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2007-2008 Instructional Grants
Projects which advance the General Education Goals by means of Instructionally-Enhanced and/or Technology-Enhanced Course Redesign

TEMPLATE FOR FINAL PROPOSALS
Final Proposal Deadline: Sunday, February 18, 2007

All final proposals should be electronically submitted as a Microsoft Word attachment by email: mailto:instructional-grant@udel.edu. Notice of receipt of final proposals will follow via email. Proposals will be reviewed by Center for Teaching Effectiveness and Information Technologies.

Title of Project	**Strengthening mathematics instruction with automated algorithmic mastery activities.**		
Principal Investigator	**Louis F. Rossi**		
Rank	**Associate Prof.**	**E-mail**	**rossi@math.udel.edu**
Department	**Mathematical Sciences**		
Co-investigator(s)	**Tobin Driscoll and Russell Luke**		
Rank	**Assoc. and Asst. Prof.**	**E-mail**	driscoll@math.udel.edu, rluke@math.udel.edu
Department	**Mathematical Sciences**		
X	***This project has been discussed with all department chairs of the Principal Investigator and Co-Investigator(s).***		

Nature of Project. Project will advance the following **General Education Goal**. *(select only one)*	
	Capstone – Goal # 7 is given priority in review of grant projects.
X	Quantitative Reasoning – Goal # 1 is given priority in review of grant projects.
	Student Multimedia Design Center – Goal # 1 is given priority in review of grant projects.
	Academic and Student Affairs – Goal # 7 is given priority in review of grant projects.
	Other *(please specify)* – Meritorious grant projects strongly supporting **one** General Educaton Goal will be considered.
To advance the above **General Education Goal**, this project will use. *(select as appropriate)*	
	Problem-based Learning
	Active Learning Approaches, e.g., case studies, collaborative learning

X	Technology, e.g., WebCT, multimedia, emerging technology
	Other *(please specify)*

Course Number	**Course Title**	**Semester(s) Offered in 2007-08**	**Est. Students Per Semester**	**Percent Major**
Math115	Pre-Calculus	Fall and Spring	45	0
Math201	Introduction to Statistical Methods I	Fall	640	0
Math241	Analytic Geometry and Calculus A	Fall and Spring	100	5
Math242	Analytic Geometry and Calculus B	Fall and Spring	50	20
Math243	Analytic Geometry and Calculus C	Fall and Spring	20	25
Math351	Engineering Mathematics I	Fall and Spring	40	0

Course fulfills the following University/College/Department requirements.

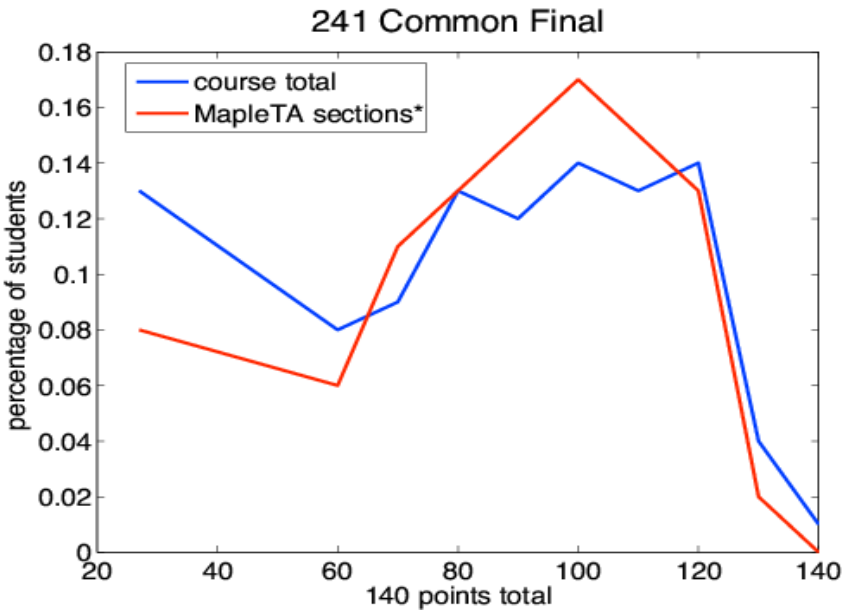
1. Description of Project *(2 page limit)*

This project will have a profound impact on how students learn mathematics at the University. Presently, the Department of Mathematical Sciences offers a wide variety of service courses used by many majors across the university. Levels of preparation and aptitude vary considerably in the students we educate. For instance, in first semester calculus, a typical lecture will have 120 students, about 80% of whom have already had calculus in high school but were unable to pass our placement exam or score at least a 3 on the AP exam (AB portion). The deficiencies vary from student to student, and traditional methods of providing feedback and tailored instruction through recitation, graded homework and office hours fall short of helping every student practice at an appropriate level and receive sufficient individual feedback on their work.

