

# Trends in Instructional Activity in STEM Disciplines at the University of Wisconsin- Madison

Prepared June, 20 2014

## Executive Summary

This report reviews recent trends in instructional activity in STEM (science, technology, engineering, and math) disciplines at the University of Wisconsin-Madison (UW-Madison). There is no single commonly used definition of STEM. For the purposes of this analysis, we have defined STEM to include the science disciplines, engineering, and math programs, and also the health professions programs. (See Appendix A for details on what disciplines are included.)

Unless otherwise specified, this report covers the years 2000-01 to 2013-14 for enrollments, student credit hours, and faculty counts, and the years 2000 to 2013 for degree trends.

### Summary of Key Findings

This report demonstrates substantial growth in the number of students at UW-Madison who take classes in or major in STEM fields. For instance:

- Undergraduate enrollment in STEM majors has increased from 32% to 41% of enrolled juniors and seniors since 2000.
- STEM majors now account for 40% of undergraduate degrees, up from about 35%; most of the increase was in the past five years.
- Peer comparison data show that UW-Madison graduates about 1,000 more students with degrees in STEM majors (about 2,600 degrees) than the average of the peers. This is largely due to UW-Madison's larger student body; 40% of degrees are in STEM majors for both UW-Madison and the peers.
- There has been a 19% increase in student credit hours in STEM Subjects compared to a 5% increase in overall student credit hours.
- Chemistry, one of the largest credit-producing departments, has had a 37% increase in student credit hours. Math, the highest credit producing Subject, has had a 19% increase in student credit hours in the past five years. Other STEM subjects have also had double digit increases.
- Since 2001, the number of faculty and instructional academic staff who teach STEM courses has not increased. With the increased enrollments in STEM courses, this has led to an increase in teaching loads. Student credit hours taught per instructor among faculty has increased 10%, while instructional academic staff who teach in STEM have seen a 50% increase in their student credit hours per instructor.

# Trends in Instructional Activity in STEM Disciplines at the University of Wisconsin- Madison

## Introduction

This report reviews recent trends in instructional activity in STEM (science, technology, engineering, and math) disciplines: there is no single commonly used definition of STEM. For the purposes of this analysis, we have defined STEM to include the science disciplines, engineering, and math programs, and also the health professions programs. (See Appendix A for details on what disciplines are included.)

The follow measures related to STEM activity are presented below:

- A. Enrollments in STEM majors. Each major was classified either as a STEM or non-STEM major. Students enrolled in at least one STEM major are counted as enrolled in STEM.
- B. Degrees awarded to students in STEM majors (referred to as STEM degrees). As with enrollments, each major was classified either as a STEM or non-STEM major. Students who graduated with at least one major in STEM were counted in STEM. Peer comparisons for undergraduate degrees, by major, are also reported.
- C. Instructional activity, as measured by student credit hours. Student credit hours are counted on the basis of enrollments in courses within a given subject area (e.g. Chemistry, Math, Biology). Most, but not all, subjects correspond to an academic department. A 3-credit course with an enrollment of 100 students counts for 300 student credit hours.
- D. Faculty. Each academic department was assigned to be either a STEM or non-STEM department. Faculty counts were based on the sum of the tenured/tenure track faculty in STEM departments.

Student enrollments and student credit hours are given at three levels.

- Undergraduates refer to students seeking bachelor's degrees.
- Graduate students include all of those seeking master's degrees and PhD (research doctoral) degrees.
- Clinical/professional doctorates is a category that includes the professional programs: MD, DVM, Doctor of Audiology (AuD), Doctor of Nursing Practice (DNP), Doctor of Physical Therapy (DPT), and Law. All of these programs except Law are counted as STEM programs.

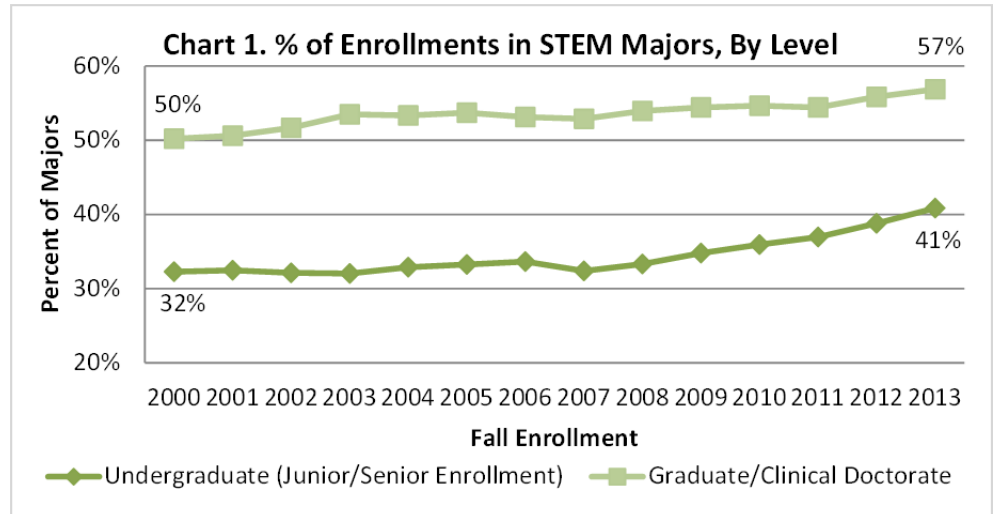
Unless otherwise specified, this report covers the years 2000-01 to 2013-14 for instructional activity (credits), enrollments, and faculty counts, and the years 2000 to 2013 for degree trends.

