The Affinity Research Group Model: Creating and Maintaining Dynamic, Productive, and Inclusive Research Groups

Much of the scholarship on undergraduate research to date has demonstrated the approach’s value as a learning experience. Findings cite a wide range of potential benefits from participation in such research for students, their research mentors, undergraduate institutions, funding agencies, employers, and society at large. Recent studies and reviews of undergraduate-research programs suggest heightened interest in investigating different programmatic models for undergraduate research and in understanding differential outcomes for such programs.

Scholars such as Donath et al. (2005), Hunter et al. (2006), Laursen et al. (2006), Seymour et al. (2004), and the National Science Foundation (2000) are deepening investigation into many aspects of the undergraduate research experience through studies of issues as wide-ranging as: 1) identification of best practices for promoting undergraduate research; 2) creation of methodologies for analyzing and describing the development of disciplinary knowledge through undergraduate-research experiences; and 3) development of a theoretical framework for describing the elements of undergraduate-research experiences that lead toward personal, professional, and intellectual growth for students.

In this article, we introduce a model for undergraduate research, the Affinity Research Group (ARG)—a comprehensive model for creating and maintaining dynamic, productive, and inclusive research groups.\(^1\) An affinity research group is, first and foremost, a team effort in which faculty mentors and students enjoy an environment designed expressly to let each member flourish. Group members have or are developing an affinity for the particular research topic, hence the name of the model. Group members share, to greater or lesser extents, common research goals, as well as goals for academic and professional development. Affinity research groups are comprised of students and faculty mentors actively engaged in discovering and sharing ideas in a cooperative environment. The ARG model embodies a set of fundamental principles and effective practices for involving undergraduates in research groups. Application of the model entails the deliberate design of research groups whose members share a common purpose—an affinity—and it emphasizes the conscious development of students’ disciplinary knowledge, research abilities, and team skills, as well as their sense of professional identity.

The involvement of undergraduates in research allows them to acquire higher levels of academic and technical ability through their interaction and cooperation with professors in pursuit of common research goals. This, in turn, enables them to persist through graduation and to consider graduate study having gained knowledge of the research processes and methods involved in an advanced pursuit of their discipline. The founders of the ARG model firmly believe in the value of including undergraduates in research because they have found that the value added to the research program, to students, and to the faculty is well worth the time spent. Involvement in research groups is a valuable tool to help undergraduate students acquire the skills and experience they need to succeed in graduate school and in the workforce. Students in affinity research groups develop problem-solving skills, communication skills, and learn to work both independently and as members of teams. In many cases, this form of participation in research as an undergraduate is the defining experience that solidifies a student’s desire to pursue graduate studies and to consider research or academia as a career path.

The model integrates best practices from a variety of sources in industry, research, and education. Using structured tasks and activities, students develop domain expertise, gain an understanding and appreciation of the research process and its practice, and acquire the skills that will make them effective leaders and successful in research, academia, and industry. The model has demonstrated success in increasing both the quality of undergraduate students’ learning experiences and their participation in advanced studies. The ARG model is an excellent vehicle for encouraging students who, although competent, may lack the necessary confidence to continue to graduate school.

Genesis and Evolution of the Affinity Research Group Model

The ARG model is founded on two important research-based practices: interaction among students and faculty outside the classroom to increase the likelihood of students’ persisting to graduation (Astin, 1985; Tinto et al., 1994; Rodriguez, 1994); and the use of cooperative-learning techniques in an academic...
setting to maximize student learning and efficacy (Johnson & Johnson, 1989a). In 1995, University of Texas at El Paso (UTEP) faculty members Andrew Bernat, Ann Quiroz Gates, and Sergio Cabrera integrated these practices and conceptualized the ARG model, with the goals of improving retention and advancement of students from computer science and electrical and computer engineering into graduate school. Because more than 70 percent of UTEP’s student population is Mexican-American, the model was originally intended to address retention and advancement of students from underserved groups (Gates et al., 1999).

Over time, the founders and others who implemented the model realized that it creates an environment that promotes the success of a diverse population of students. An important tenet of the ARG model is the involvement of students with varied educational, cultural, linguistic, and socioeconomic backgrounds and experiences. Indeed, the inclusion of student researchers from diverse backgrounds has been shown to enhance the levels of scholarship and research productivity. As Dr. William Wulf, President of the National Academy of Engineering, states:

To the extent that engineering lacks diversity, it is impoverished. It is not able to engineer as well as it could. Since the products and processes we create are limited by the life experiences of the workforce, the best solution, the elegant solution may never be considered because of that lack! (2006)

The ARG model addresses Wulf’s concerns. Not only has it shown promise for enriching the population of graduates entering engineering fields; it has also been applied in engineering and computing programs in diverse settings at institutions including the University of Puerto Rico Mayaguez, Florida International University, and Wayne State University. Faculty and student participants in affinity research groups have benefited from the kind of rich environment for creative thinking, learning, and professional growth that the model’s emphasis on diverse participation fosters. While the model was developed to address the low number of students from underrepresented groups that enter and successfully complete programs in computing, it is applicable to any discipline and student population.

