# Department of Mathematics and Computer Science

**Self Study**  
**May 2001**

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Syllabi
Christian Orientation Standard

Introduction

According to the published guidelines, it would be presumptuous at best were Westmont to guarantee specific outcomes for this standard. Yet the institution can create opportunities for its students in this area and document their participation. It may seem at first blush that the disciplines of Mathematics and Computer Science offer little promise for presenting faith-learning opportunities other than those occasioned by mentoring, in-class devotional time, and the like. There are good reasons for this belief: the trivialization of the issue by departments located in institutions insisting there be connections in places where there are none; the fact that by nature some disciplines deal with issues not as directly related to the Christian faith as do others; the possibility that, while noetic depravity may be pervasive, its effects are not uniform among the modes of thinking in all disciplines. In point of fact, however, all department members at Westmont College take seriously the integration of faith and learning in the classroom, and believe valuable interconnections exist. Of course, all members recognize their status as role models for students, and use class time in a variety of ways for devotional edification as well.

Student Learning Outcomes

A. Knowledge

There are ways that the Christian faith and the subject matter of mathematics and computer science challenge and inform each other, and departmental members themselves are actively interested in pursuing possible connections. One is finishing the third year of a Templeton project, with a goal of critically addressing issues relating to the nature of infinity. Another has just edited a book, Mathematics in a Postmodern Age: A Christian Perspective, published by Eerdmans, dealing with this very area. All department members belong to the Association of Christians in the Mathematical Sciences (ACMS), one of whose purposes is to promote thinking relating mathematics and computer science to the Christian faith. One member has just been elected to the board of ACMS; another has served as ACMS president. Collectively, department members have included in their curriculum several opportunities for reflection:

- Collateral reading assignments
  - Multivariable Calculus (MA19) frequently requires the reading of a trade book dealing with topics relevant to the course. Recent examples include Flatland and Hyperspace, with accompanying discussions, required papers, and written quizzes. These particular books deal with the notion of higher dimensions, both from a Christian and non-Christian perspective, but other readings afford opportunity for fruitful exploration of other topics.
  - Real Analysis (MA108) is a natural course for discussing the value of doing pure mathematics, and why a Christian may legitimately pursue such efforts. A variety of reading sources are candidates for review, even if they are not written within a Christian framework. A recent teaching of this class involved the reading of A
Mathematician’s Apology, with periodic classroom discussion, and a required summary paper.

- History of Mathematics (MA155) provides opportunity for looking at many Christian thinkers who were also mathematicians. As currently taught, discussion of the writings of Pascal, Cantor, and Galileo is standard fare.

- Lecture presentations
  Many courses lend themselves naturally to a discussion of themes intrinsic to Christianity:
  - Statistics (MA5)—How information is used, with accompanying ideas relating to integrity, justice, and service.
  - Calculus (MA9, 10)—The amazing interconnections of God’s creation, leading naturally to a sense of marvel and wonder.
  - Introductory Programming (CS10, 20, 30)—Ethical issues relating to the computing field.
  - Statistics (MA130)—Chance and God’s role in it.
  - Real Analysis and Modern Algebra sequences (MA108-109, MA110-111), Fundamentals of Mathematics (MA160), Automata (CS135)—The role of proof in reason and faith.

- Informal activities
  - Trips to the theater to view films dealing with a variety of ideas, such as technology and ethical issues
  - Discussion evenings in faculty homes, stimulated by video presentations of relevant ideas

B. Practices
In the subject area of Mathematics and Computer Science, most opportunities for encouraging students to cultivate habits commensurate with the fruit of the Spirit occur with contacts outside the classroom. Collectively, department members are involved in a variety of such activities:

- Bible Studies
- Dinners at faculty homes
- Involvement in local churches, with transportation provided to students who are interested

Depending on the personality of the instructor, some in-class activities also model Christian praxis. Examples include:

- Occasional departmental chapels
- Worship service in faculty homes
  A recent MA19 class held a worship service over breakfast for chapel credit. A discussion theme was an issue raised in Flatland as to what makes a being worthy of worship.
- Beginning class with scripture reading or hymn singing
C. Affections
What exactly were God’s intentions in giving us the capacity to engage in the type of inquiry demanded by mathematics or computer science? Scripture does not provide a direct answer to this question, so the answer must be inferred from broader purposes that have been revealed. If we go back to Genesis 1 and 2, we see that God’s original purpose was that we be co-creators with him in two ways: first, as stewards of this world, walking closely with him in using his creation to build cultures and to care for this world, and second, that we ourselves would be built into “sons of God.” But carefully studying anything in this world often involves forming precise definitions, measuring, forming procedures for accomplishing tasks, and thinking deductively about the way things are and the way they might be. Thus mathematics and computer science are essential components of co-creating. While such a vision does not give precise answers to every value question we might ask, it gives us a framework from which to start. If the capacity to do mathematics or computer science is a good gift of God, it reveals something about his nature, for example, his subtlety, order, beauty, and variety. When people respond to these qualities of mathematics or computer science with awe and joy and turn to God with reverence and thankfulness, they are fulfilling this purpose. With this in mind, we humbly suggest that all courses we teach within the department contribute to this end.