## A. Enrollment Trends in STEM Majors

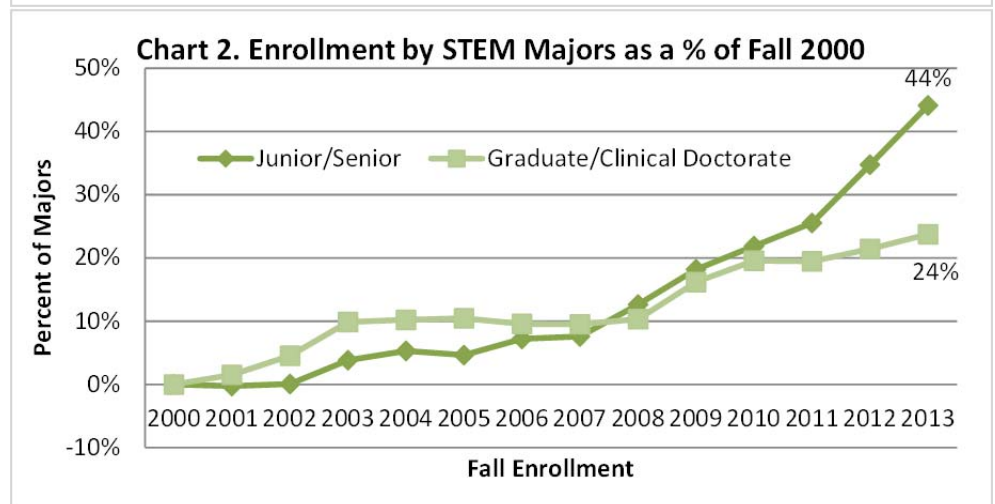
One way to measure growth is to compare the percent of all students enrolled in STEM majors over time (Chart 1). The percent of undergraduates who are enrolled in STEM majors has increased from 32% to 41% of enrolled undergraduates.

Undergraduate enrollment trends are based on junior/senior students because many lower-level students do not have a declared major.

Similarly, the percent of graduate students and clinical doctorates that are enrolled in STEM majors has increased from 50% to 57%.



Another measure of growth to consider is the percentage growth in STEM majors against a base year. This measure represents growth compared to levels in 2000 (Chart 2).



For undergraduates, the absolute growth of enrollments in STEM majors has been about 44%, most of it since 2007.

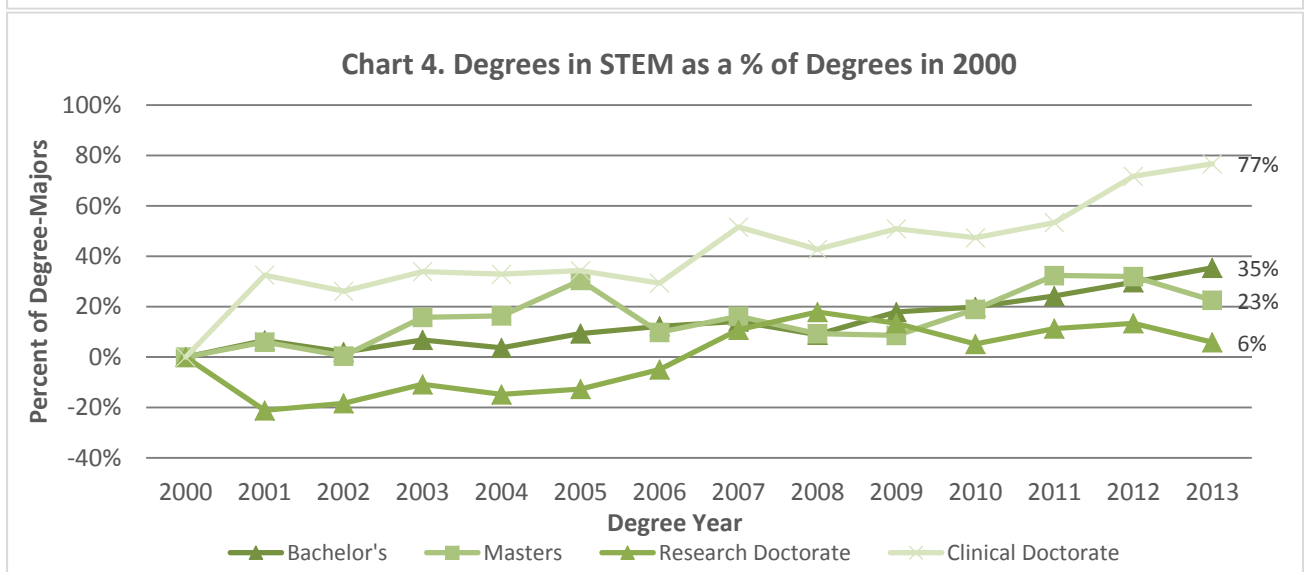
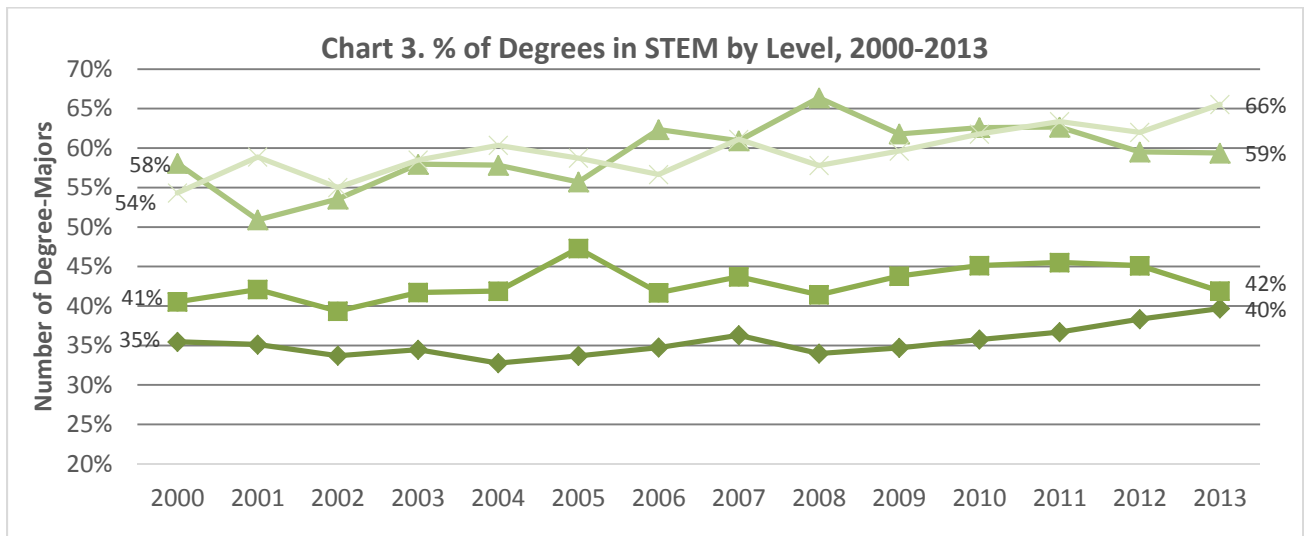
For graduate students and students enrolled in clinical doctorates, the absolute growth has been about 24%.

