AC 2007-2415: SUCCESSFUL PRE-COLLEGE SUMMER PROGRAMS

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Successful Pre-College Summer Programs

Abstract

The National Science Foundation (NSF) Engineering Research Center (ERC) for Wireless Integrated MicroSystems (WIMS) has conducted pre-college programs for seven summers (in years 2000 to 2006). During these seven summers, more than 880 pre-college students have enrolled in 30 courses. Moreover, female and minority categories each constitute more than 50% of the participants. Indeed, youth are being greatly impacted by the WIMS summer programs. The significance of the summer programs can be indicated with several factors:

1. Phenomenal participation count and percentages by female and minority students.
2. Educational content of the programs; each program has a subset of the core topics.
3. WIMS core components (microsystems and miniaturization, sensors/actuators, and microcontrol), along with societal impacts, are emphasized.

This paper provides information about each of the several summer programs, including their educational content, program structure, participant demographics, and evaluation results to help explain reasons the programs have been successful. Success is defined according to student academic preparation for technical majors and selection of those areas for a college major; students returning in future years for more advanced programs; referral recommendations by the participants and parents to other students; and results for underrepresented female and minority participation.

Introduction and Overview

WIMS ERC Structure: WIMS is a National Science Foundation (NSF) Engineering Research Center (ERC) with initial core partner universities of the University of Michigan – Ann Arbor (UM), Michigan State University (MSU), and Michigan Technological University (MTU). During its seven year duration, WIMS now has outreach partner universities of Prairie View A&M University, University of Puerto Rico – Mayaguez, North Carolina A&T State University, Howard University, University of California – Berkeley, and University of Utah. ERCs have industry partners; WIMS has about 15 such industry partners (small, medium, and large sizes) including Motorola, Freescale, Schlumberger, Stryker, Agilent, Medtronics, etc. Of course, NSF is the major partner, and each university contributes substantial internal funding. WIMS is structured with nine areas consisting of five Research Thrusts: (r1) Biomedical Sensors and Subsystems, (r2) Environmental Sensors and Subsystems, (r3) Wireless Interfaces including MEMS, (r4) Micropower Circuits, and (r5) Advanced Materials, Packaging, and Processes (formerly Micropackaging thrust); two engineered systems testbeds: (t1) Neural Prostheses and (t2) Environmental Monitoring; an Education Programs Thrust; and an Industrial Liason for external and industry relations.

Education Programs Thrust Structure: The goals of the WIMS Education Programs Thrust are to educate the next generations of engineers and scientists about WIMS and with WIMS, and to rapidly transfer results from the research domain to the classroom domain. Proactive diversity and outreach initiatives, as well as evaluation, are to be integrated within each program. As depicted in Figure 1, the Education Programs Thrust provides comprehensive opportunities with three sub-components: pre-college programs for K-12 students, university programs for undergraduate and graduate students, and professionals / society programs for practicing professionals and general society.

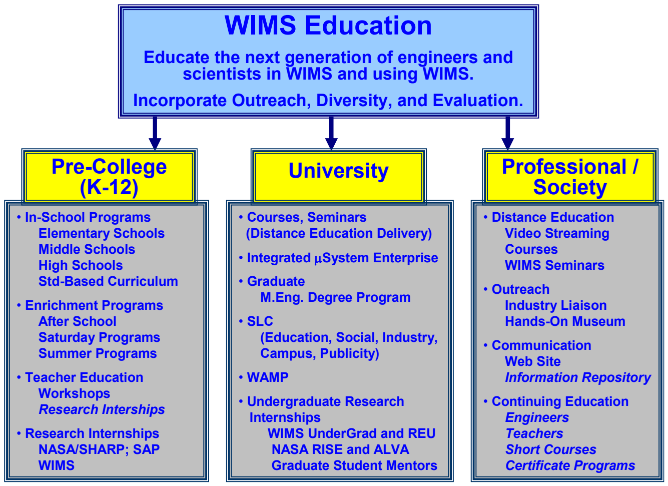

Figure 1 – Comprehensive Scope for WIMS Education Programs.

Pre-College Education Structure and Programs: The goal of the WIMS pre-college effort is to increase the number of students that select science, engineering, and math as their major in college, as well as to improve their academic ability to enter those majors. The strategy is to provide comprehensive in-school and teacher education programs, as well as enrichment programs for after-school, weekend, and summer programs.