**Philosophy of the Model**

The founders of the ARG model believe that research groups established using principles of cooperative learning provide the ideal environment for apprenticing undergraduate students into practices of scholarly and applied research. The cooperative framework on which the ARG model is based creates an environment in which students of varying levels of expertise, capabilities, interests, and backgrounds develop knowledge and skills that leaders in industry and government have identified as essential. These include problem solving, team building, conflict management, leadership, critical thinking, communication, professionalism, and ethics. A basic underpinning of the model is that such knowledge and skills must be consciously and deliberately integrated into the day-to-day activities of the research group, because it cannot be assumed that students either possess them already or will acquire them automatically through unstructured interaction with peers and mentors. For example, discussing the value of constructive criticism and involving students in critique of presentations given by their peers raises the students’ consciousness of what constitutes a good presentation. Because students learn that presentations will be critiqued, they begin on their own to vet their presentations with one or more peers prior to presenting to the group. Thus critical review of presentations and written documentation becomes part of students’ practice.

Another facet of the model’s philosophy is that the research group’s goals can be achieved and participation of a diverse group of students can be fostered while maximizing each participant’s potential. An affinity research group focuses on capitalizing on the strengths of individual students and developing strategies to strengthen their weaker areas.

While many elements of the ARG model are adaptable, in a genuine affinity research group it is essential that the faculty mentor(s) adopt the ARG philosophy as the driving force behind the research group. The following sections describe what the essential elements of cooperative learning are, how they are integrated into affinity research groups, and the learning theories that justify the model’s structure.

**Five Elements of a Cooperative Framework**

The cooperative-learning framework around which affinity research groups are built was developed by David and Roger Johnson (see Johnson & Johnson, 1989; Johnson et al., 1990; Johnson et al., 1991; Johnson et al., 1992). Based on social-
psychological theories of learning, this paradigm has been extensively applied in classrooms and for team-building in business environments. Although cooperative learning was not designed specifically for research groups, the founders of the movement suggest that it has wide applicability to all kinds of teams and groups whose members come together to accomplish shared goals.

Five basic elements must be present in the activities within the group for it to function in a truly cooperative manner:

1. **Positive interdependence:** Each member knows that she or he contributes to the success of the others and the group. When positive interdependence is present, each member of the group has a personal stake in the success of the group and believes that her or his contributions are valued by the group. Positive interdependence can be structured for the research group in a variety of ways, for instance, through assigning roles and creating shared goals. For example, students may name their project within the group; members of the research group could participate in defining or refining the mission of the research group; and students can participate in creating and maintaining a Web site for the research group.

2. **Face-to-face promotive interaction:** All members of a cooperative group work together in ways that promote each individual member’s success, as well as the success of the group as a whole. Faculty mentors should support and encourage members’ progress and involvement so that they will feel comfortable exchanging and sharing ideas and resources with each other, with the explicit goal of making each other and, therefore, the group successful. It is important to acknowledge and recognize each member’s contribution to the group. This element can be structured by recognizing students’ accomplishments at, for example, monthly meetings, birthday celebrations, and appropriate announcements at meetings and in the department of jobs well done.

3. **Individual accountability:** Each person must be responsible for his or her fair share, defined generally in terms of tasks and deliverables. This is critical for developing strong individuals and well functioning teams. Individual accountability allows students to assess their own deficiencies and areas of weakness and to seek help so that they can improve their performance in those areas. Individual accountability is structured into the model through assigning tasks, along with deliverables, to each group member.

4. **Group and professional skills:** Developing effective group participation and professional skills makes for more productive and successful interaction among group members and is key to the maintenance of positive interdependence. Faculty mentors should never assume that students come with the necessary skills to work effectively in groups. Group and professional skills should be explicitly taught and practiced in activities designed around technical topics, such as the discussion of journal articles or critiques of technical presentations. Group and professional skills include such basic skills as active listening, active participation, and recording minutes, as well as more advanced skills such as summarizing, providing directions, synthesizing ideas, asking questions, facilitating brainstorming sessions, and offering constructive critique. Group skills can be explicitly taught by asking students to identify and describe the aural and visual cues of someone modeling or practicing a particular skill. For example, students might be encouraged to listen for and identify statements that support a constructive critique, such as the following: “I think your example was effective. It might be more effective if you presented it earlier in the talk.”

