Program Review
Phase II

Department of Mathematical, Information and Computer Sciences
October 3, 2010

This document describes the second phase of the Program Review Process in the Department of Mathematical, Information and Computer Sciences. The emphasis of this phase is external scanning, analysis and recommendations for improvement. The scanning consisted of a thorough study of the curriculum including comparisons with national benchmarks for curriculum and a review of recent trends in the disciplines represented in our department. In addition, as described in the Phase I document (see Appendix: Phase I Program Review), the department undertook three main themes for the program review. The three themes are:

- To examine CS/IS curriculum to look for increased efficiencies. This work began in the spring of 2008 and lead to curricular adjustments that were implemented in 2009-10. This theme documents the work done in 2008-09 and looks at preliminary results from the adjustments made to curriculum.
- To refine the assessment processes in our Senior Capstone course. WASC has a rubric for capstone classes that was helpful in this process, and we used that as a guide for making some changes in our capstone course. As part of that process, our department developed more detailed scoring rubrics for students' speaking and writing that we will use in the capstone course. It addition it will be used as a formative assessment of writing and speaking skills in other locations in the curriculum where students are required to do projects and make presentations.
- To investigate the possibility of moving a few of our classes to a hybrid format. This is purely exploratory and further research may indicate that this is not a good option for our department or for these classes.

This analysis is described in sections on curriculum review, assessment plans and curriculum maps, the senior capstone class, new curricular directions and a discussion of hybrid classes. At the end of the document is a brief section outlining the recommendations that have emerged from this process and a timeline for implementation of those recommendations.

Response to the Program Review Committee Comments about Phase I

The Program Review Committee (currently an ad-hoc group) reviewed the Phase I document. The only suggestion from that meeting was that the Institutional Learning Outcomes (ILO's) be

included in the document. The ILO's were adopted after the Phase I document was drafted. The Phase I document has been updated to include the ILO's and a diagram showing the connection between the ILO's and department and program learning outcomes. That diagram is an abbreviated version of what can be found in Appendix: Computer Information Systems Curriculum, Outcomes and Assessment Diagram, Appendix: Computer Science Curriculum, Outcomes and Assessment Diagram and Appendix: Mathematics Curriculum, Outcomes and Assessment Diagram.

Curriculum Review

As part of the critical lines of inquiry, the department reviewed the curriculum for our three majors: Computer Information Systems, Computer Science and Mathematics. This review was focused on an assessment of faculty strengths, an analysis of the enrollment in our classes, the changing guild standards and our learning outcome assessment data. The two years of review produced some significant changes in the Information Systems curriculum as well as some suggested modification for both Computer Science and Mathematics curricula.

Enrollment Data Analysis

In the fall of 2008, the MICS Department did an analysis of course enrollments. This analysis was part of a larger discussion about fine tuning our Computer Science and Information Systems curriculum to best meet the needs of our current students and the companies that employ them.

The Computer Science, Information Systems and Mathematics curricula had been adjusted as the result of the department review in 2003 and further modifications had been made in the intervening years with a particular focus on shaping the Information Systems program.

The analysis in 2008 identified the following classes to be of concern because of low enrollments. Curricular adjustments were made and implemented in the fall of 2009:

- Eliminated CSC344 (4) Artificial Intelligence (alternating year class). Artificial Intelligence is one of the topics that will be taught periodically in CSC412 (2) Topics in Computer Science.
- Made CSC412 (2) Topics in Computer Science (annual class) a required course for all CS majors (it had previously been an elective).
- Made CSC422 (2) Theory of Computation (alternating year class) a required class for all CS majors (it had previously been an elective).
- Changed CSC494 (4) Senior Software Project (annual class) to CSC494 Software Project (alternating year), a class now taken by Juniors and Seniors.