WIMS pre-college efforts started at Michigan State University during Summer 2000, before the official start of the WIMS ERC. Those efforts have grown into two sets of pre-college initiatives. One set of pre-college programs was reported in a TASEM paper at the ASEE 2006 conference[1]. The formal WIMS pre-college initiatives, conducted by the Pre-College Associate, has summer programs (the subject of this paper), several academic year in-school programs and enrichment programs, as well as teacher education initiatives. Pre-college programs are conducted at the three core universities: MSU offers the larger set of pre-college programs; a much smaller set of pre-college programs are offered at UM and MTU.

Table 1 provides names and features of various WIMS enrichment programs for both summer and academic year. WIMS enrichment programs offer hands-on opportunities for students beginning as early as the fourth grade. Academic topics include introductions to engineering, physics, math, WIMS concepts and applications, programming, cleanroom safety, micro- and nano-fabrication, leadership, cultural and social skills, and technical writing. Each program has a cognizant WIMS faculty or staff member who has responsibility for the educational instruction and overall management of the program.

For in-school and teacher education initiatives, the WIMS Education Program has formed partnerships with the K-12 school districts of Ann Arbor, Houghton/Hancock, Okemos and East Lansing area schools, and DAPCEP (Detroit Area Pre-College Engineering Program, an academic outreach program associated with Detroit schools), and with university-level outreach organizations. Other individual schools that have partnered with WIMS are Grand Rapids High School, Cass Tech High School, and Mercy High School (an all female high school).

Table 1 --- WIMS PRE-COLLEGE ENRICHMENT PROGRAMS

Program Name	Grade Levels	Number Students	Prerequisite	Program Topics	Program Duration
SUMMER PROGRAMS					
LEGO Robotics to WIMS: Engineering Exploration	4 – 6	30 Commuter	Science, Engineering, Math Interest	Engin. Explorations; LEGO Construction & Design, Math, Physics, Engineering Concepts.	5 Days
Girls in Science and Engineering (GISE)	7 – 8 Females	15 Commuter	Science Interest	LEGO Construction & Design, Programming, WIMS Microsystems.	1 Week
National Heritage Academy	7 – 9	40 Resident'l	Science, Engineering, Math Interest	Robotic Design, Math, Engin. Explorations, WIMS Microsystems.	1 Week
WIMS for Teens	7 – 9	30 Resident'l	GPA $\geq$ 3.2 Preferred, Essay, Math/Science Teacher-Recommended	WIMS, Intro Algebra, C++ Programming, Phys.Sci, Unigraphics.	7 Days
WIMS for Women in Engineering	10 – 12	30 Resident'l	GPA $\geq$ 3.2 Preferred, Essay, Math/Science Teacher-Recommended	Integrated Math/Sci., Calculus, Chemistry, Physics, Unigraphics, C++ Programming.	7 Days
WIMS DAPCEP Short Course	10 – 12	30 Resident'l	GPA $\geq$ 3.2 Preferred, Essay, Math/Science Teacher-Recommended	Integrated Math/Sci., Calculus, Chemistry, Physics, Unigraphics, C++ Programming, Technical Writing.	19 Days
Michigan Indian Leadership Program	8 – 12	35 Resident'l	Science, Engineering, Math Interest, Native American	Academics and Leadership. Integrated Math and Science.	1 Week
World of Microsystems Summer Youth Programs	High School	15 Resident'l	Science, Engineering, Math Interest, Native American	Micro- and Electro-Discharge Machining, Micro/Nano Fabrica'n, Cleanroom Safety.	1 Week
WIMS Hispanic Engineering Exploration Weekend	High School	80 – 100 Resident'l	Teacher Recommendation	Academics and Leadership. WIMS.	2 Days
K-PhD Cognitive Learning (See TASEM Reference[1])	K – 12	80 – 100 Commuter	None	LEGO Robotics, Robotic Design, Engineering Concepts.	1 Week
WEEKEND and AFTER-SCHOOL PROGRAMS					
WIMS KIDS Club	4 – 6	8 Commuter	Science Interest	Robotic Operation & Design, WIMS Intro., Technical Skills.	Semester
TechnoSpartans Club	7 – 9	8 Commuter	Science Interest	Robotic Operation & Design, WIMS, Technical Skills, Research, Tournament.	Semester
Sunday LEGO Robotics	4 – 8	15 Commuter	Science Interest	LEGO Construction & Design, Math, Physics, Engineering Concepts.	Semester
WISE/GISE LEGO Robotics	4 – 8 Females	12 Commuter	Science Interest	LEGO Construction & Design, Research Intro., Tournament.	Semester
DAPCEP Spring Program	7 – 8	20 Commuter	GPA $\geq$ 3.0 Preferred	LEGO Robotics, Logic Gates, Electronic Displays, Sound and Cochlear.	Saturdays, Mar, Apr
After-School Research Opportunity Program	High School	Varies Commuter	Achievement in Summer Programs	Research.	Sept to Aug

