Departmental Self-Assessment
Mathematics and Computer Science
August 1, 2011

Student Constituencies

As is the case for most departments, we serve several overlapping constituencies:

a) General Education

All students are required to take a Q course for General Education, all of our department’s courses satisfy this requirement, and very few courses outside our department satisfy this requirement. So the department sees the vast majority of students in at least one such Q course. There are a few possible exceptions:

- A little over 10% of recent incoming students get AP credit for calculus, statistics, or computer science, and hence can satisfy the Q requirement in this way. But anecdotally it seems that many of these students end up taking further quantitative courses at Witt and often end up majoring or minoring either in our department or in a department requiring more quantitative courses, so we probably see most of these students in other Q courses anyway.
- About 20% of students take one of the two Q courses fully outside our department, namely, the statistics courses in Business (now BUSN 110) and Psychology (PSYC 107). It is not known how many of these students take other coursework from our department. But calculus is required for the B.S. program and recommended for the B.A. program in Psychology, and until very recently calculus was required of all Business majors, so it is suspected that most of these students in recent years have taken at least one Q course from our department as well.
- All Education majors (a little over 5% of students) are required to take at least one of the two courses nominally listed in our department but designed and taught by Education faculty members and taken exclusively by Education students (MATH 118 and MATH 119), both of which count for Q credit. It is suspected that most of these students take no other courses from our department.

Two of our courses were created explicitly to be accessible to students with less strong backgrounds who seek Q credit: MATH 112 and COMP 121. These courses do not count toward any of our department’s major or minor programs and essentially are not required by any other major or minor programs, and hence are populated exclusively by Gen Ed students.

All students are also required to take an M course for General Education, and all of our courses satisfy this requirement as well. There are several reasons why we do not know how many students elect to take their M course in our department: because all of our courses are both M and Q courses, we can’t easily distinguish students in our classes who intend to use the course for the M requirement from those who intend to use the course for the Q requirement; many students end up taking more than one M course, for a variety of reasons; and M courses are spread somewhat more broadly across several
departments. But we’ve estimated that about one quarter of Witt students satisfy their M requirement through our courses.

b) Service courses

Many students are required to take one or more quantitative courses for major or minor programs not in our department, so several of our offerings have this “service” function for other departments. The most common such courses are calculus and statistics. Precalculus is often necessary for aspiring calculus students, and it’s rare for a student who ends up majoring or minoring in our department to start in precalculus, so that course primarily has a service function as well. Some of these courses can count toward our major programs and some cannot. Moreover, the balance of departmental and non-departmental students in each course varies, and hence the degree to which the course is a “service” course varies. Below are the percentages of students in predominantly service courses who are not majoring or minoring in our department:

- Nearly 100% of MATH 120 (Elementary Functions), MATH 131 (Essentials of Calculus), and MATH 127 (Introductory Statistics).
- About 80% of MATH 201 (Calculus I).
- About 70% of MATH 202 (Calculus II).
- About 50% of COMP 150 (Computer Programming I) and MATH 227 (Data Analysis).

This set represents the majority of course sections offered on the MATH side of the department each year and the sections typically fill to capacity, and hence this group constitutes the majority of the students in our classes every year. Many of these students are taking the courses for Gen Ed purposes, either in addition to or instead of major/minor requirements outside our department. Regardless, it is accurate to say that most of our student load is dedicated to some combination of Gen Ed and service courses.

Of special note here is the department’s participation and service in the Computational Science (COSC) program. Approved by the faculty in 2002, the program actually is not a MATH/COMP departmental program, as the name might suggest. Rather, the COSC program is an interdepartmental effort, originally launched by six participating departments. That said, our department has a very significant role in the COSC program. In particular, all three of the courses semi-explicitly required for the COSC program are offered by our department: COMP 150 (Computer Programming I), MATH 131 or 201 (Essentials of Calculus or Calculus I), and COMP/MATH 260 (Computational Models and Methods). So our department serves all of the COSC students, and it does so in a majority of their coursework for the program.

c) Departmental major and minor students

The department has B.A. and B.S. major programs in both math and computer science, as well as minors in math, computer science, and statistics. In 2007 the department instituted a system of three “tracks” within the B.A. math major (in Math, Applied Math, and Statistics) that permits a bit of focus and offers some recognition for this focus. (We’re proud to report that we did this repackaging in a way that did not require any additional courses or any greater frequency of any particular course offerings!) About 25% of our math majors prepare for secondary education; such students minor in Education and follow
the traditional Math track of the B.A. math major, with additional constraints to meet state licensure requirements.