## B. Degree Trends in STEM

Degree trends represent the work that students have completed. Consequently degree trends may lag a bit behind enrollments in reflecting trends in STEM activity.

Growth in the percent of STEM degrees as a share of all degrees is shown in Chart 3. For undergraduates, STEM degrees now account for 40% of all degrees, up from 35% in 2000. Most of the growth has been in the past five years.

For graduate degrees, there has been little net change in the share of STEM degrees since 2000: 42% of master's degrees and 59% of PhD degrees are awarded in STEM majors.



Similar to enrollments, another measure of change over time is the percentage change in number of degrees measured against a base year (Chart 4). By this measure, undergraduate degrees in STEM have increased by about 35% since 2000.

There has also been growth in the volume of STEM degrees at the post-bachelor's levels. Numbers of STEM master's degrees has increased 23%. Numbers of STEM clinical doctorates have seen a 77% increase since 2000. In part this large increase in clinical doctorates is due to the implementation of new programs. The Doctor of Audiology, Doctor of Nursing Practice, and the Doctor of Physical Therapy have all been initiated since 2000 and are considered STEM in this report.

Undergraduate STEM Degrees by Major. Trends in degrees for some of the largest academic majors at UW-Madison provide a more detailed view of these trends (Chart 5).

- The Biology major is now the major held by the largest number of bachelor's degree graduates. It was established as a campus-wide major in 1999 and has been hugely successful as a cross-campus, general Biology major. Some patterns in the data suggest that the Biology major has attracted students who might otherwise have enrolled in more specialized majors such as Zoology, which has fewer degrees than in 2000.
- Mathematics, Mechanical Engineering, Nursing, and Biochemistry are other STEM majors that are showing increases in numbers of degrees in recent years.
- Some undergraduate STEM majors that were substantial degree producers at one time have transitioned to the master's or doctoral level since 2000: Occupational Therapy, Pharmacy, Physical Therapy, Physician Assistant are all now offered at the post-bachelor's level and not as bachelor's degrees. Even with this change there has been growth in STEM degrees. Students preparing for graduate work in these fields are generally completing undergraduate degrees in a range of STEM majors.
- Economics, Spanish, and International Studies are examples of large non-STEM majors that have had a substantial increase in undergraduate degrees. Many non-STEM fields have experienced a declining number of majors.

Undergraduate STEM Degrees Compared to Peers. Peer comparison data are readily available for degrees. This allows us to do a peer comparison for STEM degrees (Chart 6).

In 2011-12 (the most recent year peer data are available), 40.5% of UW-Madison's undergraduate degrees were in STEM majors, a total of 2604 degrees. The percentage of STEM degrees among peers was similar among other major research universities (39.5% at AAU institutions). However, because it has a larger student body, UW-Madison is contributing about 1,000 more STEM degrees annually (2,604 degrees) than the peer average (1609 degrees).

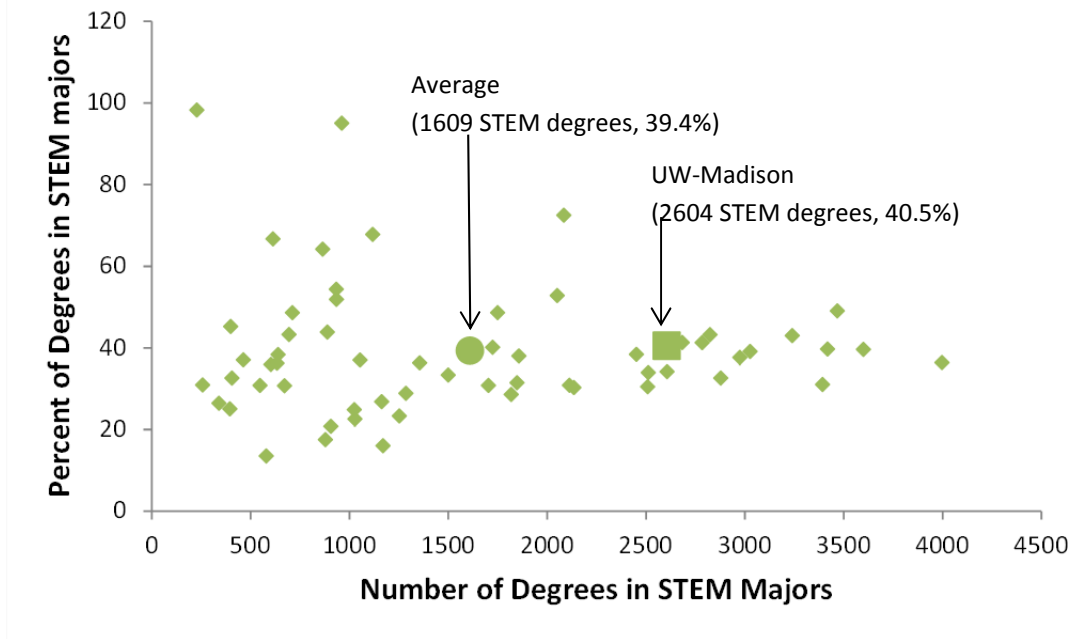
**Chart 5. Trends in Bachelor's Degrees Awarded by Major**  
**Based on the 30 Largest Majors in 2013**  
**(Sorted Alphabetically by STEM/Non-STEM Majors)**

