UNDERGRADUATE RESEARCH – STUDENTS’ REWARDS AND CHALLENGES*

PANEL DISCUSSION

Stefan A. Robila
Montclair State University, Montclair, NJ
robilas@mail.montclair.edu

Amruth N. Kumar
Ramapo College of New Jersey, Mahwah, NJ
amruth@ramapo.edu

Goran Trajkovski
Towson University, Towson, MD
gtrajkovski@towson.edu

Jeffrey L. Popyack
Drexel University, Philadelphia, PA
JPopyack@cs.drexel.edu

Sofya Poger
Iona College, New Rochelle, NY
spoger@iona.edu

INTRODUCTION:

Performing research provides the undergraduate student with a unique and enriching activity. The joys of exploration, innovation and creativity are only a few of the experiences the student goes through when performing research. Nevertheless, heavy course schedules, inadequate preparation until the last (few) semesters in college, and inexperience with group or independent work negatively affect the student’s ability to participate or remain engaged in significant research.

This panel presents the challenges and the rewards that undergraduate students face when becoming involved in research. How might computer science faculty tilt the balance in favor of the rewards? An overall opinion is that with careful management undergraduate research leads to very good results and can significantly contribute to furthering the faculty research. In the process the student acquires increased confidence in performing tasks and improves her / his job marketability. Approaches on how

* Copyright © 2005 by the Consortium for Computing Sciences in Colleges. Permission to copy without fee all or part of this material is granted provided that the copies are not made or distributed for direct commercial advantage, the CCSC copyright notice and the title of the publication and its date appear, and notice is given that copying is by permission of the Consortium for Computing Sciences in Colleges. To copy otherwise, or to republish, requires a fee and/or specific permission.
‘careful’ management can be achieved are varied and are based on the rich experiences of the panelists. They provide suggestions on how to devise the project, how to select the students and when to micro-manage and when not, and support them with examples from their research. The panel consists of five computer science faculty at different stages in their career and representing five different institutions located in four different states. The panelists’ varied backgrounds and experiences provide a wide array of opinions on the role of undergraduate research in computer science. They illustrate their views through an array of diverse undergraduate research initiatives that is diverse and is of broad appeal to computer science faculty.

STEFAN A. ROBILA

While attending college, students go through diverse and life shaping experiences. One important experience should be focused on performing innovative work, on discovery and research. However, such activities are not usually required in the curriculum. The faculty bears the responsibility of including research activities as part of regular coursework or to attract students in independent projects.

Currently, I have two directions of work involving undergraduate students. The first one, related to image processing and remote sensing is organized mainly as independent research projects not related to a course. For this type of projects, I decided to attract students interested in continuing their studies in graduate school and presented the project as an experience that allows them to develop their research skills. Some pointers: 1) With most of the work overlapping the regular semesters, allow for ‘dead’ times during busy periods such as midterm and finals. 2) Ask for regular (weekly) progress reports. These will be invaluable when any research documents will be created. 3) Use a dedicated lab space open for this project. The students seem enjoy spending long and late hours sometimes. 4) Support the student in using the acquired knowledge in research in the courses taken. This will allow the student to get a better understanding of the problem and the faculty to establish new research collaborations with other faculty. The work has resulted in a conference paper presented at an international IEEE sponsored meeting.

The second direction stems from the various courses I have taught. Of particular interest to me was computer and data security, a newly developed course presented as special topics in my department. I have included as part of the class objectives the development of an individual research project. This has resulted in a variety of topics that were investigated by the students. Some pointers: 1) Spend considerable time identifying the research topics. Students will most probably need more guidance than they think. 2) Try to separate between course requirements and the importance of research work. Students usually focus much more on the need to get a good grade than on the final outcome of the project. Some was that benefited the research process were class discussions of the progress, end of the semester presentations, publicly available webpage. 3) Provide milestones for the development of the project. 4) When possible, accommodate special needs such as extended or dedicated lab time access. The work has resulted in several papers presented at local conferences.
AMRUTH N. KUMAR

Involving undergraduate students in research can be rewarding and frustrating at the same time. The benefits of involving undergraduate students in research are many: 1) For students, it leads to increased self-confidence, improved understanding of the subject matter, and better marketability; 2) For faculty, it helps advance our research agenda in spite of a busy academic schedule, and provides us with fresh perspectives on old problems. However, involving students in research can also be frustrating: after significant investment of time and effort, students may still drop out, fail to complete their work, or fail to follow instructions, and therefore, produce results that are not reusable – all occurrences that we must minimize, if not entirely avoid.