In addition, the Information Systems curriculum was transformed into a Computer Information Systems major. This allowed the department to eliminate some of the low-enrollment classes unique to the IS major and leverage more of the existing CS classes for the CIS majors. This is a refocus of our IS program, but it is consistent with the strength and interests of the students that we are currently attracting to the CIS major. The classes that had low enrollments were:

- ISS234 (4) Introduction to Information Systems (annual class) – this class was eliminated and replaced with ISS232 (2) Introduction to Computer Information Systems (annual) and ISS242 (2) Visual Programming for Business Applications (alternating years)
- ISS304 (4) Business Applications Software (annual class) – eliminated
- ISS444 (4) Information Security and Policy (alternating year class) – eliminated
- ISS484 (4) Operations Management (alternating year class) – eliminated

In addition, the IS program had two two-unit classes ISS372 (2) Network Administration (alternating year) and ISS382 (2) Telecommunications (alternating year). It had become clear in the teaching of these two classes that students needed more information on networks. So, these two classes were eliminated and replaced with CSC373 (3) Computer Networking (alternating year) and ISS381 (1) Telecommunications (alternating year).

The net effect of these changes was a tightening of the department curriculum, the transformation of the Information Systems major to a Computer Information Systems major and a net savings of 10 or 11 teaching units per year. For the full details of these changes see (Appendix: MICS APC Curricular Proposal Fall 2008).

In the spring of 2010 a second analysis of enrollment data was conducted. That data (see Appendix: MICS Enrollment 2004-2010 All Classes and Appendix: MICS Enrollment 2004-2010 Eliminated and Independent Study Classes Removed) indicates the following:

- The changes in the MICS curriculum appear to have improved efficiency and reduced the number of low enrollment classes. Because of the alternating year cycle for some of our classes, it will take a few more years before it is clear if the desired outcome has been fully achieved.
- There has been little interest in CSC161 (1) Presentation Technology, CSC171 (1) Internet Ethics, Research and Publishing and CSC191 (1) Data Mining and Data Bases. However we expect that CSC191 (1) Data Mining and Data Bases will become part of the Computational Science minor. So we believe that we should eliminate CSC (1) 161 and CSC 171 (1).
- There is an upward trend in the number of students taking calculus: MTH144 (4) Calculus with Applications, MTH164 (4) Calculus I and MTH131 (1) Computer Aided Calculus. In the fall of 2009 this required the addition of a second section of MTH131 (1) to accommodate them and this trend continued to a lesser degree in the fall of 2010.

- There has been a related downward trend in the number of students taking MTH 303 (3) Problem Solving (the GE alternative to calculus). This has led the department to experiment with teaching 11 rather than 12 sections of MTH303 (3) annually. It is still not clear if this is sustainable in the long term.
- Downward trends in enrollment that have led to offering one section of MTH113 (3) Intermediate Algebra per year (rather than one per semester) and one section per year of each of MTH213 (3) Fundamentals of Elementary Mathematics I and MTH223 (3) Fundamentals of Elementary Mathematics II (it had previously been two sections per year). This trend appears to be holding steady.
- We are seeing consistent enrollments in the applied mathematics courses that also attract Physics and Engineering majors: MTH312 (2) Advanced Linear Algebra, MTH334 (4) Applied Mathematics, MTH344 (4) Discrete Mathematics, and MTH412 (2) Complex Analysis). However the enrollment in MTH312 (2) Advanced Linear Algebra is not as strong as what has been seen in the other three classes. Based on the curriculum standards review that we have done, we have reconfigured this set of classes and have discussed those changes with the Physics and Engineering Department.

Information Systems Changed to Computer Information Systems

The curricular area that has seen the most significant transformation in our department is the Information Systems curriculum. As mentioned above a rigorous review of both the guild standards and the class enrollments for our Information Systems classes lead the department to refocus the major to a major in Computer Information Systems. This curriculum was approved a year ago and students were transitioned to it in the fall of 2009. Individual graduation plans were written for all of the current students.

