

Building Affinity Groups to Enable and Encourage Student Success in Computing

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Abstract

The Affinity Research Group concept and model provides both undergraduate and graduate students with opportunities to learn, use, and integrate the knowledge and skills that are required for research with the knowledge and skills that are required for cooperative work. Affinity research groups include students with a wide range of experiences and skill levels, and provide them with opportunities to deepen their knowledge in technical areas. Through structured tasks and activities, students develop domain expertise, gain an understanding and appreciation of the research process and its practice, and acquire team, communication, problem-solving, and higher-level thinking skills that will make them effective leaders and successful in research, academia, and industry.

1 Introduction

The University of Texas at El Paso (UTEP), founded in 1914, is the second oldest academic component of the University of Texas system and serves a rapidly growing binational and bicultural community. The university is a regional school with 85% of the students living in El Paso County; 66% of the student population is Hispanic, closely reflecting the cultural composition of El Paso. In September 1995, NSF awarded the Department of Computer Science (CS) in conjunction with the Department of Electrical and Computer Engineering (ECE) a five-year CISE MI-I grant, entitled Building Affinity Groups to Enable & Encourage Student Success in Computing. This grant is focused on increasing the number of Hispanic computing professionals.

The Affinity Research Group concept and model provides an innovative way to involve undergraduate and graduate students in research and other technical activities outside of the classroom. Through methodic and structured activities, students deepen their knowledge in a technical area and develop skills and strategies that make them more effective leaders and successful in research, academia, and industry. An affinity research group experience instills, in many of the students, the desire to continue their education and development. Studies show that persistence may be the single most important characteristic for academic success. The Affinity Research Group concept incorporates mechanisms that address persistence. Currently there are five established groups in the departments of Computer Science (CS) and Electrical and Computer Engineering (ECE): Systems and Software Engineering Affinity Laboratory group (SSEAL), Theoretical Research and its Applications in Computer Science, Human Computer Interaction Group, Signal Processing and Communication Affinity Group (SPC), and Neuro-Fuzzy Systems. For more details and the full annual report, refer to www.sseal.utep.edu, www.sseal.utep.edu/sysadmin/, and www.ece.utep.edu/research/webspc/wwwdocs/.

2 Accomplishments

2.1 Goals, Objectives, and Targeted Activities

The *goals* of the Affinity Research Group project are to increase the retention and participation of traditionally underrepresented groups in the computing areas, and to define a framework that supports research projects, outreach programs, and curriculum development. With respect to these goals, the *objectives* of the Affinity Research Group project are: to provide an environment that supports persistence of students from underrepresented groups; to define activities that develop undergraduate and graduate students' research, technical, group, and communication skills; to document and disseminate the

infrastructure for creating and managing effective research groups that involve students with a wide range of abilities and experiences; and to develop a formative evaluation instrument that can be used to provide adopters of the model with feedback for refining their use of the model. The funded project, divided into three phases, is completing its second phase. The first phase (years 1-2) involved development of the model. The second phase (years 3-4) consisted of refinement of the model and addition of new research groups within the Departments of Computer Science and Electrical and Computer Engineering. The last phase (year 5) involves dissemination of the model outside the departments and the university.

2.2 Components and Materials Required

In year 5, the majority of students working on research projects in SSEAL were funded by sources other than this grant. Stipends from this NSF grant were used to fund undergraduate students who are new to research. A university match pays for a graduate student to assist in the assessment and documentation process and two student system administrators. The grant provided the funds to update and purchase equipment for the existing and new laboratories. For the SPC group, NSF CISE MII stipend funds were used almost exclusively to support the management team. These funds have been used in the past to develop web pages, to perform educational support tasks, and to support other tasks that cannot be easily funded by other means. The matching funds are used to support the laboratory assistants. MII funds also are used to update laboratory equipment. For all groups, the grant provided funds for materials and supplies to support activities, e.g., presentation preparations, student travel to conferences and workshops, and PI travel for dissemination of the model. Other grant-related salary expenses include a total of 4.5 summer months for the investigators. Assessment and documentation of the project is being conducted by a staff member who is funded by a DOE Hi-CREST grant.