Learning Goals

The learning goals for General Education Q and M courses are appended, as are the learning goals for our major and minor programs. The goals for the math and computer science major and minor are rather dated, and probably have not been substantially changed (if at all) since their drafting in about 1995 when Witt created the new curriculum at the switch from trimesters to semesters. These sorely need updating. In particular, the existing math major goals were written long before our current track system was implemented, and we’ll need to develop separate learning goals appropriate for each track. The computer science major and minor have undergone changes as well in the last 16 years, and the discipline of computer science certainly is changing much more rapidly than the discipline of mathematics, so the comp sci goals may need updating as well. The stat minor was created in 2001, so its statement of learning goals is a bit fresher. But the stat minor was restructured in 2005-6 and tweaked in 2006-7, and its goals need a bit of revision to reflect these program revisions.

Assessment Methods

The department for several years now has used as its primary assessment the nationally standardized ETS Major Field Tests in both math and computer science to determine how well our senior majors fare among math and comp sci majors at other schools, and to measure of how well our department is meeting generally accepted goals for math and computer science education nationwide. The department currently lacks quantitative assessment mechanisms specifically for our minor programs (in math, computer science, and statistics). And our understanding is that the General Education committee and director are responsible for assessing foundations requirements like the Q and M requirements, so we leave such assessment in their hands. Several years ago the department developed a survey of department major students and attempted to administer the survey to all graduating senior majors. This survey purported to check how well students felt that the departmental curricula met all the detailed learning goals for our major programs. There were conceptual and logistical issues with the survey, which has been discontinued in recent years.

Summary and Interpretation

Because this department self-assessment is nominally for a four-year period, we present below the results for the last four graduating classes. The ETS Major Field Test is scaled to result in scores from 120 to 200, and the raw scores themselves aren’t helpful in this context for comparing how well our students and department are performing compared to others, so we’ll focus below on percentiles. First is a listing of the percentiles at which each of our individual seniors scored from 2008-2011, among all senior math and comp sci students who took the tests nationwide. (The ETS scoring system rounds off these percentiles to the nearest 5%.)

MATH

<table>
<thead>
<tr>
<th>Year</th>
<th>Percentiles</th>
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<tbody>
<tr>
<td>2008</td>
<td>85 75 90 40 90 65 90</td>
</tr>
<tr>
<td>Year</td>
<td>2009</td>
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<td></td>
<td>95 55 55 25 80 65 65 15 80 55 15 5 50 75 60 25 90</td>
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</tbody>
</table>

**COMP**

<table>
<thead>
<tr>
<th>Year</th>
<th>2008</th>
<th>2009</th>
<th>2010</th>
<th>2011</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>50 45 55</td>
<td>70 60 20</td>
<td>65 60</td>
<td>60</td>
</tr>
</tbody>
</table>

For each of math and comp sci, the median percentile for this four-year period is 60, meaning that our typical student scored better than 60% of the math or comp sci majors nationwide.

Next is a table of our institutional percentiles in the same time period, which are based on the average score for all our students in each discipline in each year:

**MATH**

<table>
<thead>
<tr>
<th>Year</th>
<th>2008</th>
<th>2009</th>
<th>2010</th>
<th>2011</th>
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<tbody>
<tr>
<td></td>
<td>90</td>
<td>70</td>
<td>80</td>
<td>75</td>
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**COMP**

<table>
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<tr>
<th>Year</th>
<th>2008</th>
<th>2009</th>
<th>2010</th>
<th>2011</th>
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<tbody>
<tr>
<td></td>
<td>45</td>
<td>50</td>
<td>75</td>
<td>65</td>
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So, for example, Witt’s students’ average score in math in 2011 was better than the average math score for 75% of the other schools taking the exam.

We’re delighted that our students tend to perform better than students nationwide on the ETS Major Field Test, and that we as an institution fare much better than most institutions, in both math and computer science. This alone indicates that our students are, overall, meeting what the math and comp sci education communities feel are the generally accepted standards in the disciplines. But as fairly general tools, the ETS tests cannot diagnose how well or poorly we’re addressing all of the detailed learning goals we’ve articulated. The ETS has some limited break-downs into sub-disciplinary specialties, and those are indeed of some use to us as we size up the strengths and weaknesses of our major programs.