D. Virtues
Duke ethicist Stanley Haurwas once claimed that the best moral training a college can provide for its students is to require they take a solid course in mathematics. What he meant by this was that, while some effects of Postmodern thinking in our culture are good and valuable, one detrimental consequence is the loss of accountability to higher authority. In mathematics students are often confronted with demands for producing objective proofs or calculations. As such, they are forced to submit to the authority of reason. A fortiori, this phenomenon holds for any courses in computer science. In particular, the introductory courses require students to be able to produce programs that will compile correctly. In other words, they must write a careful program that obeys the rules of syntax for a given programming language. An objective standard (the compiler) is their judge in this regard, and it is quite interesting to see students blame the computer for not working properly, only to find out, ultimately, that the error was of their own making. This is both a humbling experience as well as a valuable lesson, enforced over and over again. It produces character, and teaches values of perseverance and self-control.

Assessment
Various modes of assessment are used for this standard, as described above. In addition, there is currently an objective measure on every student evaluation (questions relating to how well faith and learning were carried out for a given course). The department also maintains close contact with its graduates, and is able to assess (by means of letters, encounters at homecoming, etc.) the effects of its efforts in this area. For those students pursuing our
single subject preparation program, the final portfolio provides further evidence of the journey our students have taken, and the values they have upon leaving the institution.

**Evaluation of Performance and Suggestions for Improvement**

We have been pleased with the spiritual depth of our graduates. While we believe our department plays a crucial role in this regard, it would be foolish not to recognize the role of the entire institution. To paraphrase a popular political slogan, it takes a college to help form a student, not just an individual department. Still, as students are located within a department, the role that the department plays in their moral and spiritual education is quite significant.

Of course, we see room for improvement. Ideally, we would like to create capstone courses that will pull a wide range of thinking together and have specific sections devoted to the ways in which the Christian faith, mathematics, and computer science inform each other. A possible text for a mathematics capstone, mentioned earlier, is *Mathematics in a Postmodern Age: A Christian Perspective*. There are problems in implementing these courses, mostly relating to staffing issues. For example, the upper-level courses are taught on alternate years. This would mean having both third and fourth year students involved in any capstone course. But the very nature of a capstone course makes having third year students in it undesirable, especially when it would often be the case that they would not have had, yet, the requisite background courses needed to appreciate the depth of ideas that should be addressed.

Additionally, we would like to create a reading program for our students, and are currently discussing how such a program might be implemented. We also are interested in looking at in service learning opportunities, as a means of helping students see how their study of mathematics and computer science can be used in ministry efforts. Natural courses for this venture would be Introductory Statistics, Programming, and Database Systems.
Critical-Interdisciplinary Thinking Standard

Introduction

While it is true that mathematics is important because of its many applications, many mathematicians view the subject as a creative art in which human reason finds its purest expression. The attention to precise reasoning in mathematics as well as its emphasis on abstraction and creativity identify it as a discipline central to the liberal arts and sciences.

– Westmont College Course Catalog

Although much learning in mathematics involves acquiring specific skills, one of the highest goals of mathematics instruction is to train students to think mathematically. Mathematical thought involves the ability to deduce from general axioms, to induce from specific data, to recognize patterns among different contexts, and to solve a variety of unknown problems using known techniques. Mathematical thought is also, at its core, interdisciplinary. Applications of mathematics are indispensable in many areas of the natural and social sciences. Computer technology has affected the way many disciplines are being practiced. And larger ideas from mathematics inform our understanding of philosophical and epistemological issues. Our department views its charge to develop mathematical thinking as central to the liberal arts mission of the college.

Student Learning Outcomes

We divide this standard into four parts: (A) general critical thinking skills, (B) interdisciplinary thinking, (C) problems solving and collaboration, and (D) reflective critical thinking.

(A) General Critical Thinking Skills

The department strives to make critical thinking an explicit goal for all courses. Indeed, instructors often state this goal in their course syllabi. Instructors expect students
• to develop the ability to write coherent mathematical arguments and proofs,
• to practice the habit of reflecting on the correctness of their own work,
• to evaluate the validity of statements found in textbooks, newspapers, etc.,
• to understand the theoretical foundations behind mathematical processes, and
• to grow in the ability to assess and solve unfamiliar problems.

In an informal sample of 23 mathematics and computer science syllabi, 18 contained a reference to some sort of general “thinking” or “problem solving” goal for the course.

Every mathematics course emphasizes general critical thinking skills. Lower division courses such as Calculus, Computer Programming, and Linear Algebra concentrate more on application of critical thinking to specific problems, often outside of mathematics. Upper division courses such as Real Analysis and Modern Algebra tend to stress the discipline of writing correct mathematical proofs and the development of theory.
(B) Interdisciplinary Thinking

Mathematics has been applied to many other disciplines, and these applications play a large part in our instruction. Perhaps the most salient example is Calculus, which is also the course with the largest audience. Our Calculus students see connections between mathematics and engineering, physics, biology, population growth, diffusion of ideas, medicine, economics and finance, astronomy, computing, and a host of other topics. In both Calculus and introductory computer science, students routinely do projects involving an application to another field of study. Almost every example in our Statistics course involves an interdisciplinary application: students work on real data that has been drawn from an actual study in another discipline. Our Subject Matter Preparation Program requires students to conduct a statistical project involving data gathering and analysis, and these projects usually require some understanding outside of mathematics. Our History of Mathematics course is inherently interdisciplinary; students gain a historical perspective of mathematics and study the interplay between mathematics and other fields of knowledge. The Differential Equations course focuses on applications to engineering and biology, while Linear Algebra, Combinatorics, and Modern Algebra provide tools used in computer science, including three-dimensional graphics, network analysis, and cryptography. It is challenging to find a course in our curriculum that does not contain a significant connection to another discipline.