|                               | Degree Year |      |      | Change from 2000-2013 |               |
|-------------------------------|-------------|------|------|-----------------------|---------------|
|                               | 2000        | 2006 | 2013 | Trend                 | %             |
| <b>STEM Majors</b>            |             |      |      |                       |               |
| Biochemistry                  | 87          | 97   | 139  |                       | <b>59.8</b>   |
| Biology                       | 6           | 332  | 540  |                       | <b>8900.0</b> |
| Chemical Engineering          | 102         | 79   | 95   |                       | <b>-6.9</b>   |
| Civil Engineering             | 81          | 103  | 120  |                       | <b>48.1</b>   |
| Computer Sciences             | 150         | 92   | 134  |                       | <b>-10.7</b>  |
| Environmental Studies         |             |      | 97   |                       | <b>---</b>    |
| Industrial Engineering        | 68          | 52   | 86   |                       | <b>26.5</b>   |
| Kinesiology                   | 71          | 58   | 84   |                       | <b>18.3</b>   |
| Mathematics                   | 65          | 91   | 157  |                       | <b>141.5</b>  |
| Mechanical Engineering        | 163         | 141  | 153  |                       | <b>-6.1</b>   |
| Nursing                       | 88          | 142  | 147  |                       | <b>67.0</b>   |
| Zoology                       | 208         | 147  | 132  |                       | <b>-36.5</b>  |
| <b>Non-STEM Majors</b>        |             |      |      |                       |               |
| Business: Marketing           | 222         | 156  | 154  |                       | <b>-30.6</b>  |
| Economics                     | 184         | 281  | 494  |                       | <b>168.5</b>  |
| Political Science             | 330         | 570  | 425  |                       | <b>28.8</b>   |
| Psychology                    | 339         | 337  | 362  |                       | <b>6.8</b>    |
| History                       | 254         | 324  | 276  |                       | <b>8.7</b>    |
| Communication Arts            | 238         | 277  | 270  |                       | <b>13.4</b>   |
| Spanish                       | 136         | 234  | 243  |                       | <b>78.7</b>   |
| English                       | 239         | 335  | 233  |                       | <b>-2.5</b>   |
| Business: Fin, Inv't, Banking | 201         | 195  | 226  |                       | <b>12.4</b>   |
| International Studies         | 150         | 185  | 215  |                       | <b>43.3</b>   |
| Journalism                    | 221         | 219  | 206  |                       | <b>-6.8</b>   |
| Sociology                     | 170         | 229  | 206  |                       | <b>21.2</b>   |
| Business: Accounting          | 146         | 152  | 161  |                       | <b>10.3</b>   |
| Business: Mgmt HR             | 140         | 110  | 127  |                       | <b>-9.3</b>   |
| Legal Studies                 | 116         | 142  | 121  |                       | <b>4.3</b>    |
| Business: Risk Mgmt and Ins   | 68          | 53   | 107  |                       | <b>57.4</b>   |
| Elementary Education          | 108         | 143  | 98   |                       | <b>-9.3</b>   |
| Art                           | 103         | 122  | 90   |                       | <b>-12.6</b>  |
| <b>Summary</b>                |             |      |      |                       |               |
| STEM                          | 1118        | 1379 | 1866 |                       | <b>66.9</b>   |
| Non-STEM                      | 3249        | 3922 | 3893 |                       | <b>19.8</b>   |

Notes:

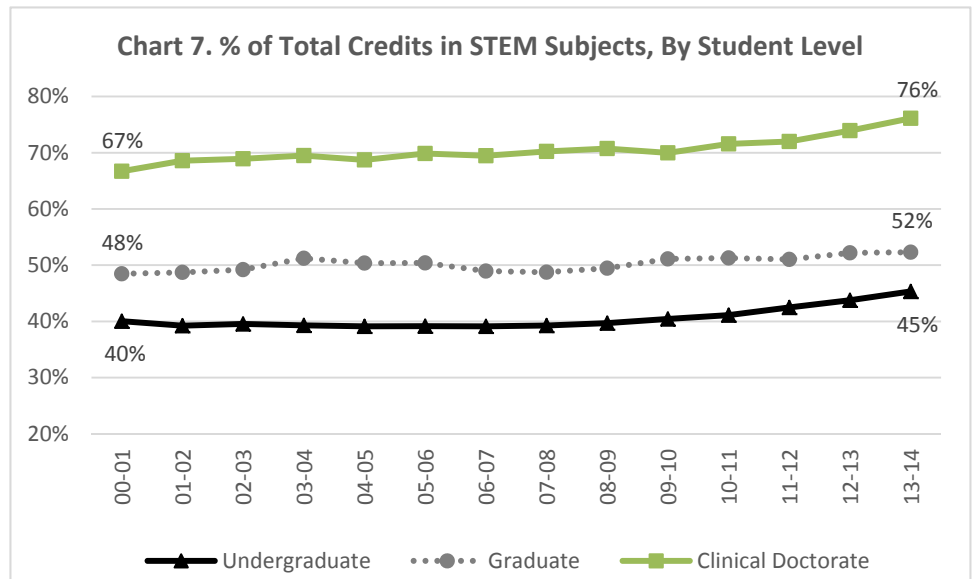
- 1) Source: InfoAccess-Retention Awards Views 2) Counts are number of majors awarded for each program.
- 3) Students completing more than one major are counted once in each major completed.