What are the characteristics of the students who make good research apprentices? What types of training should we provide them? How do we keep them motivated and focused? How do we reward them? How do we create a self-sustaining culture of undergraduate research at our institution?

Some lessons that I have learned, often, the hard way, are: 1) Students must have the right mix of ability and motivation – just one or the other will not suffice. 2) When recruiting students, it is often more effective to approach select students than to wait for students to approach us; 3) Some students prefer structure - weekly meetings, presentations etc. Others prefer flexibility - of schedule, reporting etc. It is important to identify the needs of each student. 4) It is a good idea to draw a contract upfront that helps the student measure progress and determine when a project is done. It is also a good idea to include a list of deliverables where appropriate. 5) Free-ranging students usually produce free-standing work that cannot be reused or integrated. If reuse is important, it is necessary to vet everything, and leave nothing to chance. 6) Peer pressure and peer support can be used in our favor by holding group meetings. 7) Participating in a professional conference is a great learning experience for undergraduate students. So, it is a good idea to encourage students to write up their results and present at conferences. 8) It is necessary to impress upon students that writing up research results will require at least three revise-rewrite cycles. 9) Showcasing successful student research projects can serve as an attractive tool for recruiting additional students. 10) “There is many a slip between the cup and the lip.”

GORAN TRAJKOVSKI

Graduate students research activities are normally fostered and bounded by available funding by their advisors (whose role is increasingly becoming managerial). As such, they have been the force (and legwork) beyond (almost) all newly generated research results in academia. The undergraduate research is a completely different story. Despite the efforts of funding agencies to boost the involvement of these students in the research process, we are still reluctant in getting into these ventures.

In my opinion undergrads are the single underutilized tool in research. The pluses: undergrads involve in research full with enthusiasm, and basically as tabulae raseae. It is easy to sway them in a desired direction, and expect far from equilibrium results in an autopoetic setting. However, these ventures are very risky. Apart from having to frequently intervene (and as social workers at times), we have to be very sensitive in
approaching these students. These partnerships are in general very time consuming. Students do not have a clear picture of what research entails. Researchers can hardly get them for longer than one or two semesters. The projects sometimes end up with miniscule, if at all, results, and disappointment to both parties.

How to manage student research? What do we gain if we micromanage? Are we ready to undertake unplanned adventures? How does doing research with undergraduates affect the P&T process for junior faculty? What do students gain from the experience? Those are just a few of the questions that thinking on this subject arise.

One of my ongoing projects, POPSICLE (Patterns in Orientation – Pattern-Aided Simulation Interactive Context Learning Experiment) was born in an autopoeetic small undergraduate classroom setting when experimenting incorporating research in a course. The scope has since grown, but the students came with a nice environment for studying context learning in humans, and interchange of information between human subjects when inhabiting simple virtual environments. Motivated by the initial results, more similar projects were undertaken, and finally we ended up setting up our Cognitive Agency and Robotics Laboratory as a place where we would test and calibrate our developmental and cognitive models in a realistic setting and on robotic agents. A number of students are now working on either simulations or projects for online deployment of POPSICLE, a flexible environment that enables creating of own test scenarios for human subjects. The work is being hosted on publicly accessible CVS system. Undergraduate research in the lab is attempting smaller projects such as the Victim Acquisition Agent for locating people in a disaster area, and various project in vision and locating of robotics agents. Students have presented their work on conferences and various research expos. Overall, despite the hard work, the experience has been a very rewarding one.