Within our department, we have adopted an interdisciplinary approach to computer science and mathematics. Our computer science program has the unusual feature of a three-semester introductory sequence. We adopted this sequence (instead of the usual two-semester sequence) to provide a natural integration of mathematical topics into the curriculum.

(C) Problem Solving and Collaboration

One of the primary means for cultivating interdisciplinary and mathematical thought is the use of extended projects in which students are required to solve problems, often in collaboration with others. Every mathematics and computer science course involves problem solving on some level. Problem solving skills are developed individually (e.g., in introductory programming projects) and collaboratively (e.g., in group projects in Calculus). In such projects, students learn how to organize data and knowledge, and the need for teamwork is paramount. In Statistics and other overtly applied courses, solving a problem often requires some knowledge of the context, be it political science, medicine, psychology, etc. We even have a course called “Problem Solving” in which students solve problems presented in mathematical journals and write up their solutions for publication.

Students also hone problem-solving skills in the regular routine of written homework assignments. While such assignments improve specific skills, their overall goal is to ingrain in students an ability to attack problems independently.

Our department encourages students to participate in various extracurricular activities aimed and using and developing problem-solving skills. The COMAP Mathematical Contest in Modeling is an international competition where undergraduates use mathematical modeling
to solve real world problems. The ACM International Collegiate Programming Contest is a similar competition for computer science students. Both of these activities require students to collaborate and bring together knowledge from different disciplines. Our students also participate in the MAA’s Putnam Examination, an international mathematics competition solving (quite difficult) mathematical problems.

(D) Reflective Critical Thinking

Although critical mathematical thinking is a valuable and fundamental skill, we also recognize that the development of this skill needs to be tempered with a balanced perspective on its limitations. Many of our courses involving the nature of proof include a discussion of Gödel’s Incompleteness Theorem, which gives a precise mathematical limitation on the nature of axiomatic systems. Fundamentals of Mathematics and Mathematics in Western Culture include discussions on the difference between mathematical proof and other forms of knowledge, and the implication for this difference in matters of faith. In our Artificial Intelligence course, students grapple with the nature of human thought and the restrictions of computing technology. In all of our classes, we are alert for opportunities to connect mathematics with our Christian faith, and this includes recognizing with humility the restrictions of any intellectual endeavor.

Assessment Methods

We assess our students’ abilities to think critically in a variety of ways. Obviously, testing and written assignments are important instruments, but simple objective questions are limited in the amount of information they provide regarding student thought processes. To assess critical thought, we ask longer written questions, often requiring an extended argument or proof. We expect students to be able to justify their answers with complete, coherent, and concise explanations.

In addition to written assignments and exams, we assess students’ achievement in the area of critical-interdisciplinary thinking using

- response sheets evaluating group dynamics in a group project,
- oral presentations and examinations,
- class discussion and feedback,
- journals in which students reflect on their progress and understanding,
- term papers,
- written documentation of computer programs,
- online threaded discussion groups, and
- informal dialog during office hours.

In almost every course, a successful grade depends not only on the student’s ability to make correct statements, but also on the ability to evaluate the correctness of these statements critically.
Evaluation of Performance and Suggestions for Improvement

The department views its performance in the area of critical and interdisciplinary thinking as an area of strength. This is in large part due to the nature of the subject we teach, but it is also a result of our desire to see students assimilate mathematical knowledge into a larger framework. We often notice anecdotal evidence of the mathematical progress of our students: a student who struggles with written arguments in Linear Algebra blossoms later when writing proofs in upper division courses; a student who had difficulty completing Calculus assignments later is able to publish solutions to problems presented in mathematical journals; a shy, reticent freshman becomes a regular participant in a junior level theory course. We can also point to our recent graduates as evidence that students understand the relationship between mathematics and other disciplines: approximately half of our graduates in 2001 were double majors.

There are several concrete steps we can take to improve our performance in this area. We should strive to include explicit statements of critical thinking goals on all of our syllabi, and we should revisit these goals during the semester to evaluate how they are being met. We must continue to encourage students to participate in the Putnam exam, the modeling competition, and the programming contest. Perhaps our involvement in these activities will become more regular with the establishment of a mathematical student organization (such as an honor society or math club). We can do more to encourage the use of the internet and online discussion groups to examine connections with other disciplines and provide a forum for extended discussion. And we can increase the frequency with which we assign group projects and in-class group work.
Written and Oral Communication Standard

Introduction

The Mathematics and Computer Science Department considers the outcomes of this standard to be among the central goals of our curriculum. In the description of our major in the Westmont Catalog, we emphasize that, in part, "mathematics is a language capable of clear and precise expression." Our courses for the major as well as those in the general education program provide opportunities for students to become fluent in the language of mathematics.

Lectures, class discussions, and reading assignments expose students to the varieties of communication styles in the discipline. Daily assignments, projects, and exams allow them to hone their own skills in using the language of mathematics. Indeed, nearly all assignments in our courses — problem sets which focus on exercises, drills, and problem-solving, programming assignments in computer science courses, group projects, papers, and problems and proofs on exams — require that students strive for clear, accurate, and graceful communication.

Student Learning Outcomes

1. In both speech and writing, students demonstrate a full range of abilities from lower to higher order thinking skills.