**Chart 6. Number and Percent of Undergraduate STEM Degrees Awarded by Major Research Universities (AAU Institutions)**



**C. Instructional Activity (Student Credit Hours) in STEM Subjects**

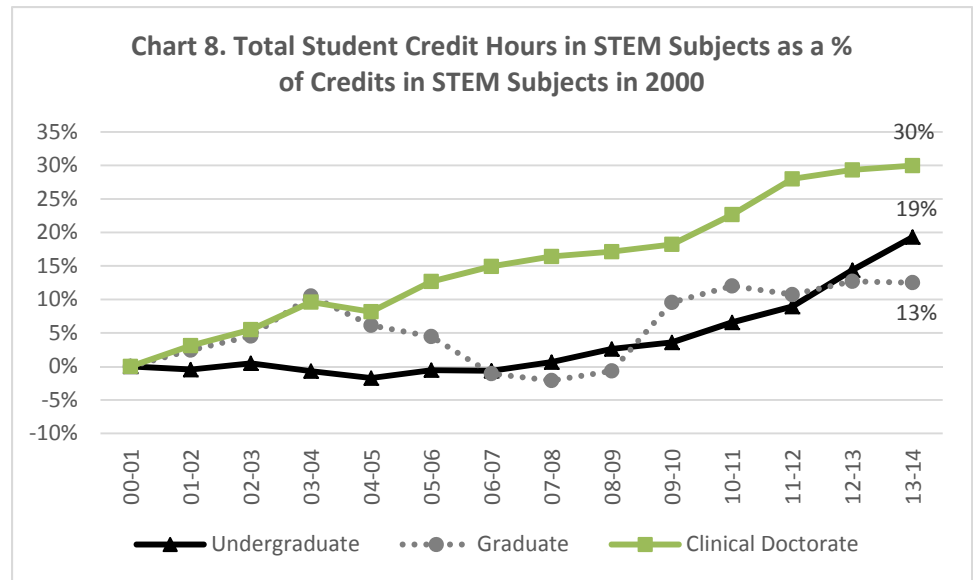
Instructional activity is measured in student credit hours. Student credit hours reflect all student activity in STEM, including both the activity of students in a STEM major, those in a non-STEM major taking STEM courses, and course-taking of students who don't yet have a major. Student credit hours may also serve as a leading indicator that suggests future patterns in enrollment and degrees.



The share of all undergraduate student credit hours that are taken in STEM subjects is 45%, up from 40% in 2000 (Chart 7). The share of student credit hours in STEM subjects now stands at 52% for graduate students and 76% for students in clinical doctorates.

In addition to growth in the share of total student credit hours in STEM subjects, there has also been substantial growth in the overall volume of student credit hours in STEM subjects at all levels (Chart 8). Since 2000, there has been:

- a 19% increase for undergraduates
- a 13% increase at the graduate level
- a 30% increase for clinical doctorates



STEM subjects that have had substantial increases in instructional activity include (Chart 9):

- Chemistry has supported the largest numerical growth in student credit hours in recent years from 37,716 in 2000 to 51,811 in 2013-14, a 37.4% increase (14,000 student credit hours).
- Math, which produces the largest number of student credit hours, has seen an increase of about 19% in the past five years.
- Physics, Mechanical Engineering, Statistics and Nursing have all seen double digit percentage increases in recent years.
- Nutritional Sciences has more than doubled its instructional activity since 2000, up to 10,719 student credit hours in 2013-14.



**Chart 9. Trend in Academic Year Credits by Subject Listing  
For the 30 Largest Credit-Producing Departments in 2013-14  
(Sorted by STEM Subjects and Non-STEM Subjects, Alphabetically)**