**Changes to Implement**

The department has been persistently self-reflective and progressive in revising its programs in recent years, but we simply haven’t bothered to update the formal statements of our learning goals and the formal assessment mechanisms. So as described above, the learning goals for the department’s major programs are terribly out of date, and do not reflect the many curricular and other structural changes
we’ve made to the programs in the last 15 years. One of the most glaring needs is to develop separate learning goals for the three tracks in the B.A. math major, though all of the sets of learning goals sorely need examination and updating.

The department would like to resurrect some form of more detailed assessment of the learning goals for our major program, from the students’ perspective. Once we revise the learning goals for our programs, we hope to develop a revised survey to check their sense of what they’ve learned and how well or poorly we’re meeting our stated goals in their major programs.

On a related note, the department might reconsider its use of the ETS test in math. The track system in the B.A. math major has been a great development, in that it permits specialization and focus and gets away from the one-size-fits-all math major that it replaced. But the test is clearly geared to assessment of a traditional, canonical math major. So students on our traditional Math track will continue to perform well, but students on the Applied Math track and Statistics track are simply not required to take all the pure math courses necessary to score well on the ETS test, and hence this test will not be a good indicator of how well Applied Math and Statistics students are succeeding in their programs.

The current Math Placement Exam has been entirely unchanged for over 15 years (except to move the exam on-line), and essentially unchanged for well over 20 years. But much has changed in math education since this exam was instituted, especially in curricula and pedagogies used in high school, use of technology in education, the sorts of abilities we expect students to have entering our classes, etc. At some point in the next few years the department may consider an overhaul of the exam. Changing the broader math placement process at Witt is of course not solely in our department’s purview and is tied in part to the university General Education requirements. But if the university faculty can make some progress on reform of our overall institutional curriculum, the department would certainly be willing to discuss the extent to which our current math placement system is working, and would consider a concomitant overhaul to this system as well.

Resource Needs

a) Staffing

The greatest resource need by far is (and has been for quite some time) an increase in full-time staffing, especially tenure-track staffing in math. For better or for worse, the department has had a long-standing reliance on visiting positions, and unfortunately now has an increasing reliance on adjuncts and overloads as well. Below is a rough tabulated summary of the staffing (in FTE), broken down by such status:

<table>
<thead>
<tr>
<th>year</th>
<th>tenured, tenure track</th>
<th>full-time visiting fac</th>
<th>adjuncts, overloads</th>
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<tbody>
<tr>
<td>1992-93</td>
<td>8</td>
<td>1</td>
<td></td>
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<tr>
<td>1993-94</td>
<td>8</td>
<td>1</td>
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</tr>
<tr>
<td>1994-95</td>
<td>8</td>
<td>0</td>
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<tr>
<td>1995-96</td>
<td>8</td>
<td>1</td>
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<tr>
<td>1996-97</td>
<td>8</td>
<td>1</td>
<td></td>
</tr>
</tbody>
</table>
1997-98  7  1
1998-99  7  1
1999-00  7  1
2000-01  7  3  ~0.2
2001-02  7  2  ~0.3
2002-03  7  1  ~0.7
2003-04  7  2  ~0.8
2004-05  7  2  ~1.2
2005-06  7  2  1.0
2006-07  7  1  1.8
2007-08  7  0  2.2
2008-09  7  1  1.9
2009-10  7  0  1.9
2010-11  7  0  1.2
2011-12  7  1  0.9

Not shown above is the staffing on sabbatical or unpaid leave each year. Given the size of the department and the fact that nearly everyone in the department takes two semesters of sabbatical leave (either in one academic year or split across two years), we have an average of about 1 FTE on leave per year, though the actual deficit due to leaves varies quite a bit from year to year.