2. Students are able to speak and write with rhetorical effectiveness, using a variety of forms and modes appropriate to a range of settings and purposes.

All of our courses promote the first two outcomes of this standard, as outlined below.

- Problems sets and regular homework assignments

Students write up solutions to routine exercises on a daily or weekly basis in all lower division courses (major courses as well as general education courses), and in some upper division courses. In these assignments, they demonstrate lower order thinking skills as they do simple computations and derivations, and they demonstrate higher order thinking skills as they solve complex, multifaceted problems. Their written work must effectively communicate solutions to problems as well as methods for obtaining those solutions.

All upper division courses require students to formulate proofs of mathematical theorems, crafting arguments in expository form according to the standards of rigor and expression that prevail in our discipline. Through these assignments, students learn to recognize and articulate clear mathematical reasoning, an activity at the core of communication in mathematics.
In most courses at all levels, students are encouraged to work together informally on homework assignments. Such collaboration provides opportunities for students to formulate questions and explain ideas with the practical goal of improving their own understanding of the material encountered in the course.

- Group projects and in-class group learning opportunities

In addition to the informal collaboration described above, more formal cooperative work among students in a number of courses provides the students with opportunities to improve their written and oral communication skills.

Students in the calculus sequence (Math 9, Math 10, and Math 10H) work on several group projects throughout the semester — assignments which require them to cooperate with two or three other students in solving a complex problem of theory or application. Together they write a four- to five-page paper discussing the problem and their solution. These assignments emphasize the importance of clear communication as well as accurate content.

Students in Fundamentals of Mathematics I and II (Math 160, Math 165) rely on group activities and exercises for much of their learning in these courses. These activities require them to communicate with one another about mathematics, and give them opportunities to improve their writing and speaking skills.

- Expository papers


- Programming assignments

Computer science programming courses require that in addition to creating correct code, students provide program documentation which must communicate clearly and concisely the functions of each section of code.

- Oral presentations

In most courses, students are occasionally required to present solutions to problems and exercises to the class in oral form.

Students in Data Structures and Algorithms (CS 120) and in Probability and Statistics (Math 130) have opportunities to present new material to the class by giving lectures.

- Oral examinations
The final examination in Probability and Statistics (Math 130) has an oral component.

- Class discussions

Interaction among students and between students and faculty plays an important role in the learning process that occurs in all our courses. Students gain experience in oral communication as they formulate questions and participate in discussions.

3. *Students' speaking and writing display creativity and the intellectual virtues of fair-mindedness, openness to ideas, openness to criticism, and judicious and patient use of reasoning.*

Our course catalog describes mathematics as "a creative art in which human reason finds its purest expression." Thus solving mathematics problems requires creativity and a "judicious and patient use of reasoning." Consequently, our students have many opportunities to develop these intellectual virtues in the speaking and writing activities outlined above.

4. *In both writing and speaking, students display historical and cultural awareness.*

5. *Students are able to speak and write about matters of the Christian faith in relation to learning without reliance on popular clichés.*

These outcomes are promoted in our course, History of Mathematics (Math 155), and through class discussions on collateral readings (e.g., *Flatland, A Mathematician's Apology*) in several courses.

6. *Students are capable of mature, critically insightful self-assessment and peer assessment of both writing and speaking.*

In some courses (Finite Mathematics – Math 7, Calculus I, II, and III – Math 9, 10, 19), students provide regular self-assessment of their work in solving mathematics problems.

Assessment

As described above, many of the outcomes for this standard are promoted by assignments, exams, and formal course activities. In each course, students are provided with guidelines (formally and informally) indicating the standards of organization and style toward which their work should strive. Consequently, we are often able to assess students' progress in achieving these outcomes with the usual methods of grading. If students are learning to communicate effectively in speaking and writing, their grades on assignments and presentations will usually reflect their success.
Evaluation of Performance and Suggestions for Improvement

We believe that our courses at all levels provide a substantial introduction to the importance of written and oral communication. Students are not usually adequately prepared by their high school education in mathematics for the level of emphasis which we place on written and oral communication in our courses, so even one course in mathematics gives many of them a new perspective on the importance of these skills. The students who take at least several courses from our department have many opportunities to make substantial progress toward achieving the outcomes of this standard.

We do see room for improvement in several areas. Our students need more formal opportunities for peer assessment of written and oral work and more opportunities to develop their oral communication skills. Incorporating into discussions of mathematics matters of the Christian faith in relation to learning, as well as matters that require historical and cultural awareness is challenging, and we should perhaps look for more ways to accomplish this goal.
Active Societal and Intellectual Engagement Standard

Introduction

Any college education and a Westmont College education in particular is intended to result in outcomes that extend beyond the geographical and temporal boundaries of the college experience. Goals whose scopes lie within those boundaries are, in some sense, subordinate to and exist in support of the more expansive goals.

The standard of active societal and intellectual engagement is one of the standards that speaks to experience, sympathies and actions that extend beyond the borders of the college experience. As such, many of the activities promoting this outcome are indirect and, indeed, are often found under the headings of other standards. Similarly, the modes of assessment tend to be indirect a well. They provide only glimpses of hoped-for future behaviors.

Student Learning Outcomes

1. Students/graduates possess the interpersonal competence and abilities to navigate a quickly changing and demanding workplace including effective communication and group cooperation.

Since another standards deal directly with the question of written and oral communication, only activities related to interpersonal communication and group cooperation will be addressed here.