The details of the changes can be seen in Appendix: MICS APC Curricular Proposal Fall 2008. The alignment of the current curriculum with both Information Systems and Computer Science guild standards (provided by the Association of Computing Machinery: Information Systems and Computer Science) can be seen in Appendix: Professional Organization Checklist for the Computer Information Systems Curriculum.

As can be seen by our data for the assessment of learning outcomes (see Appendix: MICS Annual Assessment Report 10) our old Information Systems curriculum was meeting our learning outcomes, but this change in curriculum will preserve the learning outcomes that we have for the IS major while expanding the Computer Information Systems major in such a way that students will learn more about hardware and software interaction.

Some further curricular adjustments will be necessary to effectively blend the CIS and CS curriculum, make changes needed to meet changing guild standards for CS, and stay within the allowable number of units for a bachelor's of science degree at PLNU. To accomplish this we will:

- Combine the information in CSC132 (2) Introduction to Computer Science with ISS 232 (2) Introduction to Computer Information Systems. This will become CSC133 (3) Introduction to Computer Science and Information Systems. There were redundancies between the two classes and the enrollment for ISS 232 (2) was low (Appendix: MICS Enrollment 2004-2010 Eliminated and Independent Study Classes Removed). In additions, it is good for computer science majors to have an introduction to information systems topics early in their college career.
- Eliminate ISS381 (1) Telecommunications.
- Raise CSC373 (3) Computer Networking to a four unit class to adequately cover needed topics in security.
- Eliminate ISS312 (2) Operating Systems for Computer Information Systems. To better prepare CIS majors, they need a full semester of Operating Systems (CSC314 (4)), not just a quad.

To see the details of the curricular results of these changes see Appendix: Proposed Curriculum and Appendix: MICS Catalog Text Table. A verification that these changes align with national standards can be seen in Appendix: Professional Organization Checklist for the Computer Information Systems Curriculum Update.

Computer Science

The Association of Computing Machinery's most recent set of curriculum standards has made some significant changes from the 2001 standards. As can be seen in Appendix: Professional Organization Checklist for the Computer Science Curriculum, the current CS curriculum meets most of these standards. However industry standards have been changed to put a greater emphasis on net-centric computing, security and information processing. Our student learning outcomes have been successfully met by the existing curriculum (see Appendix: MICS Annual Assessment Report 10), however to adapt to the ACM curricular changes it will be necessary to:

- Require CSC373 (3) Computer Networking. It is currently an elective. CSC373 covers many aspects of net-centric computing and security. We also need to increase the class to four units to accommodate the additional security information so the class will become CSC 374 (4) Computer Networking and Security.
- Add ISS242 (2) Visual Programming for Business Applications as an elective to give students greater experience with human-computer interactions.
- Combine CSC132 (2) Introduction to Computer Science with ISS 232 (2) Introduction to Computer Information Systems to become CSC 133 (3) Introduction to Computer Science and Information Systems. This will give students an introduction to information systems topics as well as computer science.

To see the details of the curricular results of these changes see Appendix: Proposed Curriculum and Appendix: MICS Catalog Text Table. A verification that these changes align with national

standards can be seen in Appendix: Professional Organization Checklist for the Computer Science Curriculum Update.

The department is currently investigating the creation of an interdisciplinary minor in computational science (a discipline that is producing a large number of interesting well-paying jobs). This may requires some minor adjustments in the CS curriculum. For details see the narrative on computational science below.

Mathematics

The Mathematical Association of America provides guild standards for degrees in mathematics. In addition, the California Commission on Teacher Credentialing has standards for the undergraduate education of students who want to be secondary teachers of mathematics. The alignment of the Mathematics curriculum to these two sets of standards can be seen in Appendix: Professional Organization Checklist for the Mathematics Curriculum.