2.3 Indications of Success

The grant provided funding to build the infrastructure for four laboratories in the CS and ECE departments that house approximately eighty students. The purchased equipment not only supports research activities within the laboratories, but also courses that could not be offered without the supporting equipment. In particular, a new course, Parallel and Distributed Systems, was taught in the CS department in the fall semester using the Origin 2000 in the SSEAL and assistance from SSEAL student system administrators. In the ECE department, two senior-level courses use the SPC laboratory. In addition, the laboratory supports senior projects for undergraduates and research for graduate students.

The majority of research being conducted in SSEAL is connected with the Dynamic Monitoring with Integrity Constraints (DynaMICs) and Performance Oriented End-to-End Modeling System (POEMS) projects, funded by NASA, Sandia National Laboratories (SNL), DARPA, and NSF. TRACS research projects, funded by NSA, NASA, United Space Alliance and NSF, center around text image recognition, data mining, electronic money, and security. SNL, NASA, ARO and NSF fund projects in SPC and Neuro-Fuzzy Systems. Aside from advancements made on the research foci of the research groups, the achievements during year 5 included further model refinement and formalization, outreach involvement, and model documentation and dissemination. Goals for year 5 of the project were to disseminate the model outside the CS and ECE departments and the university. This along with other indicators of success of the model and research are discussed next.

Dissemination of the model has occurred through a number of different activities. In particular, Drs. Teller and Gates gave a keynote speech on the model at the South Central Small Colleges Conference (SCSC) in April 2000, and Dr. Gates gave an invited talk to the Colorado Alliance for Minority Programs (AMP) at Adams State College and a presentation to the IEEE Computer Society Educational Activities Board. In addition, the co-PIs have given presentations at Frontiers in Education and other venues. Two NASA Headquarters site-visiting teams recently cited the model as exemplary. The success of the model is evidenced by its adoption within the department (three new research groups have been created since its

inception) and outside the department (the Model Institutions for Excellence program at UTEP is adopting the model in fall 2000 to form cohorts of research students in the Science and Engineering colleges). Outside the university, aspects of the model are being adopted by research groups at Florida International University, University Puerto Rico Mayaguez (NASA-funded Partnership for Spatial and Computational Research Project), University of Texas Pan American, and Texas A & M Corpus Christi, among others. The feedback from the SCSC keynote talk indicates that other departments are using the model. In addition, close to thirty industry representatives and professors from other universities have visited the laboratory. Dr. Jim Browne at the University of Texas Austin is asking that new proposals include the model. IEEE Computer Society EAB has expressed interest in entering in a collaborative agreement for publication of the handbook.

3 Summary of Results 1995-2000

The demographics of affinity groups' membership are as follows: 73 graduate student members (12 Ph.D. students); 102 undergraduate student members; 136 members from underrepresented groups (38 female members); 61 members graduated with BS; 38 members graduated with MS; two members graduated with a Ph.D.; 31 undergraduate members continued to graduate school. The breakdown of publications, talks, and awards is as follows: over 150 research publications; over 100 research publications (journal and conferences) with students as co-authors; 23 publications and talks on the Affinity model; 66 student presentations at student conferences; 25 student awards and recognition. Leveraged funding follows: approximately \$14,900,000 in external funding (\$11,000,000 is a collaborative grant with Geology, Electrical Engineering and Computer Science); approximately \$35,000 in university funding to renovate research space and upgrade telecommunications; approximately \$20,500 in donated equipment from Intel, Sun Microsystems, and IBM.