An underlying assumption in all departmental courses is that students will work together. In some cases this assumption is tacit while in other courses (e.g. MA009/010 Calculus, MA130 Probability and Statistics, MA020 Linear Algebra, CS example) students are explicitly encouraged to work with each other and to credit other student’s contributions in the write-ups. In mathematics courses problem sets are regularly assigned that may be difficult to solve in isolation. This invites students to form cooperative groups.

Other courses involve tasks which require students to work in groups. The Software Engineering (CS130) course is built around a project. This project requires students to independently produce components which must interface with other components according to group-developed specifications. Careful and precise communication is critical so that the components can fit together. Failure to adequately specify the components and their interfaces or to construct components in compliance with the specifications will result in a non-functional final product for the entire group. In the Fundamentals of Mathematics courses (MA160/165) the primary mode of instruction is through cooperative groups. Students work through a series of guided investigations in groups that are changed throughout the term. Students in Probability and Statistics (MA130) are required to prepare and present course material in pairs. Students in the calculus sequence (MA009/010) are required to produce cooperative papers addressing assigned questions. The individuals in the
groups are required to reflect on group processes in the form of a report on the functioning of the group and each individual’s contributions.

2. Students/graduates have broad and expansive sympathies for all those in conditions of confusion, suffering, and vulnerability as well as for the natural world.

This goal is not amenable to being directly addressed within the instruction in the mathematics and computer science program. The most effective method of addressing the issue of sympathies is via the communication of the personal sympathies of the instructor in the classroom and (more importantly) in personal conversations and advising.

The mathematics and computer science program tangentially encourages sympathies for those in need via the diversity paper required of all students in the subject matter preparation program (see description in the section addressing the diversity standard). Students are also encouraged to become involved in the local teacher-mentoring program. This program provides instruction to students and then pairs them with established classroom mathematics teachers to provide assistance to struggling high-school mathematics students.

3. Students demonstrate responsibility for their learning.

4. Students are equipped with the tools to continue learning throughout their lives, both because learning can become a source of lifelong satisfaction and because of the ever-changing nature of the world.

Learning outcomes (3) and (4) are addressed by means of generating a departmental culture conducive to their development. This seems appropriate since these outcomes are related more to habits of mind and heart than to skills and knowledge. In general, students in mathematics and computer science courses are expected to actively participate in class, assisting in building solutions, proofs and algorithms. More specifically, students in Elementary Statistics (MA005) are required to write up and submit answers to pre-lecture questions.

While not part of the formal curriculum, the following items communicate a departmental expectation that students will be involved in learning beyond what is required to pass courses.

- Students are encouraged to be involved in the departmental problem solving groups. Students work on individually selected problems published in journals to find solutions. These are then carefully written up, presented to the groups and submitted to the journal.
- Computer science students are encouraged to work with the IT department. This work involves significant independent learning and problem solving.
- Able mathematics students are encouraged to apply to summer REU (Research Experiences for Undergraduates) programs.
- Computer science students are encouraged to be involved with student research opportunities currently being developed.
• Class surveys may include questions about reading and other intellectual activities outside of the scope of the course. Similar questions may be included on exams and/or quizzes as a bonus question.
• Students may be assigned ancillary books to read that are not directly related to the content of the course.

5. Students/graduates develop a sense of Christian vocation that will inform career goals, marital choices, and other central lifestyle decisions.

6. Graduates have the skill, knowledge, and motivation to be effective participants in the civic, charitable, and cultural lives of their communities.

Outcomes (5) and (6) are addressed primarily through advising and private conversations with students. Specific activities promoted by the department which aid the development of a sense of vocation and commitment to community are:
• Teacher mentoring program described under outcome (2).
• CS projects in service organizations. These are low level project that lack content to be appropriate internship placements, but nevertheless provide a valuable service to local agencies.
• Internships. Particularly in computer science, internships provide an opportunity to experience some aspects of a career and to reflect on the experiences with a faculty member who can help the student reflect on the experiences in the context of vocation.
• Women’s group. The department has begun a group for women students in mathematics and computer science. Among other things, this group addresses issues related to vocation, career and family.

Assessment

The only outcome currently being formally assessed is the first outcome related to interpersonal competence. This is addressed by looking at the work products of the groups and by reviewing group self-assessments.

Outcomes 2 through 6 currently are being addressed primarily through anecdotal means. The anecdotal evidence is supplemented by the number of students who pursue graduate studies and indicate interest in such things as service in Peace Corp or working in inner-city schools. The paucity of evidence is not surprising since these outcomes primarily deal with future effects of current learning and experiences.

We may consider developing a survey of graduates to measure the effectiveness of our program in these areas.
Evaluation of Performance and Suggestions for Improvement

Currently available evidence indicates that, while students struggle in group activities and projects in the early classes (MA009/010), they function much more effectively in upper division courses. There seems to be significant development in student’s abilities to organize themselves within their groups, to take responsibility for developing a plan of action, and to carry out their portion of the plans.

The department should consider ways to more intentionally address issues related to outcomes (2) through (6). At present, these issues are well addressed with those students who frequent our offices and with whom we have ongoing conversations. Students who avoid spending time in the office may very well “fall through the cracks.” In particular, the process of advising should become more intentional in addressing issues related to broad sympathies, a sense of vocation and community involvement. In addition, the department will be looking at developing opportunities for service learning.