An effective approach to structuring group and professional skills is to model them for students, as well as to implement activities that allow students to practice skills. Another approach is to assign roles; these roles could vary depending on the group’s needs from day to day. For example, when the group needs to practice formulating information, the roles of summarizer, accuracy coach, checker of understanding, elaborator, and perspective-taker would be appropriate to assign. In order to resolve conflicts, roles such as devil’s advocate, asker
for justification, differentiator, integrator, extender, and prober might be assigned.

5. **Group processing:** Faculty mentors and team members regularly reflect on how well they are achieving their goals and how well each research subgroup is functioning. Based on the results, the mentors determine the programmatic changes that need to be made, and team members determine the changes that need to be made in their group.

While many research groups function cooperatively to some extent, affinity research groups integrate cooperative-learning techniques into the routine functioning of the group, which fosters group cohesion and increases the likelihood that members will be able to transfer team skills to other situations. For example, after practicing the critique of group members’ papers and presentations at weekly meetings, ARG students report that they often seek out their group members outside of formal group meetings to bounce project ideas off them, to receive critiques on papers or presentations, or simply to study for exams. In an interview, Maggie, a former member of an affinity research group, described how such group interdependence developed among the group’s members: “When Fred did his thesis, he presented his presentation to us. And this was not something that any faculty said we should do. He just did, and then we asked him questions. When Martha got her Ph.D., we did the same thing for her. When I did my thesis, they did the same thing for me.”

The five elements of a cooperative framework are structured into weekly group meetings, the day-to-day functioning of the group, and throughout the life of the research group. Because the group has dynamic membership, it is important for the faculty mentor to continually reflect on the functioning of the group, design group activities, and make adjustments as necessary. Table 1 summarizes the differences in basic philosophy between ARGs and research groups based on a traditional model.

We draw from two social-psychological theories to frame our understanding of how affinity research groups operate and why they can be successful at developing underrepresented students’ domain knowledge, professional skills, and research abilities. The theory behind cooperative learning explains how deliberate design of social structures can create an environment in which members of affinity research groups can flourish. Each individual member perceives that his or her contribu-

<table>
<thead>
<tr>
<th><strong>AFFINITY RESEARCH GROUP</strong></th>
<th><strong>TRADITIONAL RESEARCH MODELS</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Members are concerned about the progress of the team’s project.</td>
<td>Members are concerned about the progress of their individual project.</td>
</tr>
<tr>
<td>Heterogeneous membership is encouraged; competent, though not necessarily confident, students are recruited.</td>
<td>Only the best and brightest are recruited.</td>
</tr>
<tr>
<td>Group members share leadership in executing various tasks.</td>
<td>The professor leads the group.</td>
</tr>
<tr>
<td>Research, technical, team, and professional skills are emphasized and explicitly taught.</td>
<td>“Necessary” research and technical skills are taught.</td>
</tr>
<tr>
<td>Professional skills are developed through structured activities.</td>
<td>Professional skills are assumed.</td>
</tr>
<tr>
<td>Cooperative environment is a key part of the model and is encouraged and developed.</td>
<td>Environment is controlled by the research leader and may be competitive.</td>
</tr>
<tr>
<td>Process improvement is part of model.</td>
<td>Process improvement doesn’t exist or is ad hoc.</td>
</tr>
</tbody>
</table>

Table 1. How the ARG Philosophy Differs from a Traditional Research Model.

Theoretical Foundation: Cooperative Learning and the Deliberate Design of ARGs

The ARG model is intentionally engineered using the cooperative-learning framework outlined earlier. The structure of cooperative learning is derived from three broad theoretical perspectives: social interdependence, socio-cognitive development, and behaviorism. Of these three theoretical perspectives, it is the theory of social interdependence (Johnson & Johnson, 1989) that explains how different types of interaction within groups will lead to varied outcomes.
The premise of social-interdependence theory is that the manner in which interaction is structured will determine whether positive interdependence is present, and this in turn will affect group and individual outcomes. Positive (cooperative) interdependence occurs when two or more people interact in ways to promote each other's success. In positive interdependent situations, individual members perceive the attainment of their goals only if the other members also attain their goals.

The outcomes of such cooperation or promotive interaction are positive relationships, an effort to achieve, and psychological adjustment or social competence. The ARG model strives to structure group interactions in such a way as to foster cooperative interdependence and promotive interaction, resulting in the following outcomes:

- Establishment and maintenance of cooperative groups;
- Achievement of research deliverables; and
- Self-development of group members (teaming, professional, and research skills; cognitive development; emotional development).