4 Evaluation

4.1 Degree of Success

As discussed in Section 2.3.1, the goal of disseminating the model within and outside the university is being met. An orientation handbook was created this year. In addition, an affinity group model handbook is in progress. The handbook is being organized such that other faculty mentors can adapt those aspects of the model that suit their needs. The sections of the handbook include the major components of the model. Other sections cover topics such as student issues, management issues, oral presentation guidelines, and supporting templates and forms. The types of templates and forms that have been collected include: meeting record, status report, project definition, presentation critique, conference/trip report, and the SSEAL Research Assistant Agreement. In addition, increased student participation, technical papers, presentations, and grants exemplify the success of the model and research. With respect to success in student development and persistence, success indicators are conference attendance, papers, presentations, outreach involvement, involvement in extra-curricular activities, graduation, awards, scholarships, and continuation to graduate school. See summary in Section 3.

4.2 Unmet Goals

One goal that has not been met is the training of other faculty. Because of other commitments, the investigators were not able to organize workshops for training mentors, or to monitor activities in the new groups. The time required to refine, document, and disseminate the model as well as to sustain the development of students is substantial. To address this, the investigators are setting regular meetings with staff members to develop a handbook. In addition, there are efforts in progress to seek academic and teaching credit for mentoring undergraduate students. Because funding and institutional match will be terminating, it may not be possible to continue to support the system administrators that manage the laboratories. These positions are essential for maintaining a quality laboratory; as a result, strategies to

institutionalize the positions are being pursued. Dr. Cabrera recently received a \$1,400,000 commitment from Texas Instruments Foundation, and Drs. Novick and Gates submitted a white paper to Lucent Technologies. Dr. Teller is also pursuing industrial support. Last, a few students who expressed interest in continuing to graduate school took industry jobs. Because students are well trained, recruiters are offering high salaries and students are finding the offers too attractive to refuse.

4.3 Outcomes and Impact

The model is producing better qualified students, and students who are enthusiastic about learning outside the classroom. In spite of the pull from industry, there appears to be an increase in students who are continuing to graduate school. In addition, students' attitudes with respect to higher education are positive. We believe this is due to their involvement in the affinity research groups. Numerous students have received fellowships and have been selected for internships and co-op programs. The model develops students with strong team and leadership skills who will become valuable assets to industry and contributing members of society. This year, all officers of the student organization of ACM were affinity group members. Students are not only taking leadership roles in the department, but they are also serving as role models to students who are not members of affinity groups. Other indications that students are transferring the skills learned in the affinity groups include the organization of a TA orientation by two affinity group members, involvement in outreach activities by the student chapter of ACM, improvement in teaching and tutoring abilities of TAs who have been involved in the affinity groups, and formation of study groups. Professors have noted an improvement in affinity students' performance in classes. By building group models in which students are welcomed, encouraged, developed, and supported to achieve success, we are creating an innovative and scalable mentoring scheme that fosters the involvement of undergraduate and graduate students in research.

5 Immediate Impact

For the 1999-2000 reporting period, the number of students involved in the affinity groups are as follows: 84 total members, 44 from underrepresented groups (20 female students), 49 graduate students, and 35 undergraduates. Of the 84 affinity members mentioned, 35 were co-authors on technical papers, 39 attended conferences, and 40 presented talks during the reporting period. Of the 30 students who graduated during the reporting period, one received a PhD, 16 received MS degrees; and 20 BS degrees. Nine students are continuing their graduate education. The faculty mentors wrote four papers gave two talks (one keynote) on education and dissemination of the affinity model. There were over fifty technical publications, and most publications had students as co-authors. Ten students received awards or scholarships. There have been twenty-two grants submitted and a total of \$6,975,946 awarded.

5.1 Selected Publications Supported by Grant

Note: an asterisk denotes a student co-author.

Adve, R., et al. (P. Teller), "POEMS: End-to-End Performance Design of Parallel Adaptive Computational Systems," to appear in *Transactions on Software Engineering*, 2000.