In recent years software has become available that poses randomly generated mathematics exercises and automatically grades the user's input. This type of algorithmic quizzing and grading offers us a better way to tailor exercises and feedback to individuals. For the last two years, a small group of mathematics faculty has been experimenting with the Maple TA software, produced by MapleSoft, that allows one to program automated problem generation and grading. While MapleTA uses the Maple mathematics functionality, it requires no knowledge of Maple from the user -- either the student or the lecturer. Maple TA has a web-based interface through which instructors and students work and communicate. The instructors select exercises from drop-down menus of libraries which we will build with the help of this grant. The questions have infinite variation since they are randomly generated. Students respond by entering solutions as numbers, equations, formulas, sketched curves or selections from a menu of possibilities in a manner and format similar to that of a hand-held calculator. The Maple TA software can recognize different though equivalent expressions so that students are free to enter their answers in any mathematically valid way. In addition, Maple TA keeps detailed statistics on student responses so that instructors can easily identify areas where students are having difficulty and make adjustments accordingly. A particularly attractive feature of Maple TA allows instructors to design mastery exercises where students respond to a variety of questions requiring an increasing amount of expertise. Students cannot move on to the next level until they master the current level.

We have developed and used prototypes in our first and third semester calculus courses for scientists and engineers (Math241 and Math243). Maple TA supplements but will not replace existing activities such as traditional homework problem sets, quizzes and exams. However, we have had considerable success replacing some assignments out of the text with mastery exercises. Stronger students move through them quickly. Those needing more time and practice spend more time on the material, but everyone reaches a minimal level of competency. Hand-graded homework is reserved for deeper, more conceptual questions.

As an example of the impact this project could have on student learning, we present a preliminary study performed in the Fall of 2006, where two calculus 241 lecture sections used Maple TA and the third did not. Instructors administered a common final, graded it together and gathered aggregate statistics on student performance. The results are shown below.



The data shows that Maple TA has little impact on the stronger students with very high scores. The difference between these two curves at scores greater than 120 can be used to estimate the variance in student performance across different calculus lectures. In the low and midrange, differences emerge which exceed this variance considerably. Scores in Maple TA sections show a migration of performance out of the cellar (scores less than 70) and into the midrange (scores between 70 and 120). The data suggests that Maple TA has “raised the floor” for our calculus students and we would like to extend this work into other critical courses in our curriculum.

In addition to the PI's, five faculty members have expressed an active interest in participating in the project. These are faculty who want to use Maple TA and will design algorithmic problems, but lack the technical resources to implement their ideas. The participants will be Profs. Braun, Crissinger , Mwerinde, T. Rossi and Seraphin. This project requires a substantial commitment from the PI's and participants which takes time away from their active research and instructional activities. Participants and PI's will receive a modest stipend of $500 for their work during July and August as recognition for doing this type of innovative activity in addition to their regularly administered duties.

The Math Department has two computer classrooms that are scheduled as proctored laboratories where Maple TA testing can occur during certain intervals during the semester. The Department commits 60 hours per semester to proctoring in these labs. In addition, students can work exercises at any time from any computer using a web browser, in a low-stakes situation where visual authentication is not necessary.

2. Implementation *(2 page limit)*

Support involved in project (e.g., User Services, CTE, Library, Media Services)	Assistance confirmed (name of personnel)

a. *What is your timeline for development of the project (between July 1, 2007 and June 30, 2008)?*
   Address each question separately in preparing your project description.

b. *What stumbling blocks do you anticipate which may hinder the success of the project?*
   Address each question separately in preparing your project description.

c. *How will the project be sustained by your department / college upon completion?*
   Address each question separately in preparing your project description.

The thrust of this proposal concerns the technical task of building the library of exercises and our MapleTA software infrastructure. For this we will require a team of mathematics educators, software designers and programmers. We will begin by recruiting our team of Quantitative Algorithmic Task Specialists (QATS) from strong candidates across campus. As the primary qualifications are solid understanding of (in most cases) elementary mathematics and some demonstrated level of general computational expertise, we expect to find qualified applicants among both undergraduate and graduate students in many departments including mathematics, computer and information sciences, electrical engineering, FREC and economics. We will recruit them from advanced math courses this semester, current and former graders for math courses, and unsupported graduate students who have previously made contact with math faculty.

The project will begin July 1 when we will start training QATS. We anticipate this will take up to two weeks. We will expect the QATS to take a week-long workshop on Maple and LaTeX that is already offered by the Department. LaTeX, a markup language for writing mathematical documents, is the preferred way to enter questions into Maple TA. Part of the training will include pairing up with faculty participants to learn about their needs for the upcoming fall courses.

We anticipate the major stumbling blocks will be technical. Designing questions is straightforward. Implementing them sensibly for Maple TA can be a challenge. As QATS work with faculty, we expect that some faculty will develop the expertise necessary to modify and extend work developed over the summer. QATS will also develop documentation for both student end users and faculty participants on the technical content of algorithmic questions. All involved in this project will develop a best practices guide for the use of Maple TA across our curriculum.

The Math Department is committed to deploying MapleTA into other courses where there is suitable instructor commitment. Two faculty members, not included in this project for this year due to scheduling conflicts, have expressed an interest in developing MapleTA exercises in extending this project into more 100 level courses. Toward this end, the department will dedicate two graduate students, one from the existing lines and one as a match from the College of Arts and Sciences, to work as QATS during the academic year or in the summer as needed by the faculty. The two QATS will hold these positions for two years and will be staggered as first and second year students. The older more experienced graduate QATS will mentor and train the younger one.

