

# New Initiatives through the VIGRE, graduate program

The Department is proposing new initiatives to integrate graduates and undergraduates to research early, to enhance the scientific education and professional development of our students, and to enhance vertical and horizontal integration of research, education and outreach. To see successful VIGRE programs in action, the PI and the Department chair, Co-PI Larry Smolinsky, visited the University of Arizona, the University of Chicago, the University of Georgia, and the University of Utah. They met with faculty members and students and observed various VIGRE program elements. Knowledge gained from these visits is incorporated into this proposal. The proposed new activities are closely tied to existing structures and initiatives and consideration of previous VIGRE reviewers' comments.

## 1 The Research Crews

The Research Crews will be our main vehicle for vertical integration of research and education. The research crew structure may be considered to be an analog to a research/teaching laboratory in the sciences. The scientists and students working on a laboratory project are engaged in a coherent study, but each participant makes contributions. Mathematicians do not have laboratories, but we engage in research projects and study topics that have many aspects. Each crew will consist of faculty members, postdoctoral associates, graduate students and undergraduate students. It will be a piece of educational and intellectual infrastructure that may serve both education and research. The crew structure has been proposed in previous LSU VIGRE proposals but has grown into a more significant concept. It has developed from REU structures and best practices from the *University of Georgia* VIGRE groups [?]. Our Mathematics Consultation Clinic is a virtual industrial VIGRE crew (see Capstone Experience p. ?? and Outreach on p. ??).

The term *Research Crew* is used both to describe the individuals who work together in the education/research structure and an actual course through which the opportunities are offered. The goal of a crew will be to provide directed research opportunities for the junior members, mentored by the senior members, and incorporating participation and professional development for all involved. One faculty member will be the crew leader. Crews should engage in an overall coherent study, but subgroups may be engaged in different ways. For example, some or all of the members may be working on original mathematical research that may result in the publication of a paper, but other contributions are possible. Some students may work on examples and computations. Other students may be independently reading and assimilating a paper for presentation to the whole group. Students should be involved in creative mathematics and prepare written reports and make mathematical presentations to the whole crew. Students may be broken into small groups with a faculty advisor that work on specific aspects of a problem and then present the results to the full group and point out further directions. Smaller groups may meet several times during the week. New goals and tasks may be formulated through discussion. The crew leader will need to monitor that at all students are involved in a meaningful way. The crew structure will be valuable infrastructure to:

To encourage students' interest in research, it would be desirable to introduce students to research opportunities early. The VIGRE crew may also give graduate students the opportunity to interact and mentor higher-level students than in the past. In ideal case, the crews will include both graduate and undergraduate students.

Faculty proposals will be submitted to the VIGRE steering committee. The PIs will choose will choose crews in consultation with the VIGRE steering committee, the hiring committee and the graduate director. We believe that crews must be flexible to motivate faculty to participate and try new ideas. A Research

Crew may be proposed by one of our standard research groups or it may be proposed by a cross section of faculty, *e.g.*, a crew on quantum field theory may involve interested faculty and students from all areas. We expect that one of the crews will be in applied mathematics/computation.

VIGRE supported Doctoral Dissertation trainees. Board of regents and GAANN fellows will be required to participate in their second and third year. The first year VIGRE students will be required to take one extra course in their second semester, which may be a crew.

## 2 Research Connections Program

VIGRE will enhance the Research Connections Program, (see p. 3). Graduate students can spend a month during the summer or even a term on-site at a national or local laboratory or an industrial or academic institution broadening their horizons and gaining experience that may be valuable after graduation. The Center for Bioinformatics at Colorado State University, Center for Advanced Microstructures and Devices (CAMD), and the LSU Department of Chemistry have agreed to support the VIGRE proposal by incorporating LSU mathematics students into their projects. We are also investigating forming relationships with *NASA-Stennis Space Center* in Mississippi and the *The Pennington Center for Biomedical Research* in Baton Rouge. Exposure and experience in working in applied mathematics and applications provide valuable professional development for graduate students. This is an often neglected part of professional development, which is largely directed toward teaching. Students observe the academic system and develop comfort in it, but an internship experience can give a measure of familiarity and comfort and make them open to the possibility of industrial research. According to NSF representatives at the AMS meeting in New Orleans, VIGRE was motivated by the shortage of mathematicians. While there is not an acute shortage of mathematicians seeking university jobs, there is for industry jobs. Students will likely consider the most desirable jobs to be prestigious academic positions, but for the next level of position they should be prepared to choose between industrial research or college teaching.

In addition to providing internship opportunities, this program will bring mathematicians to LSU from industry and national labs to speak to students about their work and employment opportunities. LSU has a rich tradition of graduates, who have risen to prominent positions in industry.

## 3 Traineeships

To attract new students and enhance the training of its American students, the Department of Mathematics proposes to use the VIGRE grant to create three new types of graduate traineeships for US citizens. We plan to fill a total of 9 traineeships each year. These are the *Doctoral Foundation Traineeship* (DFT), *Doctoral Dissertation Traineeship* (DDT), and the *Dissertation-Year Traineeship* (DYT). To obtain a VIGRE support a continuing student will have to submit a *short proposal* to the VIGRE committee describing their goals and activity during the time of support. The proposal should state the beginning and ending period for the support, in which *research crew* the trainee will participate, and his or her research and learning goals during the period. The proposal should include a statement about planned interdisciplinary work or internships as well as expected interaction with undergraduate students. Finally, the the proposal should include a CV that contains a statement about previous participation in VIGRE activities. If travel or expenses other than participant support is involved, then a budget is also required.