Baral, C., Kreinovich, V., and Trejo, R.* , "Computational Complexity of Planning and Approximate Planning in Presence of Incompleteness," *Proceedings of the Sixteenth International Joint Conference on Artificial Intelligence IJCAI'99*, Stockholm, Sweden, July 31-August 6, 1999, Vol. 2, pp. 948-953 (Best Student Paper Award).

Chan, S. H.* , Brito, A. E.* , and Cabrera, S. D., "Characterization of Windowing Effects in Adaptive Extrapolation of Sinusoids," *Proceedings of Thirty-Third Asilomar Conference on Signals, Systems and Computers*, Vol. 2, pp. 1092-1097, Pacific Grove, CA, Oct. 1999.

Cuellar, J.* , Garcia, I.* , Vega, A.* , "Simulated Implementation of the Forward and Inverse Two-Dimensional Discrete Cosine Transform in a Field Programmable Gate Array," *International Test and Evaluation Association Conference*, White Sands, NM, 1999 (Best Student Paper Award).

Gates, A.Q., Mondragon, O.* , Saenz, F.* , and Cereceres, R.* , "FasTLInC: A Constraint-based Tracing Approach," accepted with revision to *Journal of Systems and Software*, May 2000.

Gates, A. Q. and Teller, P. J., "DynaMICs: An Automated and Independent Software-Fault Detection Approach," *Proceedings of the Fourth IEEE International High Assurance Systems Engineering Symposium*, Washington, D.C., November 1999, pp. 11-19.

Gates, A. Q., Teller, P. J., Bernat, A., Delgado, N.* , and Kubo Della-Piana, C., "Expanding Participation in Undergraduate Research Using the Affinity Group Model," *Journal of Engineering Education*, 88(4), October 1999, pp. 409-414.

Gibson, S.* , Kosheleva, O.* , Longpre, L., Penn, B., and Starks, S. A., "An Optimal FFT-Based Algorithm for Mosaicking Images, With Applications to Satellite Imaging and Web Search," *Proceedings of the Joint Conferences in Information Sciences JCIS'2000*, Atlantic City, NJ, 2000, Vol. I, pp. 248-251.

Kosheleva, O. M.* , Mendoza, C. A.* , Perez, J. S.* , and Cabrera, S. D., "Metrics for Evaluation of Lossy Compression Effects on Digit Recognition in SMD Images," to appear in *Proceedings of 42nd Midwest Symposium on Circuits and Systems*, Las Cruces, NM, August 1999.

Lucero, Y.C.* and Nava, P., "A Method for Membership Function Generation from Training Samples," *Proceedings of the 1999 International Congress on Electronics and Electrical Engineering*, October 1999.

Sada, G.* and Usevitch, B., "A Practical Binary Bit Stuffing Method for Multiplierless Arithmetic," *Proceedings of 1999 Midwest Symposium on Circuits and Systems*, Las Cruces, NM, August 1999.

Salvatore, A. P., Thorne, N. A.* and Gross, C. M.* , "Neural Network Approach to Speech Pathology," *Proceedings of the 1999 IEEE Midwest Symposium on Circuits and Systems*, August 8-11, 1999, Las Cruces, New Mexico (to appear).

Teller, P.J. and Gates, A. Q., "Progress Towards a Comprehensive Knowledge-based Monitoring System for the Development and Evolution of Software," *Proceedings of Computational Aeroscience Workshop 2000*, NASA Ames, February 2000.

Teller, P.J. and Gates, A. Q., "Applying the Affinity Research Group Model to Computer Science Research Projects," to appear in *Proceedings of the 2000 Frontiers in Education Conference*, Kansas City, MO, October 2000.

Usevitch, B., and Betancourt, C.* , "Fixed-point Error Analysis of Two-Channel Perfect Reconstruction Filter Banks with Perfect Alias Cancellation," *IEEE Transactions on Circuits and Systems II: Analog and Digital Signal Processing*, Nov. 1999, 1437-1440.