Also, the WIMS Pre-College Education team has been active in outreach programs such as the Sally Ride Festival for 5th to 8th grade girls, Michigan Young Engineers and Scientists (YES) Expo, Pfizer Science Teacher Open House, MSU Science, Engineering, and Technology Day, UM Technology Day, Detroit Area Pre-College Engineering Program (DAPCEP) Open House, and the Detroit Society of Hispanic Professional Engineers (SHPE) Chapter.

The WIMS ERC pre-college educational team has also been busy sharing information about the WIMS education progress and efforts at a number of national professional organization conferences, including the American Society of Engineering Education (ASEE) Pre-college summit in Salt Lake City, Utah, in 2004, the National Association for Minority Engineering Administrators (NAMEPA) in February 2004[2], the Women in Engineering Programs and Advocates Network (WEPAN) in April 2005, and TASEM at ASEE in June 2006[1].

Pre-College Teacher Education Programs: WIMS has hosted three teacher education programs to help secondary teachers learn about the science, math, fabrication, design and concepts for WIMS research and applications. Teacher workshops for in-school programs will be promoted after sufficient WIMS modules are available.

WIMS Pre-College Summer Programs

The specific focus of this paper is pre-college summer programs. Specific to the subject of this paper is the success of WIMS pre-college summer programs. The previous sections and paragraphs are intended to provide a context and environment for the summer programs. Education of students is the foremost objective, and educational content is the consistent feature, of WIMS pre-college summer programs (see Table 1). We are determined that a primary goal of each program is to help students prepare to enter science, engineering, and math majors during their undergraduate years.

Success factors for the summer programs might be defined in terms of
1. Number of students impacted.
2. Students that return for renewing participation in more advanced summer programs.
3. Word-of-mouth referrals.
4. Students going off to college to major in science, engineering, or math.
5. Educational content of the programs; each program has a set of academic topics. (Table 1)
6. Phenomenal participation count and percentages by female and minority students. (Table 2)
7. WIMS core components (microsystems, miniaturization, sensors/actuators, and microcontrol), along with societal impacts, are emphasized.
8. Requests by other programs to have WIMS summer program components in their program.
9. Formal Program assessment/evaluation by a third-party independent evaluator.

The education content curriculum staff primarily utilize graduate and undergraduate students as instructors, assistants, and mentors. University and high school teachers have been staff during several summers. The graduate students are the primary instructors. Undergraduate students serve as teaching assistants, academic mentors, residential facilitators and mentors, and youthful role models. Mentors are available day and night, and on weekends (as needed).

The student application includes applicant demographic data, an essay, recommendations from both math and science teachers, and the most recent report of grades (transcript usually). The student essay describes the student's interest in engineering, math, and science, along with the expectations of the summer program to benefit his/her academic studies.

Student selection for each program is done by the WIMS Program Associate and his staff. They review application files making an assessment of students that have suitable preparation for the academic/educational rigors of the summer program. Grade-point average (GPA) is certainly a major factor, with special review of achievement in math and science courses. For each program, the minimum achievement is a GPA of 3.0 to 3.2 in math, science, and related classes. Teacher recommendations are important factors, with their comments about student motivation and determination for learning and achievement receiving special consideration. Student preparation prior to the summer program must be within a window of knowledge and achievement. The college-level student assistants and mentoring staff work with each summer program participant to ensure that the student is engaged, understanding the material, and achieving. Thus student selection process considers if the applicant is likely to fit well in the environment for the range of available academic assistance. An explicit initiative of each summer program is to increase the number of historically underrepresented students who are motivated and prepared to choose careers in science, math, and engineering; Table 2 data bear out the results of this initiative to ensure generous participation of underrepresented minorities and females. Financial assistance has been provided for students as needed.

Table 2 contains some demographic information about the summer programs for each of the seven summers. Total counts are provided, along with female and minority sub-counts. The female and minority counts (percentages) are especially appealing.