Our program has been meeting its learning objectives for the major (see see Appendix: MICS Annual Assessment Report 10), however, there was one curious finding in our ETS MFT exam results. The subscore for “non-routine” problems has varied significantly from year to year. Further investigation indicated that this is a standard finding for academic departments across the country. This led us to a detailed investigation of the problems on the ETS MFT test in Mathematics to see where our students were successful and where there was a consistent pattern of errors. The analysis indicated that many of the problems that our students missed involved linear algebra and differential equations. This is not surprising because the second half of linear algebra (MTH312 (2) Advanced Linear Algebra) and the class where the use of differential equations is taught in depth (MTH344 (4) Applied Mathematics) are elective classes not taken by all students.

MAA standards and other documents highlight that the mathematics community is putting an increasing emphasis on teaching modeling and the MICS department has just hired a new faculty member whose PhD is in mathematical modeling. In addition, there is significant conversation in the mathematical community about the introductory calculus sequence in college given the fact that the most common AP exam taken by students is Calculus AB and thus many students are not taking a first semester of calculus at the university. The transition to college level mathematics means that these students are facing challenges when starting in Calculus II.

Both the information from the ETS MFT exam and the review of the guild standards suggest that some minor curricular changes are needed. To accomplish this we will:

- Rearrange the topics in MTH164 (4) Calculus I and MTH174 (4) Calculus II to move the Maple lab component (MTH131) from Calculus I to Calculus II. We believe that the lab

will be more effective when students have a broader knowledge of calculus before learning to use Maple.

- Redesign the combination MTH121 (1) Graphical and Numerical Calculus and MTH131 (1) Computer Aided Calculus, the two units of coursework that students take when they come to PLNU with AP credit for Calculus I. The guild trend has been to create a bridge class for students that uses mathematical modeling as a way of refreshing and reinforcing the Calculus I knowledge that students gained in high school (A talk given by David Bressoud, President of the MAA at the Joint Mathematics meeting in 2010 outlines this clearly). The department has concluded that the most effective way to do this is to reshape MTH121 (1) to be a mathematical modeling class that uses techniques from Calculus I. It will meet one day per week with the students enrolled in MTH164 (4) Calculus I, thus both groups of students will have seen the same mathematical models when they unite in MTH174 (4) Calculus II.
- Increase MTH232 (2) Linear Algebra to three units and eliminate MTH312 (2) Advanced Linear Algebra.
- Redesign our applied mathematics courses: MTH334 (4) Applied Mathematics, MTH344 (4) Discrete Mathematics and MTH412 (2) Complex Analysis to provide a class in differential equations, include more mathematical modeling and determine which applied topics are essential and the number of units required to cover those topics. This will have an impact on the Physics and Engineering curriculum so these changes are being made in conversation with that department. The net result of our redesign work has been to:
- Add MTH333 (3) Differential Equations. This course will use specific problems to discuss ordinary differential equations, numerical methods and partial differential equations
- Eliminate MTH334 (4) Applied Mathematics
- Reduce the number of units in MTH344 (4) Discrete Mathematics so that it becomes MTH343 (3) Discrete Mathematics
- Add MTH373 (3) Mathematical Modeling. This course will use a problem based approach to discuss mathematical models in biology, chemistry, physics, engineering and business.
- Increase the number of units in complex analysis from two to three changing MTH412 (2) Complex Analysis to MTH413 (3) Complex Analysis. This will allow for more time to cover essential topics.
- Reduce the Real Analysis and Abstract Algebra requirement for mathematics majors to 4 units of each while allowing students preparing for doctoral studies in graduate school to learn these topics in further depth as independent study classes (this will be recommended in catalog copy). This would keep our current MTH424 (4) Real Analysis I and MTH444 (4) Abstract Algebra I but remove the requirement that a student take one of MTH432 (2) Real Analysis II or MTH452 (2) Abstract Algebra II. We have looked at what similar institutions are doing and this is consistent with their practice and still keeps us in alignment with national standards.

To see the details of the curricular results of these changes see Appendix: Proposed Curriculum and Appendix: MICS Catalog Text Table. A verification that these changes align with national

standards can be seen in Appendix: Professional Organization Checklist for the Mathematics Curriculum Update.