|                                 | Academic Year |         |         | Change from 2000-2013 |       |
|---------------------------------|---------------|---------|---------|-----------------------|-------|
|                                 | 00-01         | 06-07   | 13-14   | Trend                 | %     |
| <b>STEM Subjects</b>            |               |         |         |                       |       |
| Biology                         |               | 5,416   | 14,442  |                       | ---   |
| Chemistry                       | 37,716        | 42,137  | 51,811  |                       | 37.4  |
| Computer Science                | 25,543        | 10,361  | 21,465  |                       | -16.0 |
| Electrical/Computer Engineering | 15,575        | 12,248  | 15,829  |                       | 1.6   |
| Mathematics                     | 54,564        | 48,662  | 57,809  |                       | 5.9   |
| Mechanical Engineering          | 12,202        | 13,750  | 17,948  |                       | 47.1  |
| Nursing                         | 8,367         | 11,092  | 9,940   |                       | 18.8  |
| Nutritional Science             | 4,387         | 8,354   | 10,719  |                       | 144.3 |
| Physics                         | 22,395        | 23,472  | 27,853  |                       | 24.4  |
| Statistics                      | 10,211        | 12,391  | 15,708  |                       | 53.8  |
| Zoology                         | 23,168        | 20,620  | 12,945  |                       | -44.1 |
| <b>Non-STEM Subjects</b>        |               |         |         |                       |       |
| Accounting/Information Systems  | 13,264        | 13,342  | 14,124  |                       | 6.5   |
| Anthropology                    | 11,962        | 12,551  | 12,399  |                       | 3.7   |
| Art                             | 12,285        | 9,585   | 9,585   |                       | -22.0 |
| Communication Arts              | 20,386        | 18,755  | 20,876  |                       | 2.4   |
| Curriculum and Instruction      | 15,785        | 15,589  | 13,995  |                       | -11.3 |
| Economics                       | 28,208        | 29,246  | 36,789  |                       | 30.4  |
| English                         | 31,967        | 33,161  | 28,465  |                       | -11.0 |
| General Business                | 11,360        | 6,726   | 11,307  |                       | -0.5  |
| Geography                       | 12,534        | 10,559  | 9,942   |                       | -20.7 |
| History                         | 27,726        | 30,035  | 22,074  |                       | -20.4 |
| Journalism/Mass Communication   | 11,978        | 11,067  | 11,525  |                       | -3.8  |
| Law                             | 24,739        | 25,671  | 19,996  |                       | -19.2 |
| Music                           | 11,653        | 11,151  | 9,841   |                       | -15.5 |
| Philosophy                      | 16,900        | 16,039  | 14,970  |                       | -11.4 |
| Political Science               | 31,178        | 31,506  | 19,540  |                       | -37.3 |
| Psychology                      | 30,151        | 28,338  | 27,522  |                       | -8.7  |
| Social Work                     | 7,891         | 8,113   | 10,835  |                       | 37.3  |
| Sociology                       | 19,419        | 23,415  | 20,884  |                       | 7.5   |
| Spanish                         | 20,963        | 24,915  | 21,067  |                       | 0.5   |
| <b>Summary</b>                  |               |         |         |                       |       |
| STEM                            | 214,128       | 208,503 | 256,469 |                       | 19.8  |
| Non-STEM                        | 360,349       | 359,764 | 335,736 |                       | -6.8  |

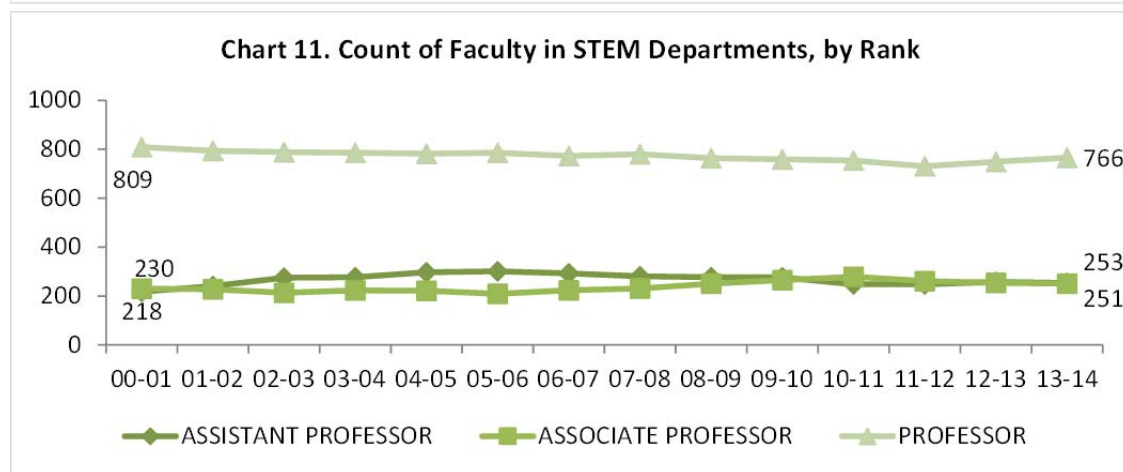
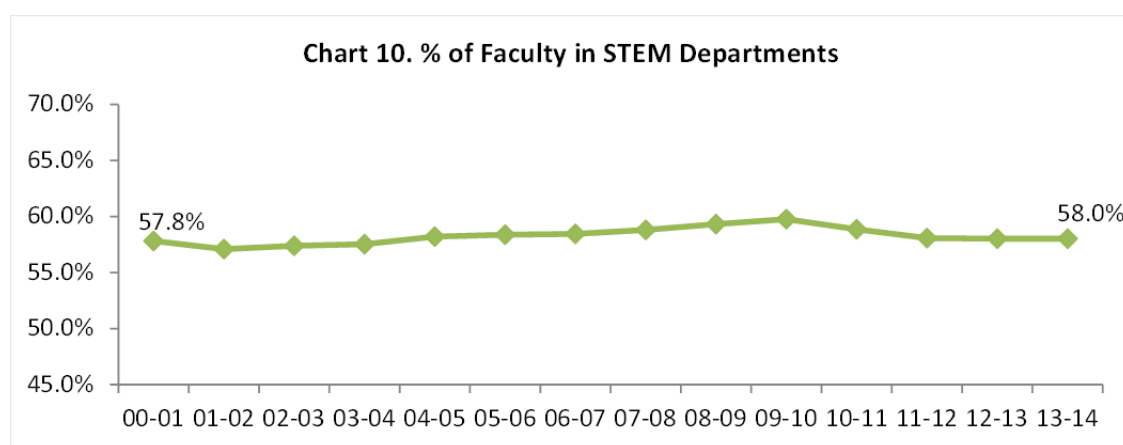
Notes:

1. Source: InfoAccess - Frozen Course Credits data view.
2. Credits are attributed to the subject listing under which the students enrolled.