JEFFREY L. POPYACK

Students’ involvement in research increases the relevance of their education. Far too many activities we design for students ask them to follow the footsteps of others. Often we ask them to implement an algorithm from the text, prove certain properties we know to be true, etc. Certainly the material they learn is important; indeed we would probably be horrified if they did not learn it! However, if this is the only type of activity in their education, the message we send is that discoveries are made by other people, and what we want students to do is learn to follow others. It is exciting for them to work on a project that advances the state of the art, and revealing to realize they can do “value-added” work.

In “The Quick and Easy Way to Effective Speaking”, Dale Carnegie’s primary thesis is that success in life begins with self-confidence, and there is no better booster of self-esteem than the ability to speak in public. As an analogue, that same measure of self-esteem as a future practicing professional may be established by producing publishable results. And as a matter of fact, those results are often presented publicly, as conference presentations and posters.

Project DUPLEX (Drexel University Programming Learning Experience) addresses the problem of effectively delivering large introductory computer programming courses to multiple audiences with different goals and needs, through course redesign and
advanced deployment of technology. This project is ideally suited to student involvement, with participants serving as software/technology developers, teaching/research assistants and users of the technology. With initial funding from NSF and the Pew-funded Center for Academic Transformation, we were able to hire a few students as research assistants, cooperative education employees, and part-time programmers. Our students shared space in one of our department’s research labs, which already had about a dozen undergraduate and graduate students in it, working on various projects. The bustle of activity made it an inviting place for them to spend time between classes, even when not working on their research projects. Between our frequent meetings and activities, and their interaction with other students in the lab, their lifestyles developed to include doing their own literature searches, proposing new directions, and submitting papers to conferences themselves. Two projects received “Best Poster” awards in their divisions at Drexel’s annual student research conferences, and two conference papers have been published in which students were the primary authors.

SOFYA POGER

Research is a scientific process of inquiry and experimentation that involves a purposeful, systematic, and rigorous collection of data. Research involves finding answers to questions or solutions to the problems, discovering and interpreting new facts, testing theories in order to revise accepted theories and/or laws in the light of new fact, and formatting new theories.

I believe that the integration of teaching and research helps to improve the quality of teaching effectiveness and student learning. Introduction of students to research methods will accelerate the pace at which they undertake independent research projects. Preparing and presenting research is a new experience for the students. The students hoping to enter a graduate degree program in a scientific discipline need to have some research experience to show on his or her resume.

As we have graduate and undergraduate students we must distinguish between the undergraduate research and graduate research. Graduate students focus on writing of an acceptable dissertation as a first step in process of publishing their work and establishing a name in profession.

Undergraduates, while striving to get a good grade in the course for which they are doing research, also concerned about completing other courses and are searching for jobs or applying to graduate or professional school. Many are pursuing careers that do not involved traditional academic research. Nevertheless undergraduate research is important as students learn the conventions of research through practice and acquire valuable presentation skills. For them research becomes an essential part of the internal transformation as they begin to understand what means to be a scholar and a researcher.

BIOGRAPHIES:

Stefan Robila, is an Assistant Professor in Computer Science and the director of the newly formed Center for Imaging and Optics at Montclair State University. His interests
lie within pattern recognition with applications in computer security (steganography) and image processing (in particular multispectral and hyperspectral imagery).

Amruth Kumar is Professor of Computer Science at Ramapo College of New Jersey. His research interests include Intelligent Tutoring Systems and Computer Science education research. He is on the eastern and northeastern boards of the Consortium for Computing Sciences in Colleges.

Goran Trajkovski is the Director of the Cognitive Agency and Robotics at Towson University, Towson, MD. In his 10 full years in academia, he has undertaken many experiments on incorporating student research in the educational process. A number of his publications are co-authored by his students.

Jeffrey L. Popyack is Associate Dept. Head for Undergraduate Computer Science at Drexel University. He has been the Principal Investigator on three NSF-DUE grants for innovation in teaching computer programming courses. He is an International Officer of Upsilon Pi Epsilon, the International Honor Society for the Computing and Information Disciplines.

Sofya Poger has MA in Computer Science from Montclair State University and PhD in Computer Science from Stevens Institute of Technology. Currently she is an Assistant Professor in Computer Science Department of Iona College. Her research interests are in Computer Vision and Computer Graphics.