The department's investigation into the creation of an interdisciplinary minor in computational science may require some minor adjustments in the mathematics curriculum. For details see the narrative on computational science below.

Alumni Survey Data

In the spring of 2010, the department surveyed alumni who had graduated in the last 15 years. The response rate on the survey was 31.7% with the majority (80.9%) of the respondents having graduated in the last decade. A detailed summary analysis of the data can be found in Appendix: 2010 Alumni Survey Results Summary. This appendix summarizes the information contained in roughly 130 pages of SPSS output.

Demographic Information:

The data indicates that the majority of our alumni entered PLNU as freshmen (80%) and almost all worked part-time, with 27.4% of them working 16 hours per week or more. 50% of this group of respondents is in graduate school or has completed a graduate degree. But they also report that only half started graduate school immediately after graduating, so it is expected that this percentage will rise over time.

Curriculum:

Our department has instituted three changes in the last five years that seem to have had an impact on developing critical skills in our graduates:

- Increasing the expectations for written and oral presentations in senior seminar (this is in addition to the writing and oral presentations that are threaded throughout our curriculum)
- Requiring all seniors in our department to take the senior seminar class
- Requiring an "integrative experience" (internship, year-long service learning project or year-long honor research project) of all of our majors.

This has a direct impact on five skills listed in the table below. The question on the survey is listed above the table.

Please tell us if your departmental course work enhanced your abilities in the listed areas:					
		Very much enhanced	Much enhanced	Enhanced	Not enhanced and N/A
Think analytically and logically	2000-2004	53.8%	26.9%	15.4%	3.8%
	2005-2009	64.0%	36.0%	0.0%	0.0%
Write effectively in the discipline	2000-2004	11.5%	23.1%	42.3%	23.1%
	2005-2009	16.0%	36.0%	36.0%	12.0%
Effective oral communication	2000-2004	3.8%	23.1%	46.2%	26.9%
	2005-2009	12.0%	12.0%	60.0%	16.0%
Solve problems using technology	2000-2004	19.2%	46.2%	26.9%	7.7%
	2005-2009	32.0%	56.0%	8.0%	4.0%
Integrate knowledge from different sources	2000-2004	15.4%	34.6%	38.5%	11.5%
	2005-2009	8.0%	52.0%	32.0%	8.0%

Based on survey results it appears that our curricular changes have increased students growth in these important skills.

We also asked alumni about their preparation for the next step in their professional development.

How well did the undergraduate curriculum prepare you for:			
	Well or Higher	OK	Poorly
Work in the field (if went into the field)	85.2%	14.8%	0.0%
Graduate school	76.5%	5.9%	17.6%
Teaching	80.0%	20.0%	0.0%

Overall, our alumni believe that they were well prepared. Further investigation indicates that the students (3) who said that they were "poorly" prepared for graduate school are all mathematics majors who are employed as teachers and appear to be getting education-related masters degrees while working full-time. The hypothesis is that the "lack of preparation" may be in education coursework and not mathematics.

Spiritual Life and Service

There is no significant difference based on graduation date reflected in how our alumni respond to questions about whether or not their experience at PLNU enhanced their spiritual life and their cultural awareness. Over 95% of the respondents said that their relationship to Christ, the desire to engage in a life of service and their value for all people was enhanced while at PLNU.

We have seen an increase in students in our department becoming involved in extracurricular activities. This is an encouraging sign of their increasing participation in the larger PLNU community.

How many hours per week were you involved in extracurricular activities?		
	2000-2004	2005-2009
None	30.8%	12.0%
1-5 hours	30.8%	60.0%
5-15 hours	23.1%	24.0%
16 or more hours	3.8%	4.0%

Employment:

Current employment information is listed below. It is clear that our alumni are finding jobs in a variety of fields. Of the alumni surveyed, only 2 reported that they were without work and seeking employment.