Theoretical Foundation: Situated Learning Theory and ARGs as Communities of Practice

An essential facet of the ARG model is the idea that groups form around goals that all members share and that newer members learn through participating in research activities under the guidance of more experienced members. The theory of situated cognition/learning (Lave & Wenger, 1991) offers a framework for elucidating how learning and development occur through participation in affinity research groups. Anthropologist Jean Lave and computer scientist Etienne Wenger (Lave & Wenger, 1991; Lave & Wenger, 1999) developed a theory of learning as “situated” in certain forms of social participation, in which it is distributed among co-participants in a community of practice. This theory focuses on processes of interaction among community members and other aspects of social situations and social practices that may foster learning.

There are several aspects of this view of learning that are embodied in the ARG model. First, the notion of situated learning suggests that learning happens when learners engage with others in authentic, meaningful—real world—practices. When teaching does not situate learners in direct, meaningful experience, the learner has more difficulty making sense of what he or she is learning, turning new experience into abstract ideas.

A Faculty Mentor on Recruiting Less-Confident Students

I happened to be in the building late one night. Earlier that week, I had given a particularly challenging problem to my junior class, so I peeked into the computer lab on my way out to see if any of my students were there. A group of students from that class were indeed there, with three of my better students listening as a fourth—Monica—explained the problem’s solution. As the three continued questioning her, she patiently explained clearly and precisely the key points of the solution that I had hoped they would discover. I was mildly surprised, since Monica had not stood out in class.

A few weeks later, one of the midterm exam questions was related to that problem, and each of the three students answered correctly. To my surprise, Monica’s answer was weak, as was the rest of her exam. When I asked her privately how she could teach others but not answer the question herself, she made no excuses. She was working full-time off campus and didn’t have the chance to review before the midterm. More importantly, whenever she had to explain things in writing, she took a very long time because she didn’t think her written English was adequate.

I continued to observe that Monica was clearly able to explain the course concepts and write programs to solve the problems, but her grades never rose above mediocre. When I had the opportunity, I offered her a job as an undergraduate researcher. Initially, she was delighted, but a few days later stated that she didn’t think she could do the work because she didn’t know enough to contribute. I assured her that she was the right person for the job.

The research position meant that Monica could spend more time on campus, and her grades improved. She went on to graduate school, completed her master’s degree, and is now a database administrator. She contributed to the group not only through her research but also through her assistance to other students in their projects and through her ability to help others collaborate in solving similar problems.
Components of the Model

The three core components of the ARG model are:

- The definition of a group’s core ideology;
- Active fostering of student connectedness, i.e., building connections among members of the group and to members of the broader discipline or profession; and
- Application of deliberate management practices that reinforce skills development and promote establishment of cooperative teams.

Each of these is discussed further in the following sections.

Core Ideology

Affinity research groups adopt a core ideology consisting of two essential components: core values and a sense of purpose that goes beyond reaching the goals of the research project. This notion has been adapted from Collins and Porras’ *Built to Last: Successful Habits of Visionary Companies* (2002). As they define it, core ideology “guides and inspires” all group members and remains relatively fixed in time (p. 48). Some large affinity research groups may work on numerous research projects that are all driven by a single core ideology. As projects are completed and new ones started, the ideology remains constant.

The core values are a set of three to six simply stated principles that guide the group’s actions. The core values espoused by the affinity research group model are:

- **Student success.** An ARG values the deliberate development of skills in each student to ensure their success.
- **Cooperation.** An ARG values cooperation in all interactions, including mutual respect of opinions and ideas of all members, promotive interaction, positive interdependence, and individual accountability.
- **Excellence.** An ARG values excellence and strives to achieve it in all its actions.

Lave and Wenger (1991) conceive of the novice’s manner of participation in the community of practice as *legitimate, peripheral participation*. That is, novices participate in a way that is engaged and is recognized as relevant to the goals of the group, but is peripheral in terms of the knowledge and skill required, the expected impact on the group’s activities, and also perhaps in terms of the degree of commitment to the group’s goals and purposes that is required of the participant. Lave and Wenger emphasize that this flexibility of modes and degrees of participation in a community of practice is crucial to newer members’ abilities to learn and develop, because it allows them to gradually take on the perspective of other more-experienced members.