Table 2 --- Demographics of WIMS Pre-College Summer Programs

Year		Number Programs	Total Student Count	Females Count (Percent)	Minorities Count (Percent)
Summer 2000		**1**	29	15 (51.72%)	29 (100%)
Summer 2001		**3**	171	84 (49.12%)	144 (84.21%)
Summer 2002		**4**	98	42 (42.86%)	87 (88.78%)
Summer 2003		**3**	55	37 (67.27%)	40 (72.73%)
Summer 2004		**3**	53	35 (66.04%)	38 (71.70%)
Summer 2005		**8**	194	109 (56.19%)	125 (64.43%)
Summer 2006		**8**	287	199 (69.34%)	213 (74.22%)
Total Sum '01 – '06		**30**	**887**	**521 (58.74%)**	**676 (76.21%)**

The first such summer course was the WIMS DAPCEP Short Course that was the nation's first pre-college course in WIMS; it has now been conducted for seven summers. Each summer, 23 to 30 students entering the 11th and 12th grade (the next school year) participate in a three to four week session. The session has lectures, laboratory exercises, video conferencing, seminars, and tours of facilities that engage the students in hand-on opportunities that enhance understanding of engineering concepts, applications, and academic content. Also, additional time is allotted for fun activities such as competitions involving modules constructed during the session. A typical daily schedule over the period of a week for the WIMS DAPCEP Short Course is in Table 3. Funding support is provided by DAPCEP, WIMS, and industry.

Table 3 --- WIMS DAPCEP Short Course Example Template Daily Schedule

DAY/ TIME	Monday	Tuesday	Wednes-day	Thursday	Friday	Saturday	Sunday
	ZZ...ZZ...ZZ	ZZ...ZZ...ZZ	ZZ...ZZ...ZZ	ZZ...ZZ...ZZ	ZZ...ZZ...ZZ	ZZ...ZZ...ZZ	ZZ...ZZ...ZZ
6:30 AM	Wake Up	Wake Up	Wake Up	Wake Up	Wake Up	ZZ...ZZ...ZZ	ZZ...ZZ...ZZ
7:15 AM	Breakfast	Breakfast	Breakfast	Breakfast	Breakfast	Wake Up	Wake Up
8 AM	Trig/ Calculus	WIMS	Trig/ Calculus	WIMS	Trig/ Calculus	Breakfast	Breakfast
9 AM	Trig/ Calculus	WIMS	Trig/ Calculus	WIMS	Trig/ Calculus	WIMS	Personal Time
10 AM	WIMS	Trig/ Calculus	WIMS	Trig/ Calculus	WIMS	Trig/ Calculus	Personal Time
11 AM	WIMS	Trig/ Calculus	WIMS	Trig/ Calculus	WIMS	Trig/ Calculus	Personal Time
Noon	Lunch	Lunch	Lunch	Lunch	Lunch	Lunch	Lunch
1 PM	Unigraphics	C++ Program'g	Unigraphics	C++ Program'g	Unigraphics	C++ Program'g	Teambuild'g Activities
2 PM	Unigraphics	C++ Program'g	Unigraphics	C++ Program'g	Unigraphics	C++ Program'g	Teambuild'g Activities
3 PM	C++ Program'g	Unigraphics	C++ Program'g	Unigraphics	C++ Program'g	Unigraphics	Teambuild'g Activities
4 PM	C++ Program'g	Unigraphics	C++ Program'g	Unigraphics	C++ Program'g	Unigraphics	Teambuild'g Activities
5 PM	Dinner	Dinner	Dinner	Special Dinner	Dinner	Dinner	Dinner
6 PM	Study or Seminar	WIMS	Study or Seminar	Special Dinner	Study or Seminar	Dinner	Dinner
7 PM	Study Hall	WIMS	Study Hall	Study Hall	Study Hall	Campus Tour	Study Hall
8 PM	Study Hall	WIMS	Study Hall	Study Hall	Study Hall	Campus Tour	Study Hall
9 PM	Bowling	Ice Skating	Planetarium	Summer Theatre	Talent Show	Game Night	MSU/UM/ MTU Trivia
10 PM	Bowling	Ice Skating	Planetarium	Summer Theatre	Movies	Game Night	MSU/UM/ MTU Trivia
11 PM	Hall Meet'g Journaling	Hall Meet'g Journaling	Hall Meet'g Journaling	Hall Meet'g Journaling	Movies	Game Night	Hall Meet'g Journaling
11:30 PM	Lights Out	Lights Out	Lights Out	Lights Out	Hall Meet'g Journaling	Hall Meet'g Journaling	Lights Out
	ZZ...ZZ...ZZ	ZZ...ZZ...ZZ	ZZ...ZZ...ZZ	ZZ...ZZ...ZZ	Lights Out	Lights Out	ZZ ZZ ..ZZ