The dependence on non-tenure-track staffing has been chronic, though exacerbated in the last decade and a half by several decisions and changes, including de facto staffing cuts:

- The department effectively lost a full-time line in 1997. Eric Wilson retired from a tenured position, and the line was “temporarily” converted to a visiting line. But this line was then filled by the next person in what was already an existing sequence of full-time sabbatical replacement visitors. So whereas the department had previously worked with 9 members (8 tenured/tenure-track lines plus typically 1 visiting position), the department was then reduced to 8 members (7 tenured/tenure-track lines plus 1 visiting position).
- After three years of struggling with the diminished staffing, the department was given permission in 2000 to restore the 9th line, albeit in an additional visiting position, rather than in a more lasting tenure-track line. But from 2000-2006 the department again had an average of 9 members (7 tenured/tenure-track lines plus an average of 2 full-time visitors), and could adequately meet enrollment demands and programmatic obligations.
- The department was soundly scolded in a 2005 external review for gradually crippling its math major and minor programs by cutting standard major/minor offerings and removing programmatic flexibility, in our attempt to continue to meet the Gen Ed and service course expectations. The reviewer also emphasized the absurdity of having only 3 tenure-track math lines in a school of our size. Fueled in great part by this scathing review, the department earned EPC endorsement in 2007 to at last restore the fourth tenure-track math line (which was “temporarily” converted to a visiting line 10 years prior). Unfortunately, the line was not filled for budgetary reasons — not just for that year but for each of the next three years, at which time the EPC endorsement effectively expired.
- Moreover, in only one of the four years from 2007-2011 was the department given permission to hire even a single full-time sabbatical replacement, leaving the department typically with only 7 full-time members (all tenured/tenure-track). Hence the reliance on adjuncts and overloads jumped up to about 2 FTE during this period.
• Given the recent university budgetary situation, the department consulted with the provost in the fall of 2010 and decided to ask for a 2- or 3-year visiting position, rather than carry out the charade of getting renewed endorsement from the EPC for a tenure-track math position that would almost surely not be approved by the provost for lack of funds. This strategy was endorsed by the EPC and approved by the provost.

So for 2011-12 the department will be back to 8 full-time members (7 tenured/tenure-track lines plus 1 visiting position). But even at this staffing level (and with only 0.5 FTE on sabbatical next year) we’ll still have about 1 FTE of dependence on adjuncts and overloads.

The department has long been concerned about the lack of permanent staffing to adequately fulfill its responsibilities and meet the learning goals for its constituencies, and this continues to be our greatest need. Even when given permission to seek full-time visitors, running nearly annual national searches to find such visitors is huge drain on time and energies. We’ve had considerable success in finding quality candidates for multi-year visiting positions, but the quality of candidates attracted to single-year positions has been marginal at best. And even the multi-year visitors are rarely involved in more than teaching classes, and hence not often engaged in advising, faculty governance and other institutional involvement, first-year seminars, student research, and the full range of responsibilities expected of permanent faculty members. This is obviously even more true of adjunct instructors. The strain of being understaffed overall, coupled with the hefty reliance on non-tenure-track faculty staffing, is a serious impediment to carrying out even essential departmental functions and obligations, let alone the kind of assessment and longer-term strategic work that we’d like to undertake. This is the crux of why staffing continues to be our greatest resource need.

Once again, the special connection between the department and the interdepartmental Computational Science (COSC) program is of note. The program was tentatively directed for its first couple years by Witt computer science faculty member Jim Noyes. Then in 2006, as per plan, the university hired a full-time Director of Computational Science, Eric Stahlberg, to take over and expand the program. This position was by no means a full-time teaching faculty position in the MATH/COMP department. On the contrary, the Director had considerable duties in nearly every vice-presidential area of the university: Advancement, Enrollment Management, Information Technology, Student Development, and of course several parts of the Academic area. But an explicit part of the expectation was that this Director would teach a couple courses per year for our department: the crucial core COSC intro course (COMP/MATH 260, Computational Models and Methods) every year, as well as two vital applied math staples (COMP/MATH 320, Numerical Analysis, and COMP/MATH 345, Optimization) in alternate years. The department was completely dependent on the Director to staff these courses, as we were left with nobody else with applied math expertise when Jim retired shortly after Eric was hired.