In affinity research groups, members become part of a group because they have or are developing an affinity for the research topic: group members share, to greater or lesser extents, common research goals, as well as goals for academic and/or professional development. Although newcomers to the group may only participate in a limited way in the group’s activities, they are not disconnected from the group’s primary practices. Rather, the idea of peripherality “suggests an opening, a way of gaining access to sources for understanding through growing involvement” (Lave & Wenger, 1999: 87). Without such an opening and the support provided by more-experienced members of affinity research groups, novice students might not have access to the skills, abilities, and knowledge that lead toward fuller participation in their fields of study (e.g. by enrolling in and completing graduate school).
core purpose of the Software Engineering Affinity Group is to engage students who would otherwise not be involved in research in addressing research problems that can benefit society through improved software-engineering approaches or techniques.

Another important aspect of the core ideology is its maintenance or “preserving the core” (Collins & Porras, 2002, p. 85). Because all members need to believe in the core ideology, it is essential to have a mechanism that inculcates it in new members and renews it in existing members. To serve this purpose, the ARG model incorporates an annual orientation to the group, discussed in the following section.

Student Connectedness
Students build connections among members of the group and to members of the broader discipline or profession through, among other means, the annual orientation and assignment of tasks. Assigned tasks and other structured activities create positive interdependence and create opportunities for promotive interaction.

Orientation. The annual orientation is used to assimilate new students into the research group; to reevaluate, modify, or reaffirm the group’s core purpose; and to facilitate members’ basic understanding of group and research skills through activities in which students practice and discuss these skills. In addition, the orientation explores the concerns of the students and faculty. The aim of this activity is to promote communication and professionalism and foster trust among all group members—both faculty and students—by understanding and appreciating each other’s concerns. Faculty concerns generally center on student professionalism—can students meet their responsibilities, manage their time, behave proactively, contribute tangibly, and be ethical? Student concerns typically center on meeting mentor expectations, contributing to research, learning the skills needed to succeed in research, and balancing coursework and research.

The orientation involves student facilitators, who are established group members. By assisting faculty mentors, the students are given the opportunity to gain ownership of the ARG and further develop their professional skills. More important, they have a chance to facilitate a cooperative meeting and apply what they have learned. The orientation provides an important opportunity for faculty mentors to facilitate students’ understanding of the structure and behaviors of the research group. In addition to reinvigorating students and faculty mentors, the orientation provides the venue to assess and evaluate the model and identify adjustments needed due to changes in group composition, project demands, and students’ concerns and attitudes.

Task assignment. Early in our work with students using the ARG model, our evaluations (Gates et al., 1999) revealed that student perceptions of their assigned tasks differed greatly from the perceptions of the faculty mentors. Students, especially undergraduates, did not understand the significance of their assigned tasks or how their tasks related to the organization and goals of the larger group. They often concluded that their work was simply “busy work” and of no consequence. Analysis of the way in which tasks were assigned revealed a lack of clear communication about the goals of the project, its motivation, and the relationships among the tasks that needed to be completed to reach the project goals. One of the key components of the ARG model, therefore, is to ensure that each student knows what the overarching goals of the group are and understands how his or her assigned task fits into that goal.

The research project’s definition gives students context for realizing the relevance of their assignments. Faculty mentors must take the lead when defining a project, which means defining both the project goals and objectives and, if the project is part of a larger project, relating those to the larger project. (For a more detailed discussion of project definition, see the following section.) It is important to make the goals and project description readily available by posting them, for example, in the research area, on an intranet, or on a Web site. Faculty mentors can use any number of methods to support students’ understanding of the project. One is to incorporate a unit in the orientation that involves discussing the project with the students. Another is to maintain a repository of background reading material as an annotated bibliography.

Management Practices
The management of an affinity research group includes project definition, scheduling of regular meetings, structured activities, and leading group processing for continuous quality improvement.

Project definition. Project definition includes defining dependencies, timelines, and deliverables. For semester-long projects, students set distinct milestones and discuss them with fellow group members. Timelines are critical to goal setting because
they help students define clear goals, evaluate their feasibility, and recognize the balance between research tasks and their coursework. They also help faculty mentors monitor students assigned to multiple tasks. Project definition benefits faculty mentors because they can be certain that students understand the steps needed to complete tasks. Project-definition activities aid in measuring a student’s progress, either formally through status reports or informally during regular meeting times. Each task has a set of deliverables, or tangible work products (e.g., annotated bibliographies, experimental designs, paper summaries, and research plans), which constitute evidence that tasks have been completed and, more importantly, archive knowledge to be shared. Deliverables help advance the research because fallacies or weaknesses in design or reasoning are more quickly exposed when explanations are written and presented in a cohesive document. Defining deliverables is one strategy for minimizing risks, developing domain expertise, and honing technical and communication skills.