Note that academic courses (cited in Table 3) include academic areas of math, science, programming, and engineering applications based on math and science fundamentals. Math topics extend from college algebra through trigonometry and calculus. Science and engineering areas are covered in WIMS instruction (microfabrication, MEMS and Microsystems, sensors/actuators, and microcontrol). The WIMS instruction is intended to have design- and research-based experimental activities, consistent with the research thrusts and testbeds of the WIMS ERC. C++ programming is presented as a separate area, but also linked with the WIMS microcontrol concepts. And, Unigraphics is used to introduce computer-aided design concepts and capabilities. Complementing the academic schedule are tours of industrial and university sites and labs, with special note of the Michigan Nanofabrication Facility (MNF) in which much of the WIMS ERC research is conducted. For student selection in the WIMS DAPCEP Short Course, a minimum GPA of 3.0 is used. Prior to student selection, students and parents must attend an informational meeting, and applicants are interviewed.

Another summer program is the WIMS for Women in Engineering (WWIE) summer residential program, a program for entering 11th/12th grade female students. The objectives are to (a) provide a glimpse of the first-semester engineering experience, (b) encourage young women to study engineering (or math or science), (c) focus on design and research experimental activities of the WIMS ERC, (d) provide an academically conducive and safe living and learning residential experience, and (e) strongly encourage young women to reach their fullest potential. This program provides knowledge and research-based experimental learning in cutting-edge WIMS technologies. Additional instruction includes college-level calculus, Unigraphics, C++ programming, Internet research, topical seminars exploring various majors in engineering, and special topics for future women engineers. The topical seminars introduce various disciplines of engineering (mechanical, electrical, chemical, material science, computer science, civil and environmental). During the program, students engage in group projects, with competitions engendering high motivation. A special presentation and discussion session is held with female faculty and industry-based practicing engineers serving as role models; lively discussions have ensued after each session. Tours of industrial and university sites and labs complement the academic schedule. For student selection to the WIMS for Women in Engineering program, each candidate must have a minimum GPA of 3.2 to 3.3 in math, science and related classes; also, candidates are sought in the top ten percentile class ranking.

The WIMS for TEENS program has the objective that participants will report increased interest in math, science, and engineering careers. Also, the participants should report increased confidence in math and science classes. Academic courses are pre-algebra and algebra, introduction to C++ programming, science concepts (chemistry, biology, and physics), computer-aided design concepts with Unigraphics, introduction to WIMS, and engineering explorations. Tours and fun-time activities are part of the schedule. For student selection, each candidate must have a minimum GPA of 3.2 in math and science classes.

Recently, WIMS has been pleased to provide two program opportunities for Native American secondary students to learn about WIMS projects and exciting applications. A new WIMS collaboration began in Summer 2005 with the World of Microsystems Summer Youth Program (SYP), coordinated with MTU Outreach and Multi-Ethnic Programs, and hosted at MTU by WIMS faculty and graduate students (see Figure 2). SYP was an intensive week-long workshop that exposed Native American students to cleanrooms and micro- and nano-fabrication. For all the students, SYP was their first exposure to microtechnologies and their first hands-on use of any research equipment. Microfabrication and micrometrology techniques were presented in the mornings, and students experimented with those techniques in the afternoons. Students made presentations on experimental results, received cleanroom safety and gowning training, and discussed technical careers and opportunities with the MTU Native American Coordinator. Students received a CD containing all workshop materials, as well as a workshop certificate of completion. Another new program collaboration was the Michigan Indian Leadership Program for Summer 2005 sponsored by various colleges at MSU; it was continued for Summer 2006. It is a college preparation program that invites about thirty-five

Native American eighth through twelfth grade students to a one-week summer residential program that focuses on academic and leadership skills development. For Summer 2006, as in Summer 2005, the students were exposed to the cutting-edge MEMS and Microsystems associated with the WIMS ERC. Students took math, physics, and WIMS courses designed to encourage students to choose math, science, and engineering as a career. Also in Summer 2006, the newly developed WIMS module on heat was piloted, accompanied with its electronic thermometer as the focus microsystem instrument used to demonstrate science principles, as well as gain student hands-on experience. New WIMS initiatives with Native American students should bring the excitement of WIMS to their education and career options.

