

# Preparing International Graduate Teaching Assistants as Future Engineering Professionals Through Undergraduate Tutoring and Mentoring Program

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**Abstract**—International graduate teaching assistants (IGTA) offer enrichment to an engineering program by bringing cultural diversity, academic experience, and research skills. In this paper, it is postulated that the development and training of successful and competitive IGTA is dependent on several variables including orientation and training, academic and social support, communication and interpersonal skills, and competency. The proposed model is based on the participation of the IGTA in the tutoring and mentoring program of The University of Akron's College of Engineering and can be used as a general guide in preparing IGTA entering the engineering professional community in the United States.

## INTRODUCTION

Tutoring and mentoring of undergraduate students can be utilized as a valuable tool for the development and training of International Graduate Teaching Assistants (IGTA) students as future mentors and educators in engineering education. Further, tutoring and mentoring experience prepares the IGTA to (a) attain a higher level of competence in science, math, engineering, and technology (SMET), (b) participate in a cultural enrichment program that benefits and values diversity, (c) communicate and work effectively in a cooperative setting, (d) improve interpersonal skills and self-concept. It has been revealed that mentoring provides a means of cultivating and encouraging talent, and therefore faculty advisor and IGTA participating in mentoring and tutoring program serve as resources to motivate undergraduate students<sup>2</sup>. Undergraduate students are sometimes uncertain about going to graduate school; and therefore, the involvement of a mentoring process through the participation of a tutoring program can be a means that clarifies their intent to pursue those career goals. Interaction of IGTA and undergraduate students during tutoring and mentoring allows a means to have broader perspective to communicate effectively with a variety of audiences in a cultural diversity setting<sup>3</sup>. Further, interaction between IGTA and undergraduate students enhances the quality of interpersonal performance and communication skill that may be necessary in a technical surrounding<sup>4</sup>.

While a substantial body of literature now exists concerning graduate education, educators must also pay attention to the strategies and variables related to training and preparing IGTA for a career as engineers or educators in the United States or other countries. Some strategies that have been previously adopted by

educators on training IGTA as engineering professionals in the graduate education include cooperative learning<sup>5,6</sup>, communication and interpersonal skills<sup>3,4,7</sup>, mentoring<sup>2</sup>, international joint programs between universities<sup>17,19</sup>, exchange research and cultural programs<sup>18</sup>. Based on available literature on graduate education and undergraduate mentoring programs, we have developed a general framework for understanding the factors that contribute to the successful development and training of IGTA. It is postulated that the successful training IGTA as engineering professionals is dependent on the conjoint influence of several variable constructs, to include (a) orientation and training, (b) technical background and research, (c) communication and interpersonal skills, and (d) academic and social support. The model on training IGTA as engineering professionals is based on the IGTA activities in the Women in Engineering Program (WIEP) and the Increasing Diversity in Engineering Academics (IDEAs) Program, a minority engineering program at The University of Akron's College of Engineering. IDEAs and WIEP undergraduate tutoring programs at The University of Akron. The undergraduate mentoring and tutoring programs are designed to (a) enhance academic performance and increase recruitment and retention of students in engineering, (b) focus on academic excellence and preparation of students entering research in engineering, (c) and emphasize both competence and the contribution of the scholarly research in the engineering community. The proposed model on the training of IGTA as professionals emphasizes success by removing artificial barriers, rewards performance, and provides nonthreatening environments to students committed to engineering profession<sup>10</sup>.

## PROGRAM DESCRIPTION

The undergraduate tutoring and mentoring programs, the IDEAs and WIEP programs were initiated by The University of Akron's College of Engineering in 1990 and 1993 respectively. At that time, a need was seen to develop programs for underrepresented minorities and women to enhance the academic performance and improve the retention rate. Having identified general program goals and analyzed students' needs, the next step was to develop a model for the learning environment. Based on a review of program and ideas, some of the components that were identified and adapted to meet situational constraints involved structured workshops, tutoring, and mentoring of students<sup>13</sup>. Undergraduate students are

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encouraged to work with IGTA through academic activities including tutoring and mentoring. The IGTA serve as mentors, role models, and counselors, and provide an internal support network. The IGTA demonstrate by example that success is achieved through competency and not through ethnic group status alone, and also work to encourage a sense of self-efficacy among the newer students.