The duration of each traineeship is not fixed. It may be up to 11 months with a possible 11-month extension. It may also be restricted to one semester or summer support. The maximum combined traineeship support is 33 months. The stipend will be up to \$25,000 per calendar year, and may be supplemented by \$3,000, \$5,000, or \$8,000 in university enhancement/supplement funds awarded by the Graduate School to deserving applicants nominated by the Department. The maximum amount of traineeship support and supplement is \$30,000 as it is with the Board of Regents Doctoral Fellowships and the GAANN Doctoral Fellowships.

**Doctoral Foundation Traineeships:** One important objective of the VIGRE Program is to recruit promising young American doctoral students. To this end, the Department will offer DFTs to rigorously selected US citizens who are not already enrolled in the graduate program at LSU. Special attention will be paid to underrepresented groups. The initial duration is 11 months, but the trainee can submit a request for an extension to maximal 11 more months. The purpose of these traineeships will be to support exceptionally promising doctoral students in their initial study at LSU with no duties required other than those that enhance the professional preparation of the student. It will free the student's time and energy for the effort of bridging the gap between undergraduate and graduate study, and to begin forming a solid foundation for a career in mathematical research. The trainees will have to take *one extra course* in the second semester. This course can be a *research crew* or one of the core-two courses.

**The Doctoral Dissertation Traineeships:** DDTs may be offered to doctoral students who have started research work with an advisor who will have to submit a strong written recommendation. Prior participation in a research crew will be considered positively by the VIGRE committee in its decision.

Students who have been supported by the *DFT* are expected to have teaching duties before they can apply for a DDT Traineeship.

Dissertation Trainees will have no regular teaching duties, but their activities during the traineeship period is expected to contain interaction with undergraduate students and/or professional development. This can consist of mentoring and participating in crews, mentoring undergraduate students, helping with extended computer lab work, assisting in the Mathematics Consultation Clinic and the VIGRE REU, the GEAUX Math@LSU warm-up or the appropriate K-12 outreach projects.

**The Dissertation-Year Traineeships:** DYT's will be offered to students who have already had *at least one year* of teaching experience at LSU and are strongly expected to complete the doctoral dissertation during the one year of such support.

To apply for the stipend the student must submit to the VIGRE committee the material stated in the beginning of this subsection as well as a letter from the chair of the advisory committee. This letter must provide convincing evidence that the doctoral dissertation will be completed successfully during the proposed year of support. A student who has received a Dissertation-Year Traineeship is not eligible for any further support from VIGRE funds in case he or she is not able to carry out the plan to complete the dissertation successfully in one year.

## 4 VIGRE related programs

**The Research Connections Program:** The Department encourages its students to visit other departments and universities during their study. For the last five years and continuing at least through spring 2008, the Department has had Board of Regents grants to cover international travel and expenses for graduate students to make extended visits. VIGRE senior personnel Robert Perlis has been the PI for these two travel grants. Through this program, 22 graduate students have made trips of a month or more to participate in special research semesters, conferences, or university consultations. On the most recent grant, students visited Amsterdam, Darmstadt, Innsbruck, Lausanne, Madrid, Moscow, Novi Sad, Paris, Sydney, Utrecht, Valladolid and Vienna. The Research Connections Program also complements benefits available to LSU graduate students through the Mathematical Sciences Research Institute (MSRI). As an academic sponsor, LSU sends advanced students to graduate programs organized by MSRI.

**Communication skills:** During the first year, in addition to the core classes in mathematics, all graduate students are required to participate in the *Communicating Mathematics* course. About half of the course focuses on the teaching of mathematics. Students are required to observe the classes of an assigned experienced mentor, to complete questionnaires on these observations, and to present mini-lectures, first before their graduate peers, and then before their mentor's undergraduate class. These presentations serve as focal points for in-class discussions of a broad range of pedagogical issues. The other half of the course concentrates on expository issues. Each student is required to write a short survey paper in LaTeX, prepared under the supervision of a faculty member. Students present a 15-minute talk on this paper to the class

and interested faculty organized in short special sessions. After each special session the students discuss the presentations. This project enables the graduate students to meet more faculty members than they would see in their lecture courses. The talks are presented in conference-style sessions with the speaker using overhead transparencies or a computer-based slide presentation. This course introduces students to the tools needed for clear and effective communication of mathematical ideas.

Beyond the first year, students get experience speaking in seminars and, later in their program, at conferences. Many faculty believe that our students do well in conference presentations compared to their peers and it is due to their early training.

**GEAUX Math@LSU:** The new warm-up program *Graduate Education and Acclimation to the University eXperience* or GEAUX Math@LSU, is a two week educational and social gathering for incoming graduate students to prepare them for their study at LSU as well as their duties as Teaching Assistants. A committee of five graduate students Rick Barnard (3rd year), Leah Childers (2nd year), Moshe Cohen (3rd year), Susanna Dann (3rd year) and Amber Russell (1st year) have been working on the planning. The idea was initiated by observing the University of Chicago *WOMP* program [?]. The basic goals of GEAUX Math@LSU, which are all strongly related to the basic goals of the VIGRE program, are to: train graduate students in planning and decision making; give senior graduate students the opportunity to develop and present advanced mathematical material; integrate the incoming students into the departmental life; begin to inculcate students into the mathematical culture; provide a bridge from undergraduate curricula to the challenging first-year graduate core program; and begin peer mentoring among graduate students.

The program will take place during two weeks prior to the start of fall classes. There will be several lectures on Point-Set Topology, Algebra, and Analysis, as well as enrichment talks to preview advance material. There will also be social events at LSU and downtown, a tour of the LSU campus as well as university orientation and orientation for international students. TA training and the technical aspects of the computer systems will be included. Further information can be found at [?]