#### D. Trends in Number of Faculty and Other Instructors in STEM

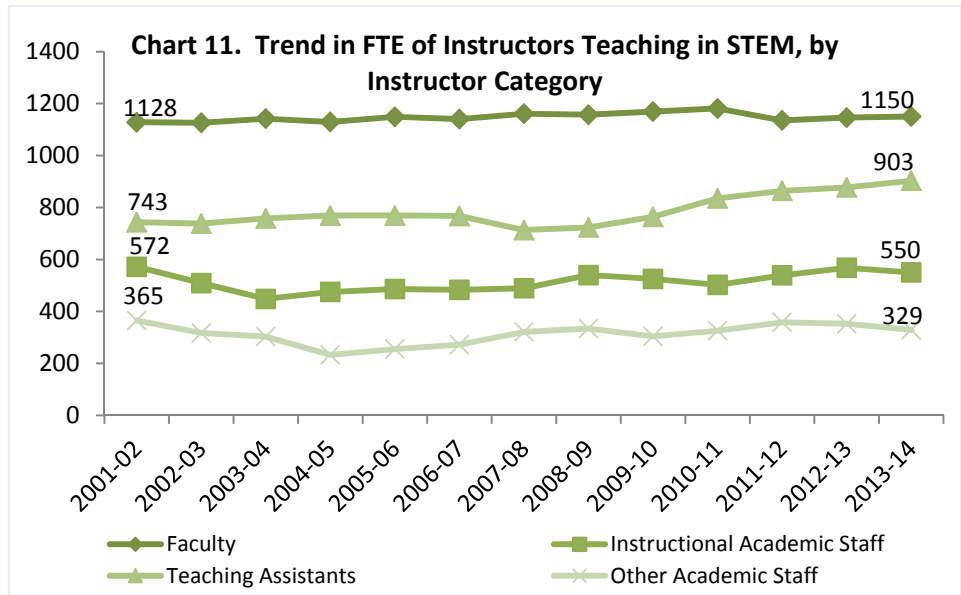
Since 2000, the percent of tenured/tenure track faculty who hold appointments in STEM departments has been fairly steady at near 58% of the total faculty headcount; 57.8% of the faculty were in STEM departments in Fall 2000 compared to 58.0% in Fall 2013 (Chart 10). By rank, there were slight shifts in STEM departments from full professors to the associate and assistant professor ranks (Chart 11). In STEM departments, there were 809 full professors in 2000 compared to 766 in 2013, 230 associate professors in 2000 compared to 251 in 2013, and 218 assistant professors in 2000 compared to 253 in 2013.

The percent of faculty who are appointed in the Biological Sciences (32.8% in Fall 2013) or in the Physical Sciences (22.2% in Fall 2013) has also been stable over this time period.



In addition to examining faculty appointments in STEM departments (Chart 10, 11), we reviewed trends in counts of all instructors for STEM courses. These counts are based on the total full-time equivalent (FTE) appointments of instructors, including faculty, academic staff, and teaching assistants (Chart 11; 2001-02 was the first year that the data source used for this analysis was available).

The instructional FTE count for faculty, for instructional academic staff, and for other academic staff who teach STEM courses has been fairly constant over this time period. The instructional FTE of graduate teaching assistants has increased by 22% from 743 to 903; most of the increase is since 2007-08 (Chart 11).

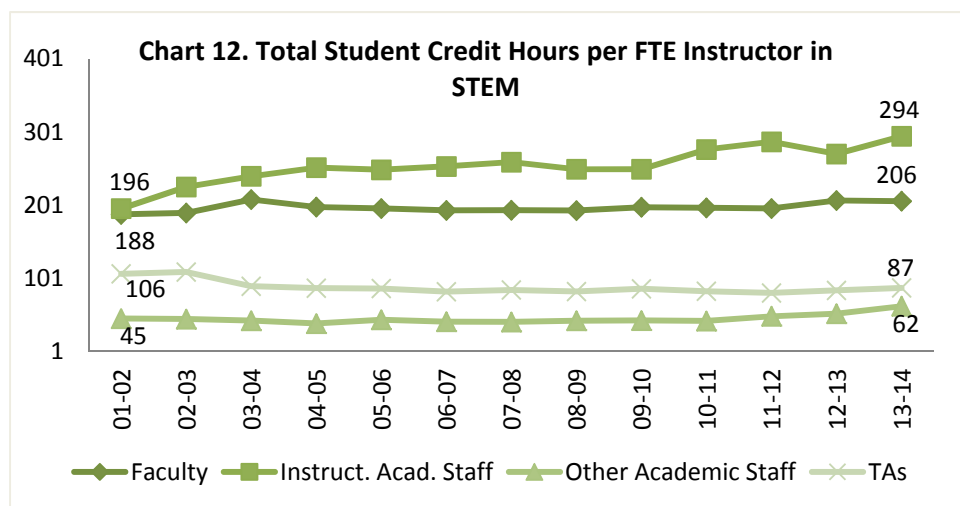


Since 2001-02 there has been an increase in students but no matching increase in STEM instructors in most categories, there has been an increase in teaching load per faculty member (student credit hours taught) in STEM courses (Chart 12).

In 2013-14, for instructors in STEM courses:

- Each tenured/tenure track faculty taught 206 student credit hours on average, a 10% increase;
- Each instructional academic staff taught 294 student credit hours on average, a 50% increase, the largest increase for any instructor category;
- Each other academic staff (for example researchers or academic administrators) taught an average of 62 student credit hours, a 38% increase.
- Each teaching assistants taught about 18% fewer student credit hours per FTE. This decrease was mostly due to a correction in workload in the early 2000s to meet workload standards.

In summary, increased STEM enrollment has led to increased instructional activity. This has primarily been met with increased teaching loads on the part of faculty, instructional academic



staff, and other academic staff who are teaching STEM courses. In addition, there is a contribution from an increase in the number of TA's over the same time period.

Appendix A.