Initially the focus of the mentoring and tutoring program was on helping undergraduate students only. Over the years, there has been a need to also train and develop the skills of the IGTA to prepare them for the working environment in engineering education or industry. When the program first started, there were only five IGTA who participated in the program as mentors, currently there are over fifteen IGTA participants per year, and overall we have had over seventy IGTA participants in the engineering tutoring and mentoring program. The IGTA who wishes to participate in the undergraduate mentoring and tutoring program in engineering must demonstrate self-confidence, good problem solving skills, and enthusiasm to work in a diversity setting. While these indicators may not be fully sufficient in providing the depth and capabilities of an individual IGTA, they serve as pointers that a participant is committed to the program and its goals.

The IGTA must sign a contract allowing them to participate in the mentoring and tutoring program. From a psychological perspective, the contract has the effect of formalizing IGTA's commitment to the ideals and goals of the program<sup>11</sup>. The four primary components, which are identified as workshop factors for success, are discussed in greater detail in the remainder of the section. The components and related program variables are summarized in Table 1.

**Table 1**  
**Linkages Between Model Constructs and Program Components**

Constructs	Related Variables
A. Orientation and Training	<ol style="list-style-type: none"> <li>1. Commitment to tutoring and mentoring</li> <li>2. Opportunity to pursue a career in engineering</li> <li>3. Reasons for pursuing an engineering career</li> </ol>
B. Technical Background	<ol style="list-style-type: none"> <li>1. Achievement in SMET competency</li> <li>2. Self-efficacy in SMET disciplines</li> <li>3. Growth in SMET courses completed</li> </ol>
C. Academic/Social Support	<ol style="list-style-type: none"> <li>1. Role Models</li> <li>2. Counseling and mentoring</li> </ol>

	3. Cooperative learning environment
D. Communication skills	<ol style="list-style-type: none"> <li>1. Oral communication</li> <li>2. Written skills</li> <li>3. Presentation of technical work</li> </ol>

## PROGRAM COMPONENTS

### Orientation and Training

Some form of orientation and training is necessary to facilitate the assimilation of new IGTA in a tutoring and mentoring group<sup>8</sup>. Orientation and training is an effective cooperative model for building affinity groups to enable and encourage student success in tutoring and mentoring program<sup>9</sup>. The orientation period allows the IGTA to explore the importance and the value of tutoring and mentoring. In addition, the orientation period allows them to go through a self-assessment period that facilitates determining their commitment to the undergraduate tutoring and mentoring in an engineering setting.

### Technical background, tutoring and mentoring activities

Many entering undergraduate students are inadequately prepared in high school for calculus, chemistry, and physics courses required for engineering majors<sup>20</sup>. In response, special weekly academic workshops are designed for each of the entry-level classes (Pre-calculus, Calculus I, Physics 1, Chemistry 1, and Statics). The workshops stress group study, group communication and problem-solving techniques. The IGTA provides the students with week-long supplementary instruction in the form of workshops or tutoring. The workshops focus not only on academic excellence, but also on promoting positive competition and peer pressure. The IGTA are available to the students seven days a week during study periods that have been specifically designed for them to work with undergraduate participants. Undergraduate students enrolled in the tutoring and mentoring program are required to attend the study hall for at least twelve hours per week. If the twelve-hour requirement is not met for two consecutive weeks, the student may be dropped from the program unless he or she meets with the program director and discusses their absences. The upperclassmen students participate in research project under the guidance of IGTA and faculty. The upperclassmen students demonstrate by example that success is achieved through competency and not through ethnic group status alone, and also

work to encourage a sense of self-efficacy among the newer students. The following are some tutoring and mentoring topics that the students are participating in: (a) A Study of Fatigue Behavior of High Strength Aluminum Alloys, (b) Linear Stability Analysis of a Horizontal Single Boiling Channel with Thermal Wall Capacity Understanding the Stress, Strain, and Mechanical Response of Automotive Suspension System, (c) Thermal Behavior of Cross-Flow Heat Exchangers During Transients, (d) Modeling Techniques for Predicting the Dynamic Response of the Human Spine, (e) Nonlinear Analysis of a centrifugal Fan, and (f) The Microstructure and Hardness of Silicon Carbide Synthesized by Plasma Pressure Compaction. Through tutoring and mentoring activities and tutoring, students gain competency, self-efficacy, growth, and experience in SMET disciplines and engineering tutoring and mentoring.