Unfortunately, when the institution couldn’t find a way to pay the Director’s salary and Eric finally left in Fall 2010 after four years, the department at once lost the only person with expertise to teach applied math, as well as an ongoing (albeit not tenure-track) Wittenberg staff member who was expected to teach 2 courses (0.3 FTE) per year for the department. Although the greatest impact of Eric’s departure is to the university’s interdepartmental computational science program, within our department the loss is especially threatening to the Applied Math track of the B.A. math major. Fortunately, when searching for the 2- or 3-year visitor in math approved by the provost to start in Fall 2011, we found an applied mathematician who can cover the courses required for the Applied Math track, so this particular need is covered for the short term. But because this is a visiting position, the Applied Math track is on unsure footing for the more distant future. For this reason, the department’s greatest priority is to restore the
fourth tenure-track line in math (that was effectively cut in 1997, then approved for restoration in 2007 but never filled for budgetary reasons) as soon as possible, and to fill this line with an applied math specialist, who can then also cover the departmental obligations to the interdepartmental COSC program.

b) Non-Staffing

The department’s non-staffing needs are not nearly so pressing but are worth noting:

- Our acute shortage of office space was addressed when the building was renovated in 2003.
- We have adequate access to classrooms and computer labs, and the physical environment of those spaces was improved considerably during the 2003 renovation. Still, one room (BDK 144) has suffered a couple major floods from internal leaks, and another (BDK 320) suffers terribly from the notoriously leaky building roof. But the floods were fairly quickly addressed, and the building roof is under repair this summer.
- Computing hardware is a chronic concern, as machines age and performance demands increase:
  - The recently-established faculty machine replacement cycle hopefully will serve basic ongoing needs in faculty offices, though computer scientists in particular have more than basic faculty needs and may need special consideration.
  - Unfortunately, the new replacement cycle doesn’t cover adjunct machines. The three machines we have in our two adjunct offices were so old and slow as to be unusable, and the department was forced to use a considerable share of its meager budget this past year to update two of these machines, just so that Witt could provide our adjuncts with functional computers.
  - Performance of the student machines in our main computer classroom/lab (BDK 144) has been sluggish.
  - The instructor’s machines in most of our classrooms continue to need updates. The instructor’s machine in BDK 320 in particular has been an embarrassment, especially because that’s the room in which we formerly featured outside speakers, job candidates, seminar presentations, etc., but no longer do so in great part because of the painfully slow computer.
- It’s not clear who will oversee the WARP high-performance computing cluster, now that Eric Stahlberg has left. At one point, Amil Anderson and Paul Voytas had volunteered to help keep the facility from falling apart until the institution found a new COSC director. But it’s not clear when or even whether a new director will be hired.
- We continue to work productively with ITS concerning software needs for our courses and other work. Of special concern, however, is Mathematica. We have become accustomed to a fairly comprehensive license, paid for mostly though Eric Stahlberg’s grants and negotiating. Now that Eric is no longer around to continue to find ways to pay for this state-of-the-art tool, we’re working with ITS to reconfigure the license to match more modest needs and budgets.

Plan for Continued Assessment

For the time being, we’ll continue to rely on the nationally standardized ETS Major Field Tests in both math and computer science. But as indicated above, we’re reconsidering its appropriateness for the Applied Math and Statistics tracks of the math major, and may seek some other assessment for students
on those tracks. Also as mentioned above, we will revise the learning goals for our major and minor programs. Based on the new learning goals, we also hope to develop a revised version of our discontinued student survey of departmental majors, and possibly extend this to students in our minor programs.

Within the past couple years we’ve developed a departmental alum database, which is fed through a web form. A departmental Faculty Aide hounds our recent alums to contribute info to this resource. Part of the info we solicit includes a critique of the strengths and weaknesses of our programs, and suggestions for how their experience might have been improved. This can be a rich source of valuable information and feedback on our programs, for use in our assessment.
General Education Requirements: Q and M Courses

From Wittenberg’s Academic Catalog:

Mathematics: The student should achieve a level of competence in mathematics that provides the necessary foundation for subsequent college learning and should also strengthen problem-solving and reasoning skills through continued use.

Requirement:

1. Demonstrate competence in mathematics. Competence may be demonstrated by completing one course (four semester hours) during the first three semesters in mathematics, statistics, or computer science that meets the foundational mathematics goals with a minimum grade of C- or S; or by earning a sufficiently high score on an examination administered on campus by the Department of Mathematics and Computer Science. Quantitative courses are designated with a “Q” in the course number.