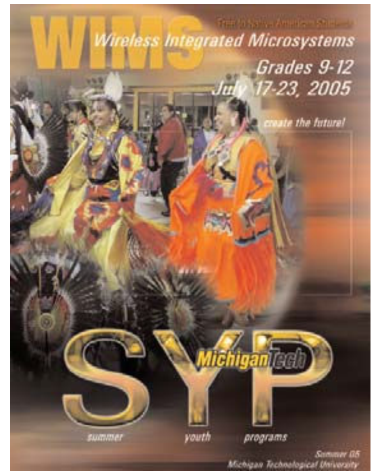

Figure 2 – MTU Summer Youth Program Brochure Cover

Students entering grades 11 and 12 participate in the WIMS DAPCEP Short Course and WIMS for Women in Engineering. Those students are eligible for two recognition awards. The selected top student receives a $1,000 scholarship to Michigan State University College of Engineering. A second recognition is the opportunity for a selected student to be an assistant and peer mentor in another summer program.

Also, among the graduates of those two programs that have completed high school and enrolled in college, about 80% have enrolled at Michigan State, Michigan Technological University, and the University of Michigan, and have selected science, engineering, or math as a major for college studies. That high success to attract students indicates a kind viewpoint by students and parents toward the WIMS Summer Programs, as well as a close relationship developed with the program staff and mentors. It could be viewed as an effective recruiting tool.

On-Going and Future WIMS Pre-College Program Plans

The WIMS-based curriculum modules project has a goal to use MEMS and microsystems as the relevance factor in effective high-school and middle-school science curriculum units that address, and align with, state and national science and math standards. The WIMS-based units are being designed to enrich existing science and/or math units by infusing WIMS examples into high-school and middle-school academic core classes. Efforts are progressing nicely toward developing and providing curriculum materials. The K-PhD pre-college effort has TASEM (technology assisted science, engineering, and math) modules[1]. Based on heat as the physical science principle, a module was recently developed that is consistent with the State of Michigan Science Education Curriculum Standards[3,4]. The module was designed to have five lessons in one-week. Also, a WIMS electronic thermometer unit has been developed to accompany the heat module so students could have laboratory experience with heat and temperature sensing. Middle and high school science teachers have warmly received the pre-release units. Arrangements have been established for WIMS to partner with the Grand Rapids Union High School as early as April 2006. The Grand Rapids Middle and High School Science

Coordinator has been quite supportive in bringing the WIMS curriculum module to their school system district-wide.

During the next several years, WIMS-based modules are to be developed, and could be widely used in enrichment and teacher education programs. The primary goal is to produce a number of WIMS curriculum modules, starting with the heat module (with electronic thermometer), and then working closely with teachers to use the modules in their every-day "in-school" classes. Another goal will be to provide "take-home-to-study" materials for students. Similarly, teacher education programs will help teachers learn about microsystems so they can "spread the word" to their students each day. Teacher education initiatives will include time for teachers to modify modules to fit their individual teaching styles and classrooms, perhaps through Research Experiences for Teachers (RET) supplements. WIMS-based curriculum deliverables will include numerous educational modules that when combined should lead to textbook(s).

Evaluations of Pre-College Summer Programs

For most summers, the summer programs have gathered information for both a subjective evaluation, as well as a formal evaluation prepared by a third party independent evaluator. Information about both evaluation types are presented in this section.

Subjective Evaluation: One indication of success for the summer programs is that non-WIMS organizations are actively seeking to have their students participate in the summer programs, for organizations that are internal to the three core universities, as well as external K-12 school districts. Internal university organizations and outreach programs often ask that components of the WIMS pre-college summer programs be introduced into their summer programs. An example is the request to have WIMS introduced in two different Native American programs at two different universities for summers 2005 and 2006. The Michigan Indian Leadership Program has existed at MSU for numerous summers; their administrators sought out WIMS pre-college administrators to provide WIMS technical content to their student participants. The Summer Youth Program is coordinated by the MTU Outreach and Multi-Ethnic Programs office, with WIMS MTU faculty and graduate students providing the academic technical content and mentoring through the World of Microsystems program. An example of an external request is the major collaboration underway with Grand Rapids Public Schools, the second largest city in the State of Michigan; that alliance is so strong that two of their high school science teachers served as chief assistants to the Director of WIMS summer programs during summer 2006 and they arranged the huge student enrollment in the WIMS Hispanic Engineering Exploration Weekend. Several other school districts have requested, and have been provided, modified versions of the summer programs offered during the academic school year, either as enrichment activities during classes or as after-school activities for elementary, middle, and high schools (in the school districts of Lansing, East Lansing, Woodcreek, and Holt). A relevant anecdote can be cited for almost every success factor listed in a previous section in this paper.

Formal Evaluation: The summer programs have been evaluated by a third party independent evaluator for all summers. Evaluation is still being done and the report written for the Summer 2006 programs.