### Communication and interpersonal skills

In designing the undergraduate tutoring and mentoring and tutoring program, emphasis was placed on the competence of the program and ability of the program to address communication and interpersonal skills of all students. Through tutoring and mentoring, both undergraduate students and the IGTA communicate, interact and gain ability to work together in a cooperative and multi-cultural setting. Also, during tutoring and mentoring activities, students gain academic experience and formed collaborative groups to experience the value of working in teams, common tutoring and mentoring group sections, and learned tutoring and mentoring survival skills. Working in teams is a common theme across all of the various tutoring and mentoring activities and help the students to help themselves through the development of peer support and study networks<sup>13</sup>. Study groups offer many benefits including an emphasis on self-support and self-help, networking, and the development of communications links<sup>12,14</sup>.

It has also been suggested that the creation of a cooperative environment and the use of group-centered approaches may be more compatible with the value systems of learning<sup>15,16</sup>. Faculty mentors and the program coordinator expect deliverables out of the students' projects. Deliverables may be in the form of a presentation, abstract, poster, literature review, or publishable paper. For example, the tutoring and mentoring on the microstructure and hardness of silicon carbide synthesized by plasma pressure compaction has been published in the Journal of Alloys and Compounds. Other papers have been presented as posters or orally at various student conferences, including The American Society of Mechanical Engineers OLD Guard competition.

### Academic and social support

Undergraduate students and the IGTA participating in the undergraduate tutoring and mentoring program meet every week with program coordinators to discuss their progress, social and academic problems, and augment the focus of their goals. The support structure for the IGTA and undergraduate student participants involves the IDEAs and WIEP Directors, engineering faculty, and administrators. The role of the program coordinators is both complicated and multidimensional. The key responsibilities of the coordinators involve the overall administration of the program coupled with the supervision and management of the tutoring and mentoring program. As a result of the wide scope of responsibilities, the program coordinators are expected to have a unique set of skills and abilities including valuing of diversity, so as to serve as a "champion of change" while also promoting a broad knowledge pertaining to tutoring and mentoring in engineering<sup>12</sup>. To be effective, coordinators must also have developed skills in multicultural career and personal counseling. Together, the coordinators arrange all the activities for the participants and academic workshops to reinforce excellence in students' academic progress, and tutoring to help the students in those areas where they show deficiencies. Also, the program coordinators develop an assessment and evaluation procedure for the program, while concurrently maintaining a database that includes students' records. The coordinators also serve a critical role as a liaison and advocate to program sponsors. Given the importance of administration support, the work of coordinators is to maintain support for the program among sponsors.

### DISCUSSION

Aspects of the program that need improvement have been identified. One problem related to scheduling and maintenance of the peer networks. Networking among the participants was stressed during the orientation workshops. Optimally, one would like to have groups of peers networking throughout their tutoring and mentoring program pathway in order to ease the anxieties throughout college. This is difficult to accomplish in that students come from different backgrounds, have different interests, and may have time conflicts that require alternative schedules. Thus, it is not always possible to maintain a continual network of the program participants. A second problem involved deficiencies in some of the IGTA's educational backgrounds and tutoring style. Thus, a future goal is to develop early intervention workshops and programs that focus on academic backgrounds and style of teaching. A third and more difficult problem to solve involves undergraduate students who have multiple, significant life issues. The problems may be emotional, social or economic in nature, and may present obstacles to the student's future success. For example, students may lack social or familial support, or their current living arrangement may be one in which the family or community environment is a negative factor. In such cases, a

university counselor or one of the mentors associated with the program may have to spend a significant portion of his/her time offering nonacademic counseling or simply serving as a sympathetic ear and a comforting voice.

In summary, the tutoring and mentoring program in engineering provides both the IGTA and undergraduate students with a peer support network, a collaborative learning environment, hands-on tutoring and mentoring activities, and a model to inspire and maintain their determination to commit to high academic and career standards in engineering. Overall, the program appears to have been successful in meeting its goals of motivating, increasing cultural awareness and diversity, providing positive attitudes, increasing IGTA communication and interpersonal skills and mentoring ability, and improving the performance and retention of the IGTA and undergraduate students in engineering education. The undergraduate tutoring and mentoring program in engineering can be used as a model for developing career and professional preparation in areas where the IGTA have been traditionally neglected.

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