What category best describes your current job?		
	2000-2004	2005-2009
Computer industry	24.0%	30.4%
Business (not in a computer related job)	12.0%	8.7%
Teaching	36.0%	21.7%
Industrial mathematics (actuary, mathematician, etc)	0.0%	4.3%
Other	28.0%	34.8%

Student Comments

We regularly gather information from students in the classes that we are teaching and make pedagogical and curricular adjustments as needed. In the spring of 2010 a number of informal conversations were held with the students in our Senior Seminar about the curriculum. Here are the highlights of their comments:

- There is currently too much overlap in content between ISS414 Data Base Management Systems and ISS424 Internet Applications Development. The curriculum was reviewed and different texts will be used. After two years a second analysis will be done (these classes are taught on an alternating year basis).
- Students need more structured practice speaking in public before they reach Senior Seminar. We will be using the Oral Presentation Rubric formatively with students in our department so that they will be very familiar with it and with our expectations before they have to give their presentation in Senior Seminar (see Appendix: Oral Presentation Rubric)
- Though some mathematics students dislike the programming classes that they are required to take as freshmen, they affirm their value by the time they are seniors and have to work on projects. We have heard similar comments from recent alumni as they enter the job market. We are increasing the programming requirement for mathematics majors by two units for a total of 10 units of programming.
- The students find that experience working on practical problems and projects helps them to gain internships and recent graduates affirm that this experience is valuable when seeking a job. The students have responded positively to the idea of creating a Computational Science minor and the idea of expanding the number of classes related to applied mathematics.

We are fortunate that our department is relatively small (about 80 majors) and quite social so all faculty hear good quality feedback from our students on a regular basis. Our interactions with them also allow us to use them as sounding boards for some of our ideas for curricular or pedagogical change.

Curriculum Maps and Assessment Plans

As part of this program review, the department spent time creating a diagram for each major that connects:

- PLNU Institutional Learning Outcomes
- MICS Department Learning Outcomes
- MICS Program Learning Outcomes

- A Curriculum Map
- Global Learning Outcome Measures
- Detailed Learning Outcome Measures

The diagrams can be found in:

Appendix: Computer Information Systems Curriculum, Outcomes and Assessment Diagram

Appendix: Computer Science Curriculum, Outcomes and Assessment Diagram

Appendix: Mathematics Curriculum, Outcomes and Assessment Diagram

An updated assessment plan for all of the majors in the department can be found in Appendix: Learning Outcomes Assessment Plan. This indicates the departmental learning outcomes and the data being used to assess those outcomes. It also gives the program learning outcomes and the measures for those outcomes, indicating which need to be developed. The signature assignments will be developed in the next three years (see five year goals below).

Senior Capstone Modifications

One of the themes for study indicated in Phase I of our Program Review was to refine the assessment processes in our Senior Capstone course. What we stated was

WASC has a rubric for capstone classes that will be helpful in this process, and we will use that as a guide for making some changes in our capstone course. As part of that process, our department needs to develop more detailed scoring rubrics for students' speaking and writing that we can use in the capstone course, as well as using it as a formative assessment of writing and speaking skills in other locations in the curriculum where students are required to do projects and make presentations.

The department developed draft rubrics early in the spring of 2010. These rubrics were used on a trial basis in the spring 2010 Senior Seminar. To see the draft rubrics see Appendix: Draft Oral Presentation Rubric and Appendix: Draft Written Presentation Rubric. The presence of the detailed rubrics helped the students to know what was expected and made faculty assessment of student work easier and more consistent. However, use of the rubrics indicated that some minor adjustments needed to be made. The final version of the rubrics can be seen in Appendix: Oral Presentation Rubric and Appendix: Written Presentation Rubric.

In developing the list of Program Learning Outcomes for the department, it has become clear that we need to add to the Senior Seminar a short paper where students are required to discuss

the “historical development, contemporary progress and societal role” of their discipline. The prompt for a short paper (3 pages) and the rubric will be developed in the next two years.