To more fully communicate the department’s commitment to individual investment in lifelong learning, we are investigating the development of a summer reading program. Students would be encouraged to read a common book over the summer. Separate texts would likely be recommended for lower and upper division students. These readings would the form the basis of discussion in classes and in departmental gatherings in the fall.
Technology Standard

Introduction

Technology has transformed our society. The ways in which we communicate, learn, work, and view the world have all been dramatically changed by the advent of the personal computer and the world wide web. To be an active member of our society today, one must be able to make use of technology to obtain, organize and communicate ideas and information. Our students will not be successful in today’s society if they are not able to make effective use of technology.

Our departmental mission is that of teaching the principles and ideas of mathematics and computer science in the context of the Christian liberal arts. How does this mission relate to technology? First, all truth comes from God. As we learn more about the laws and principles of creation, we learn more about God the Creator. This includes the laws and principles governing technology, as well as the laws and principles governing mathematics and computer science.

We are made in the image of God, and thus are made as creative people. Creativity is one of the most important attributes of a person involved in technology, mathematics, or computer science. We are also rational and logical beings, again in the image of God. Logic is also an important attribute of a person involved in technology, mathematics, or computer science. As we become more conformed to the image of God, we grow in the qualities that are necessary to be effective in technology, and as we grow in our knowledge and understanding of technology, we see more of who God is.

As Christians we are called to be “in the world but not of it”; this applies to our use of technology. We must have ability and fluency in the usage of technology without allowing technology to take the place of human relationships and personal interactions. In Genesis we learn that after the fall, the ground produced thistles, and man had to toil to eat of the ground. Technology is part of the fallen world. Our calling as Christians is to redeem the creation, including technology. As Christians we must wrestle with ethical issues in technology, such as intellectual property rights, computer security and privacy, and the “digital divide” between those who have access to technology and those that do not. Christian mathematicians and computer scientists must lead the way, both in words and actions, in addressing these very difficult problems.

With regard to our mission of teaching, the use of technology can enhance the educational experience of students with a wide range of learning styles. For example, class time may be divided between lectures that make use of PowerPoint slides or web resources such as algorithm animations (reaching auditory and visual learners) and a hands-on computer laboratory exercise (reaching kinetic learners). Further, lectures can consist of a combination of the presentation of concepts and the application of those concepts in real programs or problems that can be developed, written and solved or executed using technology in the classroom.
Student Learning Outcomes

(A) Familiarity with technology and software

General software:
Most of our courses require a mastery of general purpose software, email, and access to the world wide web. Students prepare papers using word processing software, submit assignments online, access course materials that are available on our course websites, and communicate using email. In addition, we have been making use of online course management systems such as Blackboard and WebCT, which include tools for managing threaded online discussions, access to course and outside materials, submission of assignments via a digital dropbox, and online gradebooks.

- word processing programs (most courses)
- communication through email (most courses)
- world wide web access (materials posted on our course websites include syllabi, assignments, PowerPoint lecture slides, links to related online materials, Java applets, and exemplary student solutions) (most courses)
- Blackboard, WebCT (CS 10, 20, 30: Introduction to Computer Science, CS 120: Data Structures and Algorithms, CS 105: Programming Languages, and numerous courses in the near future)
- PowerPoint slides created by students for oral presentations (CS 120: Data Structures and Algorithms)
- Excel usage (Math 5: Introduction to Statistics)

Discipline-specific software:
In addition to general software, many courses also require the learning and/or use of various software packages specific to mathematics and computer science. Such software includes integrated development environments for developing software, simulation packages, and graphing software.

- Visual C++ (CS 10, 20, 30: Introduction to Computer Science, CS 120: Data Structures and Algorithms)
- Java JDK (CS 130: Software Development)
- Lisp (CS 116: Artificial Intelligence)
- Visual Prolog (CS 105: Programming Languages)
- Matrix123 (a matrix manipulation program developed in our department) (Math 7: Finite Math)
- mic1 (microarchitecture simulator software) (CS 45: Computer Organization and Architecture)
- Scientific Workplace (Math 9 and 10: Calculus, Math 80 and 180: Problem Solving)
- DPGraph (Math 9 and 10: Calculus, Math 19: Multivariable Calculus, Math 40: Differential Equations)
- Mathematica (Math 9 and 10: Calculus, Math 19: Multivariable Calculus)
Many of our students also acquire knowledge of additional discipline specific software through work in the Information Technology department and through internships. In addition to teaching students to use software, we also make use of technology as a teaching aid during class sessions. For example, we demonstrate various algorithm animations as an aid to visualizing algorithms in a number of our computer science courses.

**Hardware:**
Students in our program gain familiarity with a variety of computers and other hardware items through usage in class and during laboratory sessions.

- Windows NT computer lab (*laboratory sessions for CS 10 and 20: Introduction to Computer Science*)
- Sun workstation (Unix) lab (*research projects in distributed systems and CS 140: Networks*)
- microprocessor boards (*CS 45: Computer Organization and Architecture*)
- computer, digital projector and visualizer in technology classrooms (*most courses*)

**(B) Electronic resources in research and critical evaluation of data**
Students are routinely required to access electronic resources. Materials are available through our departmental and course websites for almost all of our courses, and students are required to access this information. Several courses also make use of materials available at Blackboard or WebCT. A number of our courses require papers or projects in which students are expected to conduct research using online resources as well as print media. With regard to the critical evaluation of data, in one class, students keep a notebook that includes examples of the misuse of statistics in the media. Students also are taught to perform estimation in order to evaluate the correctness of calculations.