The Math Department purchases the Maple TA license through its own instructional computing resources and remains committed to its deployment. In addition, students with a scholarly project involving Maple TA activities may pursue their interests for credit as undergraduate research. The Department is committed to funding two QATS positions for the two years following the end of this CTE grant if it is funded.

3. Assessment *(2 page limit)*

An assessment guide is available at www.udel.edu/cte/eval.htm*.*

Support involved in project (e.g., CTE, Office of Educational Assessment)	Assistance confirmed (name of personnel)

a. *Describe how you will evaluate the students' learning. What assessment means will you use to evaluate student achievement of project goals (e.g. assignments, student work, portfolios, types of exams)?*
Address each question separately in preparing your project description.

b. *How you will determine the effectiveness of the project?*
Address each question separately in preparing your project description.

We have identified five project outcomes, and designed formative assessment plans for each one.

1. The MapleTA question banks to be developed in the summer and used in the fall and spring are an outcome from this project.

   Assessment plan: We will track the quantity and quality of question banks produced in each subject area. Beginning in the fall, we will track the number and proliferation of bugs associated with different types of automated activities. Our plan includes hourly support for QATS for these purposes as needed during the fall and spring semesters. If the source of the problem is in the server software, will post our findings to the appropriate MapleSoft technical support boards.
2. The QATS themselves as a human resources are an outcome.

   Assessment plan: We will gather feedback on their satisfaction with the project and what they have learned through a questionaire at the middle and end of the summer. We will also gather similar information on QATS from the course instructors. This project may provide some QATS with an opportunity for scholarly research in student learning through automated quizzing.
3. UD faculty participation is an outcome.

   Assessment plan: We will identify how many faculty participate in this program and deploy MapleTA in their courses. We will also determine how the material is used included the fraction of the students' grades that is determined by MapleTA. We will measure instructors reflections on their satisfaction with MapleTA at the end of the summer and at the end of Fall and Spring semester where appropriate.

4. A MapleTA best practices wiki will be an outcome.

   Assessment plan: The PI's and participants will participate in a project wiki to record our progress as we develop and deploy MapleTA in different ways in different courses. It is our hope that we will create an authoritative manual on MapleTA best practices in courses.
5. Our students are our principal outcome.

   Assessment plan: Maple TA stores all student activity and allows instructors to explore student learning in a variety of ways. In addition to raw scores, instructors can examine student performance parameters such as how much time students spent on a task or success rates for specific question types. This data provides a perfect opportunity for the PI's, participants and QATS to quantitatively study the impact of different Maple TA activities on student learning.

   The faculty participants are all experienced instructors who are aware of weak spots in student learning. We intend to target these common deficiencies and track improvements in student performance. The Mathematical Sciences Department has developed a new assessment plan that tracks student retention of concepts. Data on student retention of skills and concepts will be available to faculty participants as we enter our first assessment cycle.

   To gage student satisfaction with MapleTA, we will explore using online evaluations where we can supplement the existing departmental survey questions with questions focused on MapleTA satisfaction and impact.

4. Funds Requested - typically awards have not exceeded $20,000 *(2 page limit)*

Address each aspect separately in preparing your project budget.

ITEM	AMOUNT REQUESTED	DEPT/COLLEGE actual and in-kind funds	EXPLANATION/JUSTIFICATION
TOTAL of Budget Items	$20,000	$4,860	
Faculty summer S-contract	$4,000+ $320 no retirement fringes		*Faculty summer total amount by rank including appropriate fringe benefits (8% no summer retirement) or (37% summer retirement) may not exceed $4,750 Asst; $5,410 Assoc; $6,300 Full Professor.*
Graduate stipend			
Graduate stipend fringe 4%		$28,000	The department and the college of Arts and Sciences have committed one GTA line each to support two QATS as described in Section 2.
Graduate student non-contract (no fringe), or undergraduate student misc wage (no fringe)	$15,680	$2,400	We are requesting funds for summer stipends for 5 QATS at $2500 per full-time QATS for July and August. We request another $3,180 for part-time work during the fall and spring semesters to fund QATS as needed to refine, correct, modify and augment Maple TA question banks, and possibly to supplement proctoring should peak demand exceed current resources. The Department will continue to provide proctors during the fall and spring semesters for the computer laboratories (currently $1,200/semester).
Consultant non-UD S-contract			
Consultant non-UD S-contract fringe 8%			
Equipment (itemize/detail)			
Software (itemize/detail)		$2,460	The Department will continue to maintain the software license for Maple TA (currently $2,460/year).

Supplies & Books (itemize/detail)			
Conferences & Travel (itemize/detail)			
Other (itemize/detail)			
Sustainability costs		$7,260(software and proctoring)+ $28,000 (2 graduate QATS)	Costs to be covered to sustain course and maintain equipment and software once grant funds are expended.
Pending support from other source(s)			
Prior grant(s) (2000-2006)			