Task dependencies reinforce positive interdependence among group members. An effective practice is to dedicate a meeting (or an orientation component) to discussing the value of defining research goals, setting timelines, and defining deliverables. Faculty mentors can ask students to develop semester-long research plans before the meeting and have students work in pairs or small groups to constructively critique another member’s research plan.

Meetings. The ARG model promotes management of the group using regularly scheduled meetings. These enable faculty mentors to track student progress, promote the refinement of short-term goals, solve problems encountered by students, and develop domain expertise. By having students discuss the status of assigned tasks and problems they encountered, as well as engaging them in discussions that deepen their understanding in their area of specialty, students remain focused, gain knowledge, and consider possible changes in research direction.

Structured activities. The ARG Handbook outlines a number of activities that promote connections among students, for example, working in pairs. In this activity, the mentor identifies two students to collaborate, review, and critically analyze each other’s work. Ideally, a faculty mentor assigns this activity to two advanced students who have a working knowledge of the research project. One student is assigned to lead the effort. Deliverables can be assigned to the pair as well as to the individual student. The activity is also key to mitigating risk in ARGs. If one student leaves the project, continuity is still preserved through the remaining student of the pair. This is particularly important for a task on a critical path. In addition to building positive interdependence, students have the opportunity to develop technical, research, collaborative, critical analytic, and technical writing skills and to gain practice in goal setting and time management.

Group processing for continuous quality improvement. Group processing facilitates the identification of strengths and weaknesses in processes and revision of processes that address the weaknesses. This activity provides students with a mechanism for regularly assessing how they are functioning in the research group and allows them to provide feedback to the mentor.

It is important that the faculty mentor realize the importance of consciously structuring the elements of cooperative teams. Indeed, managing a research or any other type of collaborative team is not a trivial task, and there has been a great deal of research and literature devoted to it. See, for example, Achinstein (2002), Calderon (1999), and Strahan (2003) regarding managing cooperative teams of teachers; Wondolleck and Yaffee (2000) on collaboration in natural-resources management; Jermann, Soller and Muhlenbrock (2001) and Olson and Bly (1991) on computer-supported collaborative learning and work systems; and Matthiassen (2002) on collaboration in systems-design research.

Table 2 summarizes the three main components of an ARG by looking at the benefits of each from the perspective of a faculty mentor and of a student.

Results of the ARG Experience

Evaluation of the ARG model (Gates et al., 1999, Della Piana and Bernat, 1999) was completed by an independent evaluation team that used a multi-method approach: surveys, interviews, and participant observation. Based on the nature and context of the project, evaluation focused on the model’s impact on students. The evaluation activities and results were designed to help ARG faculty mentors improve, articulate, and assess the impact and effectiveness of the model.

The demographics of affinity groups’ membership for 1995-2000 were as follows: 175 total members; 42 percent graduate student members (7 percent Ph.D. students); 58 percent undergraduate student members; 78 percent members from underrepresented groups (22 percent female members); 35 percent members graduated with BS; 22 percent members graduated with MS; two
### Table 2: Summary of Components of an Affinity Research Group