- access information using departmental and course web pages (*most courses*)
- Blackboard/WebCT (*CS 10, 20, 30: Introduction to Computer Science, CS 120: Data Structures and Algorithms, CS 105: Programming Languages, and numerous courses in the near future*)
- research project using online resources (*CS 105: Programming Languages*)
- use of online documentation for C++, Java languages (*CS 30: Introduction to Computer Science, CS 130: Software Development*)
- students keep a statistics notebook that includes examples of the use and misuse of statistics in media (*Math 5: Introduction to Statistics*)
- estimation to evaluate the correctness of calculations (*numerous mathematics courses*)

**(C) Ethical perspectives on technology**
Our introduction to computer science courses (*CS 10, 20 and 30*) include a component on ethics in technology that covers various topics such as:
• software piracy, intellectual property rights (including an online discussion about the 
ethics of Napster)
• security and privacy of electronic information
• safety and dependability of electronic systems
• illicit use of computer resources
• the "digital divide" between those with access to technology and those without
• pornographic materials on the internet

In addition, students in these classes have attended the following special activities and 
sessions relating to ethics:

• guest lecture by religious studies professor Telford Work on the topic: "In the Matrix But 
Not Of It: Can Christians Use Computers?"
• class attendance at a seminar on technology and ethics given by David Batstone, a 
Westmont graduate
• viewing and discussion of the film "Pirates of Silicon Valley"

Assessment Methods

There are many ways in which we assess the use of technology. Primarily, we look at the 
end products that students create through the use of technology, but in some cases the process 
of using the technology is observed as well.

• papers that are prepared using word processor software are graded for professional 
appearance as well as content
• computer programs completed as graded assignments must make use of an integrated 
development environment for development, debugging, and testing
• oral presentations by students must make use of visual aids, often including PowerPoint 
slides
• graphing calculator usage is observed during class and assignments that require the use of 
such calculators are graded
• statistics journals that document the use of statistics in media are graded
• computer laboratory sessions are supervised and observed
• online threaded discussions are monitored
• students are required to submit assignments online

Evaluation of Performance and Suggestions for Improvement

We view the area of technology as a strength for our department, which is not surprising 
given our disciplines. We believe that we are performing quite well in this standard. 
Students in our program are exposed to a wide variety of software tools (both general 
purpose and discipline specific) and hardware items. Our majors graduate with demonstrated 
competence in technology (in some cases, competence even beyond our own). Non-majors
who take courses in our department also grow in their facility and familiarity with technology.

Of course, there is always room for improvement. Some ways that we could improve in our use of technology include:

- begin to make use of video conferencing capability for classes
- syllabi should mention specific expectations and objectives for the use of technology
- computer laboratory sessions need close supervision to ensure that students employ a systematic approach to programming rather than trial and error. To address this concern, we could try paired programming, in which one student functions as the navigator and the other as the driver

In addition, better facilities will help us to improve in the area of technology. For example, we have a strong need for more technology classrooms, especially as our computer science program grows. We also need a separate room for our Sun workstation lab, which is currently housed in a faculty office. A student lounge area that includes computer stations would be very helpful. We look forward with great anticipation to the completion of our proposed new science building, which will serve to meet all of these needs.
Diversity Standard

Introduction

While the mathematical sciences, like the natural sciences, received much of their modern development in post-medieval Europe, the 20th century has witnessed an increasing participation by individuals from many cultures in the continuing development of these sciences. Thus, while mathematicians and computer scientists in Europe, North America and Australia continue to play important roles, they no longer dominate their fields to the extent that once was the case. Significant contributions are made by talented and aggressive researchers from Asia, South America and Africa.

Indeed one icon of modern mathematics, the Indian genius Srinivasa Ramanujan (The Man who Knew Infinity), continues to be a major influence on research around the world over eighty years after his untimely death.

As a second example, the reader is hopefully aware of the much-heralded proof by Andrew Wiles of a long standing conjecture about numbers first posed by Pierre Fermat, a contemporary of Descartes and Pascal. The proof is actually the culminating argument (in hundreds of pages) in a sequence of significant contributions by many others towards the final resolution of the Fermat Conjecture. In particular, some key contributions were made in the 1950s by the Japanese mathematicians, Goro Shimura and Yukata Taniyama. Indeed the main result by

Faculty profile

Of the six departmental members, four are men and two are women. The hiring of both women within the last two years has brought a much needed gender-balance to a formerly all-male department - a welcome development given that a large percentage of the department's majors are women.

Since all six members are of European heritage, the department faces a challenge to be aware of and sensitive to issues of equity and diversity and to incorporate this understanding into the academic environment. To meet the challenge, the departmental members have been prepared, in part, by their varying life-experiences.

One senior member spent three years of his early childhood living in Cuernavaca, Mexico, while his parents were involved in a small business. During the summer of 1993 his family spent a month in Guatemala engaged in intensive language study. In the fall of 1995 he spend a sabbatical as a Fulbright Fellow teaching at the Universidad Francisco Morazon in Tegucagalpa, Honduras.

A second senior member has acquired a speaking proficiency in Spanish. While at college he spent two years working with an inner city church with an African-American congregation on the south side of Chicago. Later, after receiving his Ph.D. he was stationed with the U.S. army in Korea for a year, where he developed a number of close friendships with Koreans with whom he still corresponds. He was thus able to observe and develop an appreciation for a non-Western culture and point of view.