Formal evaluation of the WIMS Summer Programs is done to assess effectiveness and impact of programs. Evaluation consists of assessing the curriculum objectives, the methods and program structure, and outcomes. The curriculum objectives are assessed by reviewing written goals, curriculum documents, materials used by teachers and students, and attending classes to observe teacher/student interactions. Outcomes are assessed by confidential surveys and discussions with program staff (administrators and teachers), surveys and discussions with student participants, and follow-up surveys of the parents several weeks after program completion. During the program, a focus group session is held with student participants to engender group dynamics discussion. Future evaluation plans are to seek feedback from DAPCEP and other funding stakeholders.

Subjective Qualitative Formal Evaluation: Students commented that they learned about their individual strengths and weaknesses with regard to:

Public Speaking	Teamwork
Leadership	Problem Solving
Time management	Responsibility
Persistence	Preparations and planning for the future

In a one to two-month follow-up survey, parents overwhelmingly responded that the summer programs:

Met their expectations;
Will benefit their child's future academic studies; and
Helped their child grow personally.

Following are samples of statements from students and parents:

- My greatest challenge was working on the final presentation in WIMS because we had to work together as a group and agree and manage our time.
  — DAPCEP participant
- I learned how to accept other's input and suggestions.
  — WIMS for Women participant
- I enjoyed the program immensely and the opportunity to meet these women. I am thankful that I have a clear idea of the traits an engineer must possess.
  — WIMS for Women participant
- The program overall was well organized, academically challenging, and very beneficial to the students.
  — Parent

Objective Formal Evaluation: For objective evaluation results, a summative evaluation[7] was done by a third-party independent evaluator for three of the summer programs: WIMS DAPCEP Short Course, WIMS for Women in Engineering, and WIMS for Teens. Quantative and qualitative data were gathered from student participants, instructors, teaching assistants, mentors, and parents/guardians. Data was obtained via two sources: **(1) confidential survey instruments** and **(2) small-group discussions**. After each summer, the evaluator prepared a report to provide summative feedback about each program, as well as general recommendations and discussion. The evaluation reports are used to make decisions about the programs, including their effectiveness, qualitative impact, and continuation, by focusing on each program's objectives, processes, and outcomes.

Student Participants Survey: Students in each program completed a confidential survey that addressed academics, instructors, mentors, residence halls, future plans, challenges of the program, teamwork, overall experience, and presentations and tours. For the WIMS DAPCEP Short Course, student participants completed a confidential survey instrument that included 41 ordinal scale questions, four nominal scale questions, three fill-in the blank, and five open-ended questions. For the WIMS for Women in Engineering program, student participants completed a confidential survey instrument that included 54 ordinal scale questions, seven nominal scale questions, and seven open-ended questions. For the WIMS for Teen program, student participants completed a confidential survey instrument that included 55 ordinal scale questions, two nominal scale questions, one fill-in the blank, and eight open-ended questions. Categories of the survey questions were: (a) Personal Benefits of the Program, (b) Instructional Staff, (c) Mentors, (d) Educational Sessions and Presentations, (e) Housing, Food and Social Activities, (f) Career Choice Considerations, and (g) Open-Ended Questions and Responses. A rating scale of 1 to 5 was used for (a) to (c): *1 = Strongly Agree, 2 = Agree, 3 = Neutral, 4 = Disagree, 5 = Strongly Disagree*. A rating scale of 1 to 4 was used for (d) to (e): *1 = Excellent, 2= Good, 3 = Average, 4 = Poor*. For (f) Career Choice, a rating scale of 1 to 4 was used: *1 = almost no knowledge, 2 = little understanding, 3 = moderate understanding, 4 = very good understanding.* For a reader interested in the details of the survey instruments, please contact the authors.

Small-Group Discussions Evaluation Sessions: Then, following completion of the survey instrument, students met in **small group discussions** (3 to 4 students) of four questions: (1) What was good, and what changes could be made to make the primary academic courses better? (2) What classes and/or presentations did they learn the most? (3) What was worthwhile about the program? and (4) What are their recommendations for changes? These discussion results were written on flip-charts and shared with the evaluator.

With five years of evaluations (the summer 2006 report is in final preparation), the approach for this paper will be to present some summary evaluation assessment results. Evaluation results for the DAPCEP program and the Women in Engineering program are provided in this paper; very similar evaluation results could be presented for the WIMS for Teens program.