New Curricular Directions

The change from Information Systems to Computer Information Systems is one of the most significant curricular changes made by our department in the last few years. We have a few minor adjustments to make but it appears that we now have a program that is working well for our students and is using PLNU resources efficiently.

As the department has reviewed national trends, faculty strengths and curriculum, it has identified two further curricular directions that are interrelated. These are computational science; and applied mathematics and modeling.

Computational Science

Computational science is the use of computer modeling and simulation to advance other fields. For example, the human genome project involves the management, analysis and sorting of vast amounts of data, this is a computing task, not a biological one. Environmental science is increasingly dependent on geographical information systems (GIS) which gather, store and display data in graphical ways on maps. GIS involves a heavy dependence on computer scripting and databases. The Society for Industrial and Applied Mathematics describes computational science in the following way:

Although it includes elements from computer science, applied mathematics, engineering and science, computational science focuses on the integration of knowledge for the development of problem-solving methodologies and robust tools which will be the building blocks for solutions to scientific and engineering problems of ever-increasing complexity (Undergraduate Computational Science and Engineering Education, Source.)

Computation Science is now widely accepted, along with study of theory and the conducting of experiments as a crucial third mode of scientific investigation and engineering design (Source). Research shows that many of the emerging new professions involve computational science (“5 College Majors on the Rise”, Chronicle of Higher Education, August 31, 2009) and four of the top ten fastest growing occupations involve the ability to connect computation with other bodies of knowledge (Bureau of Labor Statistics). Finally, there is additional research that shows that female students are attracted to computational science in greater numbers than those attracted to traditional (non-biological) STEM (Science, Technology, Engineering and Mathematics) disciplines (Undergraduate Computational Science and Engineering Education, Source.)

Because of the collaborative nature of PLNU and the strong working relationships in the Rohr Science Building, we believe that PLNU is an excellent candidate for starting a computational science minor built around the notion of having mathematics and computer science students study enough of biology, chemistry or physics to be able to understand the basics of problems in those disciplines so that they could apply their computing and modeling knowledge as part of a multidisciplinary team. Similarly, the goal would be to provide students in biology, chemistry and physics with enough knowledge about computing and modeling so they could work effectively as part of the same multidisciplinary team.

Research indicates that a computational science program should be designed to be consistent with the needs of the surrounding community. Research into the job market (see Appendix: Computational Science Research) indicates that the basic knowledge includes the following:

- Statistics
- Scripting
- UNIX
- Modeling
- Programming
- Database
- Scientific Knowledge

It is clear looking at this list that all of the PLNU students studying scientific majors (Biology, Chemistry, Physics/Engineering, Mathematics, Computer Science) are already learning at least half of the topics on this list and the question becomes how to craft classes that will give students a useful knowledge base in an area in which they are not majoring (see Appendix: Computational Science Research). There have been some preliminary conversations in the Rohr Science Building about this idea. We believe that we know how to make minor adjustments in the MICS curriculum to make it “computational science friendly” for biology, chemistry and physics majors.

In the summer of 2010, the MICS and Biology Departments jointly took a group of students to the ESRI conference, the main national gathering for users of GIS. That three day experience highlighted the fact that there is a need within our building to collaborate in working with critical scientific tools that involve multiple academic specialties and that we have the desire to engage in such collaborations. Many students in our building already double major or major/minor between departments so we have some experience as a community with this type of a program. But more discussion and work is needed to determine if the idea is feasible and to bring a practical model to fruition.

Applied Mathematics and Modeling

We have more than one source of data that indicates that we should strengthen our curriculum in the area of applied mathematics with a particular focus on modeling.