<table>
<thead>
<tr>
<th>GROUP COMPONENT</th>
<th>FACULTY MENTOR PERSPECTIVE</th>
<th>STUDENT PERSPECTIVE</th>
</tr>
</thead>
<tbody>
<tr>
<td>CORE IDEOLOGY</td>
<td>Drives the group's planning and decision-making.</td>
<td>Provides the group with direction, guidance, and inspiration.</td>
</tr>
<tr>
<td>STUDENT CONNECTEDNESS</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Orientation</td>
<td>Helps me...</td>
<td>Helps me...</td>
</tr>
<tr>
<td></td>
<td>• assimilate new members and reinvigorate established ones,</td>
<td>• deepen my understanding of the ARG model,</td>
</tr>
<tr>
<td></td>
<td>• provide a forum for voicing concerns and understanding student perspectives, and</td>
<td>• voice concerns and understand the faculty mentor’s perspective, and</td>
</tr>
<tr>
<td></td>
<td>• develop student advocacy for increasing numbers in a targeted discipline.</td>
<td>• realize the importance of increasing the number of qualified people working in</td>
</tr>
<tr>
<td></td>
<td></td>
<td>science, math, engineering, and technology fields.</td>
</tr>
<tr>
<td>Research project definition</td>
<td>Helps me...</td>
<td>Helps me...</td>
</tr>
<tr>
<td></td>
<td>• align tasks to mission and goals,</td>
<td>• understand my contribution as it relates to the whole project and</td>
</tr>
<tr>
<td></td>
<td>• ensure that we have a work breakdown that will let us achieve our goals, and</td>
<td>• connect to the research project.</td>
</tr>
<tr>
<td></td>
<td>• identify and mitigate risks.</td>
<td></td>
</tr>
<tr>
<td>MANAGEMENT SCHEME</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Defined dependencies and timelines</td>
<td>Helps me...</td>
<td>Helps me...</td>
</tr>
<tr>
<td></td>
<td>• understand steps for completing the research or project,</td>
<td>• understand the importance of tasks and their interdependencies and</td>
</tr>
<tr>
<td></td>
<td>• identify the project's critical path and possible risks, and</td>
<td>• realize the importance of making progress on defined tasks.</td>
</tr>
<tr>
<td></td>
<td>• structure individual accountability.</td>
<td></td>
</tr>
<tr>
<td>Defined deliverables</td>
<td>Helps me...</td>
<td>Helps me...</td>
</tr>
<tr>
<td></td>
<td>• enforce accountability and</td>
<td>• contribute to the project, and</td>
</tr>
<tr>
<td></td>
<td>• document results.</td>
<td>• practice communication skills.</td>
</tr>
<tr>
<td>Meetings and activities</td>
<td>Provides a way to..</td>
<td>Provides a way to..</td>
</tr>
<tr>
<td>--Group meetings</td>
<td>• share research progress and results,</td>
<td>• solve problems,</td>
</tr>
<tr>
<td></td>
<td>• identify research problems and brainstorm solutions,</td>
<td>• practice skills, including developing domain expertise,</td>
</tr>
<tr>
<td>--Activities</td>
<td>• develop students’ skills and research background,</td>
<td>• contribute to the research effort, and</td>
</tr>
<tr>
<td></td>
<td>• troubleshoot problems, and</td>
<td>• exercise cooperative team skills.</td>
</tr>
<tr>
<td></td>
<td>• model professional skills.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Provides a way to..</td>
<td>Provides a way to..</td>
</tr>
<tr>
<td></td>
<td>• advance research findings and students’ skills,</td>
<td>• develop domain expertise,</td>
</tr>
<tr>
<td></td>
<td>• practice cooperative team and professional skills, and</td>
<td>• practice skills, and</td>
</tr>
<tr>
<td></td>
<td>• build student confidence and competence.</td>
<td>• refine and advance the research agenda.</td>
</tr>
<tr>
<td>Process improvement</td>
<td>A means of assessing and evaluating progress of the project, students, and subgroups.</td>
<td>A means of self-assessing progress and subgroup interaction.</td>
</tr>
</tbody>
</table>

Members graduated with a Ph.D.: 30 percent of the undergraduates continued to graduate school. To illustrate the results from emphasizing diversity in an ARG, Figures 1 and 2 compare ARG membership in one group (SSEAL) in the computer-science department at UTEP to the demographics of the department as a whole with respect to gender and ethnicity. The number of students in SSEAL during the period reported was 47, and the number of computer-science students in 1999 was 306.

Analyses of the model have shown that students come to a research project with the expectation of learning and improving basic research skills. Evidence from student essays supports this claim. In examining student responses describing a time when working with others on a research project went well, it was found that participation in an affinity research group helped the students develop skills that in turn facilitated their research.
Evaluation surveys showed that the ARG model contributes to expanding students’ knowledge about groups, research, and graduate-school opportunities. Personal issues that students cited as encouraging them to participate in an affinity research group included a professor’s invitation, financial assistance, and better job opportunities in the future. Results from evaluations indicate that 55 percent of undergraduates were very sure that they would attend graduate school, 30 percent were moderately sure, 5 percent were unsure, and 10 percent were sure that they would not attend. In essays, students observed that the ARG model provided them with techniques for working with others. They felt that learning how to resolve conflict, give constructive criticism, brainstorm solutions to problems, ask questions, and communicate with team members helped them transfer these techniques to group situations outside of their research groups.

For most students, the ARG experience was the first time that they had participated in research, and they had preconceived notions of the research process. For the majority of students, the experience of the affinity research group helped them improve the research, technical, group, communication, and leadership skills that they may have lacked prior to becoming involved. They felt more connected to the university, aware of the needs of other individuals, and confident of their own abilities to function as members of research groups. An unanticipated consequence of the ARG model has been the fostering of a commitment by members to help other students succeed in computer science and research.

