$

4.2. Proposed Performance-Based Progression Rate

Second, all the students' tracking rates analyzed in the current study (retention, progression, and graduation) are not affected by the grades of the students. While this might not be a problem for the retention rate and the graduation rate; it can be viewed as a shortcoming in the progression rate, because it does not allow distinguishing between students who advance toward graduation while maintaining higher grades and those also advancing at the same rate while receiving only the passing marks. Thus, an additional metric may be devised for monitoring this aspect, such as the portion of students with a cumulative grade point average (CGPA) above a set threshold. Alternatively, a performance-based “within-institution/program” progression rate ($\widehat{PR}''$) may be introduced, rather than being merely based on passing courses regardless of the level of academic performance. Such a performance-based progression rate may be expressed as

$$\widehat{PR}'' = \frac{\text{students maintaining a satisfactory pace and satisfactory CGPA}}{\text{retained students}} \quad (28)$$

4.3. Proposed Discipline Classification for STEM Programs

Third, we point out here that some STEM (Science, Technology, Engineering, and Mathematics) programs may have ambiguity in terms of their classification into one of the nine broad disciplines covered in this study, such as being possibly considered an “engineering” program while also possibly viewed as a “computer/information science” program. In such a case, we propose that the official title of the program is used as a criterion for the classification [240–243]. If the program title has the word “Engineering”, then our suggested engineering retention and progression benchmarking rates can be used for that program. This proposed method for resolving any classification conflict is aligned with the program eligibility requirement for accreditation by the leading accreditation body [244–246] ABET (by the Accreditation Board for Engineering and Technology, Inc.), where the word “engineering” in the program's name is necessary to be accredited according to the Engineering criteria of ABET, whereas the phrase “engineering technology” in the program's name is necessary to be accredited according to the Engineering Technology criteria of ABET [247–249]. For example, we prefer that a “Computer Engineering” undergraduate program utilizes our suggested benchmarking rates for the (engineering) discipline, whereas we prefer that a “Computer Science” program utilizes our suggested benchmarking rates for the

(computer/information science) discipline. Similarly, we prefer that an “Architectural Engineering” undergraduate program utilizes our suggested benchmarking rates for the (engineering) discipline, whereas we prefer that an “Interior Architecture” program utilizes our suggested benchmarking rates for the (architecture) discipline.

4.4. Logical Condition on the Retention-Progression Ratio

Fourth, the way how the raw progression (persistence) rates were obtained explains why the progression rate here is always larger than the retention rate for the same discipline; because each retained student is automatically progressing (persistent), while not each progressing (persistent) student is necessarily retained. If these raw progression (persistence) rates were obtained based on the study advancement within the same institution or program, then the progression rate is always less than or equal to the retention rate; because each progressing (persistent) student is automatically retained in this case, while not each retained student is necessarily progressing (persistent).

4.5. Limitations of the Current Study

Fifth, the limitations of this study include the assumed value of the penalty factor and the model for the discount factor, which are not based on empirical data. However, logical justification was provided for these parameters. Also, the set of nine disciplines selected for further retention and progression analysis can be outside the interest of a reader from other disciplines. However, those readers interested in other disciplines can apply our proposed model to the raw data and obtain their own discipline-specific rates. In addition, the study was based on US datasets. However, the large data size and the reporting robustness make it attractive to higher education institutions outside the USA, especially when these rates are viewed as external (non-local) points of reference to be augmented with national rates.

We also acknowledge the limitation implied by our proposed classification method for programs that may appear to fit in two of the nine broad disciplines for which we provided discipline-specific tracking rates. The proposed classification method was entirely based on the official title of the program, and this neglects several important components of the programs, such as the program objectives (PO), the program learning outcomes (PLO) – also called student outcomes (SO) [250], and the program description. Despite these limitations, using the program title per se for inferring the broad discipline of the program has an advantage of sustainability, because the program title can remain the same for an extended period of time while the program objectives, program learning outcomes, and program description change as a result of a periodic program review or as a result of an update in the criteria set by an accreditation body by which the program is accredited. Also, using the program title alone for classifying the program makes the classification process quick and easy to implement without the need to refer to more details about the program.

We admit that our study is largely descriptive with regard to its results, particularly the discipline-specific rates. For example; while our study’s findings show that the student’s retention rates in (Engineering) and (Architecture) are relatively high, the study does not provide an interpretation for this phenomenon. However, it should be noted that such a deeper evaluative analysis is beyond the scope of our study, and it warrants a separate research work to address these important aspects and extend our work.