- Our ETS major field tests indicate that this is a place where our students could use further education (see the Mathematics section of our Curriculum Review area above)
- Alumni survey comments indicate that “applications” of their knowledge was an important component of their PLNU education
- As indicated above, computational science is an important emerging discipline that combines both computing and mathematical modeling with scientific knowledge

Because of the increasing number of ways that mathematics is applied to various fields, the mathematics community has put an increasing emphasis on cross disciplinary work (Undergraduate Programs and Courses in the Mathematical Sciences: CUPM Curriculum Guide). This had lead to a number of workshops and publications supporting expanded work in applied mathematics and mathematical modeling in other scientific and business disciplines.

In addition, we have hired a new faculty member whose expertise is in mathematical modeling, particularly in biological problems, will strengthen both our modeling and computational science efforts.

We are proposing a number of curricular changes that will bring more applied mathematics and modeling into our curriculum (see the description on the Mathematics section above and Appendix: Proposed Curriculum).

Hybrid Education

The department reviewed a collection of documents on hybrid education and has decided to experiment with teaching a limited number of classes in a hybrid format. It is hoped that providing some computer mediated content will allow students to spend more time on task preparing for class and completing certain laboratory activities. The candidate classes for this experiment are:

- CSC133 Introduction to Computer Science and Information Systems
- CSC181 Excel
- MTH131 Computer Aided Calculus (the calculus lab)
- MTH121 Calculus and Modeling (the proposed bridge class for students entering college with AP AB calculus credit)
- MTH203 Elementary Statistics (this is our service statistics class)
- MTH303 Problem Solving (our broad general education class)

For some of the classes, the addition of computer mediated content will reduce the seat time in class, for others it will provide additional reinforcement of concepts. We teach multiple sections of three of these classes annually and it is our intent to design a randomized experiment to test

learning outcomes between hybrid and traditional classes. One recent report from the National Bureau of Economic Research discusses the fact that in spite of the well publicized paper on hybrid learning from the Department of Education, there is a significant lack of solid experimental data that compares student learning outcomes for hybrid vs. traditional methods of course delivery. We would like to begin to address that gap as part of our own evaluation of the efficacy of hybrid classes.

The department has done a rough scoping of the work and time needed to modify these classes to be taught in a hybrid manner. These modifications will take two years, with a further two years of learning outcomes testing. For details of this analysis see Appendix: Hybrid Scoping.

Recommendations

In summary, as the result of this Program Review, we recommend that we:

Change our curriculum as described in the body of this document. For the details of those changes see Appendix: Proposed Curriculum and Appendix: MICS Catalog Text Table. Updated curriculum maps can be found in Appendix: Computer Information Systems Curriculum, Outcomes and Assessment Diagram Updates, Appendix: Computer Science Curriculum, Outcomes and Assessment Diagram Updates and Appendix: Mathematics Curriculum, Outcomes and Assessment Diagram Updates.

- Pursue computational science minor in conversation with science department.
- Develop and test hybrid classes.
- Phase in the additional assessments of program learning outcomes as described in our updated assessment plan.

A five-year timeline for implementing these recommendations can be found in Appendix: Five Year Timeline for Recommendations.

Response to Comments from Reviewers, November 12, 2010

Dr. Joel Adams of Calvin College reviewed our Computer Information Systems and Computer Science sections of this Program Review. His comments can be found in Appendix: CIS and CS Comments from Joel Adams. Dr. Adams review was affirming of the department's proposed curricular modifications and the fact that the decisions are data driven. His report asked a few questions and made some comments. The department's response to Dr. Adams comments and the adjustments made based on his review can be found in Appendix: MICS Response to Adams Review.

Dr. Matthew Lunsford of Union University reviewed the Mathematics portion of the Program Review. His comments can be found in Appendix: Math Comments from Matt Lunsford. This section will be created once we have received the comments from our outside reviewers. Like Dr. Adams, Dr. Lunsford was positive about the curricular modifications being proposed by the MICS Department. Our response to Dr. Lunsford's comments and the adjustments made based on his review can be found in Appendix: MICS Response to Lunsford Review.

The Mathematical, Information and Computer Science Department is thankful for the thoughtful work done by Dr. Adams and Dr. Lunsford. They have helped to make us a better department.