**Summary and Future Work**

Research groups can be structured in numerous ways: hierarchically, integrally, or a combination of both. A hierarchical model, the more traditional approach, is based on a pyramidal structure where the layers represent a decreasing order of expertise and authority. Traditional hierarchical research groups often involve students who already possess a certain level of academic sophistication that enables them to make meaningful contributions to research without a significant amount of additional training, and they often create a competitive rather than cooperative environment. An integral model is one in which faculty mentors and students work as equals. The ARG model considers a hybrid model because it incorporates aspects of both: as is typical of a hierarchical group, the faculty mentor holds a leadership position and provides direction to the other members of the group.

Two important and connected aspects of the philosophy of ARGs that set them apart from other types of research groups are: 1) the deliberate structuring of activities designed to create a cooperative environment in which students with different abilities can succeed in research and/or other important tasks; and 2) the structuring of relationships among group members in a way that fosters cooperation, ensures accountability, and furthers the educational and research goals of the group. The model is transferable to groups that include only undergraduates, as well as to numerous disciplines. The ARG model also promotes an integrative structure among the students in the group because all student members work together as equals and each student acquires the skills to be a leader and expert in some aspect of the research being done by the group. By actively encouraging involvement of students who demonstrate promise and by providing the students with active...
mentoring and training in research, the affinity model encourages and nurtures participation from a wide range of students, including those from underrepresented groups.

Continuing work consists of ethnographic investigations with current and former participants to try to answer two questions. First, how do faculty mentors’ ideologies about the goals of research and student involvement in research relate to participants’ success and the development of cohesive, productive teams? Second, what is the nature of the interactive processes that affinity research groups engage in and how do these processes promote group cohesion and the development of team and research skills?

Endnote
This paper is based on work supported by the National Science Foundation (NSF) through grants DUE-0443061 and CNS-0540592. Any opinions, findings, and conclusions or recommendations expressed in the paper are those of the authors and do not necessarily reflect the views of the NSF.

References
Strahan D. Promoting a collaborative professional culture in three elementary schools that have beaten the odds. Elem School J, 2003(104):127-146.
Ann Quiroz Gates
The University of Texas at El Paso
Department of Computer Science, CS234
500 W. University
El Paso, Texas 79968
915-747-6952
Fax: 915-747-5030
EM: agates@utep.edu

Ann Quiroz Gates is professor and chair of Computer Science at the University of Texas at El Paso. Her areas of expertise are in software property elicitation and scientific workflow-driven ontologies with applications to geoinformatics. Gates is a member of the NSF Advisory Committee for Cyberinfrastructure, and she has been an active member of the IEEE-Computer Society (IEEE-CS), where she serves on the Board of Governors (2004-2008) and chairs the Awards Committee (2005-2007). In 2003, Gates received the university’s Chancellor’s Council Award for Outstanding Teaching. She was named to Hispanic Business magazine’s 100 Influential Hispanics in 2006 for her work on the Affinity Research Group model.

Steve Roach
The University of Texas at El Paso
Department of Computer Science, CS234
500 W. University
El Paso, Texas 79968
915-747-5727
Fax: 915-747-5030
EM: sroach@utep.edu

Steve Roach is associate professor of Computer Science at the University of Texas at El Paso. His areas of expertise are in formal approaches to software assurance and software engineering. His software-development efforts include the theory compilation component of the Amphion deductive synthesis system, the Saturn Viewer and CASVU programs for NASA’s Cassini mission to Saturn, and a variety of data acquisition, process control, and modeling programs. Roach is a member of the IEEE and the ACM.

Kerrie Kephart
The University of Texas at El Paso
Department of Teacher Education, EDUC 601
500 W. University
El Paso, Texas 79968
915-747-6446
Fax: 915-747-7441
EM: kkephart@utep.edu

Kerrie Kephart is assistant professor of Bilingual Education/ESL in the Department of Teacher Education at the University of Texas at El Paso. Her research interests include advanced academic literacy, professional and disciplinary socialization, and second-language learning. She is part of a cross-disciplinary team of faculty and student researchers investigating innovative practices in engineering pedagogy and their effects on undergraduates’ development of engineering literacy and discourse knowledge, a project funded by the National Science Foundation.

Elsa Villa
The University of Texas at El Paso
Department of Teacher Education, EDUC 601
500 W. University
El Paso, Texas 79968
915-747-6947
Fax: 915-747-7441
EM: evilla@utep.edu

Elsa Villa is a lecturer in the Department of Teacher Education, Division of Mathematics, Science and Technology, at the University of Texas at El Paso (UTEP). She formerly served as the director of the Engineering Programs Office at UTEP for 11 years where she worked closely with engineering faculty in designing and implementing instructional strategies to improve classroom learning. Ms. Villa is a doctoral student in curriculum and instruction at New Mexico State University, and her research interests include professional learning communities and teacher identity.