2. Complete one additional mathematical-reasoning-intensive course. Mathematical-reasoning-intensive course may be used to meet other general education learning goals. Mathematical-reasoning courses are designated with a “M” or “Z” in the section number throughout the Master Schedule of Classes published each semester by the Registrar’s Office.
Learning Goals for the in Major in Mathematics

Mathematics majors should:

a. Have a basic understanding of the areas of modern mathematics that are generally acknowledged as fundamental to the study of undergraduate mathematics. These include:
   
   i. differential and integral calculus and its applications
   ii. discrete mathematical modeling
   iii. logic and set theory
   iv. topological and algebraic properties of the real number system
   v. theory and techniques associated with abstract vector spaces
   vi. abstract algebra, particularly group theory
   vii. theoretical foundations of single variable calculus

b. Be able to use the techniques of discrete and continuous mathematical modeling to formulate and solve problems.

c. Understand the essentials of logic, reasoning and mathematical proof as well as how to use definitions, state axioms and prove theorems.

d. Understand the use of symbolic, numeric and graphical methods to formulate and solve problems.

e. Be able to use modern technology as a tool to understand and solve mathematical problems.

f. Be able to undertake independent work, to study and explore new ideas and areas of mathematics, and to continue to do so after graduation.

Learning Goals for the Major in Computer Science

Computer science majors should gain an understanding of:

a. The use of the computer to solve problems. These problems relate to problem analysis, data manipulation, information storage and retrieval, and programming.

b. The computer's history, its place in society, its strengths, and its limitations.

c. The essentials of mathematical analysis and modeling, along with appropriate mathematical reasoning and problem-solving skills.

They should also:

d. Learn the systematic study of the computer, algorithms and data structures. This is done by the study of formal properties, implementation through various computer languages and architectures, and applications in solving important problems in a variety of disciplines
e. Develop an ability to design, develop, evaluate and document computer programs, in a high-level computing language, that can be used to efficiently solve various types of symbolic and numeric processing problems.

f. Learn and apply the scientific approach (treating the computer as a scientific instrument). This requires factual, operational, and experimental knowledge of the computer.

g. Understand the important principles of algorithms, computer architectures, operating systems, and computer languages.

h. Develop an ability to communicate clearly and effectively through writing and speaking.

i. Gain experience in pursuing specialized computer science topics in depth through independent reading and research, and through group activities.

Learning Goals for the Mathematics Minor

Mathematics minors should:

a. Have a basic understanding of the following areas of modern mathematics:
   i. differential and integral calculus and its applications
   ii. discrete mathematical modeling
   iii. logic and set theory
   iv. topological and algebraic properties of the real number system

b. Be able to use the techniques of discrete and continuous mathematical modeling to formulate and solve problems.

c. Understand the essentials of logic, reasoning and mathematical proof as well as how to use definitions, state axioms and prove theorems.

d. Understand the use of symbolic, numeric and graphical methods to formulate and solve problems.

e. Be able to use modern technology as a tool to understand and solve mathematical problems.

Learning Goals for the Computer Science Minor

Computer science minors should gain an understanding of:

a. The use of the computer to solve problems. These problems relate to problem analysis, data manipulation, information storage and retrieval, and programming.

b. The computer's history, its place in society, its strengths, and its limitations.
c. The essentials of mathematical analysis and modeling, along with appropriate mathematical reasoning and problem-solving skills.

They should also:

d. Learn the systematic study of the computer, algorithms and data structures. This is done by the study of formal properties, implementation through various computer languages and architectures, and applications in solving important problems in a variety of disciplines

e. Develop an ability to design, develop, evaluate and document computer programs, in a high-level computing language, that can be used to efficiently solve various types of symbolic and numeric processing problems

f. Learn and apply the scientific approach (treating the computer as a scientific instrument). This requires factual, operational, and experimental knowledge of the computer.

g. Develop an ability to communicate clearly and effectively through writing and speaking.

Learning Goals for the Statistics Minor

Statistics Minors should:

Understand statistics as the science of using empirical observation to inform one's understanding of the world. To this end, students must learn the fundamental principles for

a. effectively organizing and summarizing data,
b. designing appropriate observational studies and experiments,
c. constructing and assessing data-based models of real-world phenomena, and
d. knowing what conclusions can and cannot be drawn from data.

In the application of these principles, students must

e. learn the appropriate use of the more common statistical tools and methods and
f. recognize the abuses and limitations of these tools.

In all of these pursuits, students are expected to

g. make extensive use of appropriate statistical software and other computing technology,
h. articulate their ideas both in technical and in non-technical written and oral form, and
i. apply their statistical expertise to study in the major discipline.