**University of Wisconsin-Madison  
Science, Technology, Engineering and Math (STEM) Disciplines  
In the US Department of Education Classification of Instructional Programs (CIP Codes)**

Note: Each academic department, major, and course Subject listing has been assigned to a CIP Code. This list represents UW-Madison academic activities assigned to STEM and health professions CIP Codes. It includes programs and units active as of June 2014.

| CIP    | CIP Descriptor                       | CIP    | CIP Descriptor                                | CIP    | CIP Descriptor  |
|--------|--------------------------------------|--------|---|--------|---|
| 010308 | Agroecology                          | 260301 | Botany/Plant Biology                          | 510912 | Physician Assistant                                     |
| 010901 | Animal Sciences                      | 260305 | Plant Pathology                               | 510913 | Athletic Trainer  |
| 010905 | Dairy Science                        | 260403 | Anatomy                                       | 511005 | Clinical Laboratory Science                             |
| 010907 | Poultry Science                      | 260502 | Microbiology, General                         | 511102 | Pre-Medicine/Pre-Medical Studies                        |
| 011001 | Food Science                         | 260508 | Microbiology and Immunology                   | 511201 | Medicine  |
| 011102 | Agronomy and Crop Science            | 260701 | Zoology/Animal Biology                        | 511401 | Medical Scientist                                       |
| 011103 | Horticultural Science                | 260702 | Entomology                                    | 512001 | Pharmacy, General                                       |
| 011201 | Soil Science                         | 260801 | Genetics, General                             | 512002 | Pharmacy Administration, Policy, and Regulatory Affairs |
| 030101 | Natural Resources/Conservation       | 260805 | Plant Genetics                                | 512003 | Pharmaceutics and Drug Design                           |
| 030103 | Environmental Studies                | 260806 | Human/Medical Genetics                        | 512004 | Medicinal and Pharmaceutical Chemistry                  |
| 030104 | Environmental Science                | 260901 | Physiology, General                           | 512010 | Pharmaceutical Science                                  |
| 030205 | Water, Wetlands and Marine Resources | 260904 | Endocrinology                                 | 512099 | Pharmacy, Other   |
| 030206 | Land Use Planning and Mgmt           | 260910 | Pathology                                     | 512201 | Public Health   |
| 030501 | Forestry, General                    | 260911 | Oncology and Cancer Biology                   | 512205 | Health/Medical Physics                                  |
| 030502 | Forest Science and Biology           | 261001 | Pharmacology                                  | 512208 | Community Health and Preventative Medicine              |
| 030601 | Wildlife Management                  | 261006 | Environmental Toxicology                      | 512306 | Occupational Therapy                                    |
| 110101 | Computer and Information Sciences    | 261007 | Pharmacology and Toxicology                   | 512308 | Physical Therapy  |
| 140101 | Engineering, General                 | 261101 | Biometry/Biometrics                           | 512310 | Vocational Rehabilitation Counseling                    |
| 140301 | Agriculture Engr (Bio Systems Engr)  | 261201 | Biotechnology                                 | 512401 | Veterinary Medicine                                     |
| 140501 | Biomedical Engineering               | 261301 | Applied Mathematics                           | 512501 | Veterinary Science/Vet Clinical Sciences                |
| 140701 | Chemical Engineering                 | 261307 | Conservation Biology                          | 512505 | Veterinary Pathology and Pathobiology                   |
| 140801 | Civil Engineering                    | 261309 | Epidemiology                                  | 512509 | Comparative and Laboratory Animal Medicine              |
| 140901 | Computer Engineering                 | 261501 | Neuroscience                                  | 513101 | Dietetics/Dietician                                     |
| 141001 | Electrical Engineering               | 269999 | Biological and Biomedical Sciences, Other     | 513801 | Nursing/Registered Nursing                              |
| 141101 | Engineering Mechanics                | 270101 | Mathematics, General                          | 513818 | Nursing Practice  |
| 141201 | Engineering Physics                  | 270501 | Statistics, General                           | 600314 | Veterinary Surgery Residency                            |
| 141401 | Environmental Engineering            | 301901 | Nutrition Sciences                            | 600403 | Anesthesiology Residency Program                        |
| 141801 | Materials Engineering                | 310505 | Health and Physical Education, General        | 600412 | Emergency Medicine Residency Program                    |
| 141901 | Mechanical Engineering               | 400201 | Astronomy                                     | 600413 | Family Medicine Residency Program                       |
| 142301 | Nuclear Engineering                  | 400202 | Astrophysics                                  | 600414 | General Surgery Residency Program                       |
| 143501 | Industrial Engineering               | 400401 | Atmospheric Sci & Meteorology, General        | 600416 | Neurological Surgery Residency Program                  |
| 142701 | Systems Engineering                  | 400501 | Chemistry, General                            | 600417 | Neurology Residency Program                             |
| 143901 | Geological Engineering               | 400509 | Environmental Chemistry                       | 600419 | Obstetrics and Gynecology Residence Program             |
| 149999 | Engineering, Other                   | 400599 | Chemistry, Other                              | 600421 | Ophthalmology Residency Program                         |
| 150899 | Mechanical Engineering Related       | 400601 | Geology/Earth Science, General                | 600425 | Pediatrics Residence Program                            |
| 260101 | Biology, General                     | 400607 | Oceanography, Chemical and Physical           | 600428 | Psychiatry Residency Program                            |
| 260202 | Biochemistry                         | 400801 | Physics, General                              | 600431 | Radiologic Physics Residency Program                    |
| 260203 | Biophysics                           | 510201 | Communication Sciences and Disorders, General | 600499 | Medical Residency Program, General                      |
| 260204 | Molecular Biology                    | 510202 | Audiology/Audiologist                         | 600534 | Medical Oncology Residency Program                      |
| 260205 | Molecular Biochemistry               | 510204 | Audiology, Speech-Language Pathology          | 600546 | Orthopedic Sports Medicine Residency Program            |