4.6. Example of Real-World Application

Sixth, our discussed remark here is a demonstration of a real-world situation where the availability and comprehensiveness of our benchmarking of students’ tracking rates become very useful. This example corresponds to the new (second version of 2024) national institutional accreditation system within the Sultanate of Oman. This Omani system, called Institutional Standards Assessment (ISA), for higher educational institutions in Oman is divided into sections called “Standards”, and each Standard is further divided into subsections called “Criteria”. There is a total

of six standards and 45 criteria in the second version of the Institutional Standards Assessment (ISA) in the Sultanate of Oman [251]. In the second standard (Standard 2: Academic Provision and Resources), the last (10th) criterion is (Criterion 2.10: Student Performance and Graduate Outcomes). This criterion stipulates that “Student retention, progression, attrition and completion data is routinely collected, reported and effectively utilised to inform planning and resource allocation, and enhance student support services”. Through our proposed benchmarking retention rates (the complement of which are the proposed benchmarking attrition rates), progression rates, and graduation rates (same as “completion rates” in version 2 of ISA) presented in this study; higher education institutions in Oman can claim with evidence their fulfillment of this national accreditation component to the Panel Assessor Members, who typically include members from outside Oman. With the benchmarking values reported here in our study, the collected students’ tracking rates at Omani higher education institutions can be then interpreted as being low (corrective actions are needed) or high (no corrective actions are needed). Such comparison and subsequent action taken afterward (if applicable) shows a systematic and robust process to effectively utilize the collected students’ tracking rates for the purpose of informing the institution-level planning and resource allocation. The benchmarking values reported in our study also serve as a valuable way for managers of Omani institutions to respond to inquiries from ISA Panel Assessor Members (either during the on-campus investigative visit or during submitting self-assessment reports before the visit) regarding how they can judge the adequacy of their students’ tracking rates, and what benchmarking levels they have for that. Because our study synthesizes the retention and progression rates at multiple time windows, and also takes into account the factor of the foundation year with regard to the progression rates; our benchmarking values can suit a wide spectrum of higher education institutions in Oman, regardless of how they define their own tracking time window and regardless of having a foundation year or not. The comprehensiveness of our benchmarking data which are pre-customized for many educational settings makes them widely applicable in this real-world example.

4.7. Comparison with Other Studies

Seventh, the last remark is a comparison with some of the rates reported here with those reported in external sources. For example, we reported a benchmarking graduation rate of 64.2% for full-time bachelor's degree students (within 150% of the study duration). Comparing this to the average for the 23 countries of the OECD (Organisation for Economic Co-operation and Development), the graduation rate was 67% within three years after the nominal study duration for bachelor's programs [252]. The two rates are close to each other, and this can lead to a statement that the OECD countries (collectively) are on a par with other institutions in terms of this higher education quality metric. We reported a benchmarking one-year overall retention rate of 75.93% for full-time bachelor's degree students. The American University of Ras Al Khaimah (AURAK), located in Ras Al Khaimah in the United Arab Emirates (UAE), reported a value of 77% (average of seven historical records between the cohort of Fall 2016 and the cohort of Fall 2022) [253]. The similarity of the two values also indicates a satisfactory quality metric for AURAK. In Australia, a study showed that by age 23 years, 21% of the additional students had dropped out from their university without receiving a qualification [254]. If this is taken as equivalent to a retention rate of 79% (attrition rate of 21%), then this value is also comparable to our benchmarking value.

5. Conclusions

We developed benchmarking rates for undergraduate students. The overall benchmarking retention rate is 76%. The benchmarking progression without a foundation year is 75%. The overall graduation rate is 64%. This study can be extended in future work in multiple ways, such as making it a periodic source of external benchmarking retention, progression, or graduation rates; through updating the results based on new releases of the underlying datasets. In addition, future comparative studies are proposed with datasets from other geographic regions if deemed to be comprehensive, longitudinal, robust, and well-documented. Also, the use of empirical analysis to

verify or modify our assumed modeling parameters (penalty factor and relaxation factor) is another proposed extension of this work.

6. Recommendations

Actionable recommendations from this study include

- We recommend that new higher education institutions (or those established ones but not yet adopted a definition for their retention, progression, or graduation rates) define their retention, progression, or graduation rates such that they meaningfully serve as a proper normalized metric, bounded between 0 and 1, according to the mathematical formulas we provided for this purpose.
- We recommend that academic accreditation bodies or academic ranking services should clearly define the retention, progression, or graduation rates if they ask higher education institutions or academic programs to report them. A good example of this is the UK-based universities ranking service QS (Quacquarelli Symonds), which defines it “Retention rate” as “The percentage of first-year undergraduate students who continue to their second year of study.” Thus, it is clear that the tracking window for this rate is one year from admission (or a Fall-to-Fall retention year) [255].
- We recommend that new higher education institutions pay a lot of attention before comparing their retention, progression, or graduation rates with those reported by another agency since mismatching definitions lead to wrong comparisons and interpretations.

Data Availability Statement: The main quantitative outcomes of this study are contained within this manuscript.

Declaration of Competing Interests Statement: Not applicable (no competing interests).

Nomenclature

ABET	Originally an acronym for (Accreditation Board for Engineering and Technology)
AR	Attrition rate (the complement of the retention rate; their sum is always 100%)
AURAK	American University of Ras Al Khaimah
CIP	Classification of Institutional Programs
HEP	Higher education provider (similar to HEI)
IES	Institute of Education Sciences (part of ED)
ISA	Institutional Standards Assessment of the Sultanate of Oman
NCR	Non-continuation rate (same as the attrition rate)
OECD	Organisation for Economic Co-operation and Development
PLO	Program Learning Outcome
PO	Program Objective
pp	Percentage point
SO	Student outcome

STEM	Science, Technology, Engineering, and Mathematics
TR	Tracking rate (a generic name for the retention rate, progression rate, and graduation rate)
UAE	United Arab Emirates
UNESCO	United Nations Educational, Scientific and Cultural Organization

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