The third senior member attended high school and university in Hawaii, where he experienced a multi-racial and multi-cultural student body and faculty. During the summer
of 1988, he spent seven weeks at the University of Granada in Spain as a guest of their Department of Algebra. During the summer of 1992 he spent two weeks teaching a short course on combinatorics at Mackenzie University in Sao Paulo, Brazil. He is married to a woman of Spanish heritage and has numerous Hispanic in-laws.

All three members have also participated in an intensive ten-day study of Latin-American issues, which took place in Cuernavaca and Mexico City.

Student profile

The department houses both mathematics and computer science majors, each of which has several tracks. As is the case nationwide, both majors differs sharply by gender. The mathematics major continues to attract on average as many women as men. Indeed, the department graduated an equal number of mathematics majors of both sexes from 1990 through 2001. By contrast, the CS major at Westmont continues to be the near-exclusive province of men, following a nation-wide trend that is much discussed at the national level. Indeed all CS majors graduated from Westmont between 1990 and 2001 have been men. But we hasten to add that there are currently several women who are likely CS majors.

Since much has been written about the gender gap in the CS profession, let us just give a prime reason for this: women are generally not attracted to that which attracts nearly all men to the profession - computer games. Strange, but true! Indeed none of those few women students at Westmont who are interested in the CS major are "turned on" by computer games. We mention this with the hope that the reader will not get the impression that this gender gap is the result of male hostility to women - although that may occur in certain quarters of the profession-at-large. There are clearly subtle issues of gender-perspectives at work. Fortunately, our current full-time CS faculty member is a woman. Besides her very presence being a challenge to prevailing images of the CS profession, together with our second woman faculty member (in mathematics) she has taken a strong interest in the personal as well as professional welfare of women in both majors.

In terms of ethnicity, most of our majors have been of European extraction. Of all 58 graduates since 1990, only one has minority status, an Hispanic who graduated this year (2001). This reflects largely the ethnic distribution of the college student body, which over recent years has seen a rising percentage of minorities. As a consequence we expect this to be reflected in the demographics of our graduates in the coming years. Indeed two mathematics majors with minority status are scheduled to graduate in 2002.

History

An appreciation for the diversity of the mathematical experience is gained through taking the History of Mathematics course, MA 155, taught every second year. Though a two-unit course currently, the department is considering expanding it to four units. While its content varies slightly, the topics include both European sources and non-European sources (early Egyptian and Babylonian work that influenced the Greeks; Hindu and Arab contributions to algebra and numerical computation; Chinese contributions in several areas). An attempt is made to insure gender balance through introducing individuals such as Hypatia of
Alexandria, Maria Agnesi, Sophie Germain, Sonya Kovalevsky, Ada Lovelace and Emmy Noether either in the lectures or in selected readings.

Although much of the modern history of mathematics has seemingly been shaped by developments in Europe in the 1500s and after, it is hoped that the student will come to appreciate (1) the contributions of other, earlier cultures and (2) the universal, inclusive nature of mathematics as a discipline in the 21st century.

While MA155 is only required of mathematics majors in the secondary education track, it is in fact taken by most mathematics majors as well as by a few CS majors.

Community Service

The past two years the department have been involved in the Community Alliance for Minority Participation program (CAMP), a state-funded program that places college mathematics/science majors in teaching internships in high school math/science classes with a high percentage of minority students. Of the eight students graduating with mathematics degrees in 2000 or 2001, seven participated in this program. Of all four departments in the Natural Sciences Division, this department has by far the highest percentage of graduates who have taken part in this program over the last two years.

Subject Matter Preparation Program for Mathematics

 Majors in the teacher preparation track must write a paper on multiculturalism and teaching mathematics for inclusion in their portfolio. In this paper, they interact with their reading of books such as Multicultural Mathematics: Teaching Mathematics from a Global Perspective by Joseph, Nelson and Williams (Oxford University Press) and Multiculturalism in Mathematics, Science and Technology (Addison-Wesley), a collection of activity-oriented lessons for grades 8 and up.

In addition they must take Explorations in Teaching (ED 101) in the Education Department. This course deals explicitly with implications of the cultural, ethnic and gender diversity within the California classroom, as well as the task of "finding strategies which encourage all students to excel." This course includes some classroom experience, with our students being placed in high school math classes, and thus encountering issues arising with diverse student populations in the state.

Finally, all students in this program take MA 155, History of Mathematics.

Outside Departments and Other Activities

All of the above occurs in the context of a liberal arts college that is strongly committed to developing an awareness of global issues in its students, and this affects the content of coursework outside the department. Thus all graduating seniors are required to have completed a two-semester course, "World Civilization," which while placing some emphasis on the Western tradition, also seeks to promote an understanding of non-Western cultures. This course is one component of the general studies requirements that also include
components in the behavioral sciences, the social sciences, literature, philosophy, the fine arts and the natural sciences.

Students are also encouraged to spend a semester or a summer abroad. In addition to college-sponsored programs in England, Europe, the Middle East, Central America and the Far East, students also have the option of studying abroad for a semester in a national university.

The college has a tri-weekly convocation requirement. Within this setting, issues of gender, ethnicity, race, and sexual orientation are discussed on a regular basis, and varying points of view are given expression by faculty and invited off-campus speakers.