WIMS DAPCEP Short Course Objective Evaluation Results: Over the seven years of the WIMS DAPCEP program, "personal benefits of the program" have received high ratings of strongly agree to agree. None of the categories received neutral or lower rating. About 93% of participants have reported increased empowerment in math, science, and problem solving. "Instructional staff" categories received high ratings of strongly agree to agree; the lowest rating for instructors was for their accessibility (agree, but tending about 40% toward neutral). "Mentor" categories received high ratings of strongly agree to agree. Educational sessions and presentations had two main sub-categories: (1) Academic courses received rating of excellent, except for C++ Programming received a rating of average; and (2) As for guest speakers and lab tours, a rating of excellent was received. Dorm room and food were rated as good and average, respectively. Career choice received rating of moderate to very good understanding about engineering as a career. At the end of the program, 80% to 85% of participants have indicated that they were considering engineering as their career choice. About 80% of the high school graduates have entered engineering as a major at MSU, MTU, or UM (this follow-up percentage was not done by the independent evaluator; summer program staff contacted previous students). Open-Ended questions had responses across the spectrum, addressing courses, projects, activities, other female participants, and other challenges. A desire for more individual time appeared often; dislike for C++ programming was a frequent comment.

WWIE Objective Evaluation Results: Over the five years of the WWIE program, "personal benefits of the program" have received high ratings of strongly agree, though the category "experience college" has had mixed rating of neutral. About 90% of participants have reported increased empowerment in math, science, and problem solving. "Instructional staff" categories received high ratings of strongly agree to agree. "Mentor" categories received high ratings of strongly agree to agree. Educational sessions and presentations had two main sub-categories: (1) Academic courses received rating of excellent, except for C++ Programming received a rating of good; and (2) As for guest speakers, female presenters received rating of excellent, while some noted male presenters received rating of average. Dorm room and food were rated as good to average. Career choice received rating of moderate to very good understanding about engineering as a career. At the end of the program, 60% to 70% of participants have indicated that they were considering engineering as their career choice. Considering engineering as a career choice at that level percentage is important because other surveys have learned that parents and teachers steer females to choose majors other than engineering and math-based sciences (physics and chemistry), though people-helping majors such as biology and biomedical engineering are apparently "acceptable majors for females" in our United States culture. Open-Ended questions had responses across the spectrum, addressing courses, projects, activities, other female participants, and other challenges. A desire for more individual time appeared often.

For students in residential summer programs and in on-campus programs (e.g., DAPCEP 7th/8th grade program), certainly one might suggest that the best type of evaluation would be a many years longitudinal study to follow the students through their high school and college course selections, as well as assess their success during college. Their continued interest would be revealed by their selecting science, engineering, and math classes during high school, as well as their participation in other summer programs, and their selection of a major in college. However, first, we believe that type of study is far beyond the scope and responsibility of our work. We would prefer to rely on surveys and work products of others about the impact and nature of successful summer programs[5,6]. Second, such a longitudinal study would require large and long-term funding, far beyond the financial capabilities of the WIMS pre-college budget. The annual budget for such an evaluation study would likely exceed the annual budget of all WIMS summer programs.

Closing Summary --- and Closing Statements

In closing, about 885 pre-college students have participated in thirty WIMS summer programs with duration from 5 days to 4 weeks over the years 2000 to 2006. About 80% of the students that have graduated from high school have selected one of the three core universities and majored in science or engineering during their first year selections. Moreover, minority students have represented more than 76% of the participants, and female students have represented more than 58% of the participants; in our opinion these results are "never before seen" unheard of percentages for minority and female students. Independent evaluation has borne out that academic objectives are being offered, the programs contents provide effective academic growth in the participants, and the outcomes are positive as determined by student participants and parents. The summer programs are evaluated for meeting needs and goals. Some summer programs have been stopped (1x4 and LEGO Robotics), and one redesigned and restarted (LEGO Robotics to WIMS), with all programs under continual evaluation and evolution. New programs are added as needs are perceived and requested (Michigan Indian Leadership, World of Microsystems Summer Youth Program, and WIMS for Women in Engineering). These WIMS pre-college summer programs are positively touching the lives of youths. With the large number of summer program courses over an extended duration of seven years, the academic preparation focus of the programs, the growth of requests to have alliances with WIMS pre-college summer programs, and the phenomenal results for female and minority participation, the term "successful" seems to be an appropriate descriptive.

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MSU (DPO, Recruiting and K-12 Outreach, CoE)
UM (EECS, MEPO, GISE/WISE, CoE)
MTU (SYP, Outreach and Multi-Ethnic Programs, CoE)
DAPCEP Program at UM and at MSU

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List of Acronyms

CoE	College of Engineering (at MSU, MTU, UM)
DAPCEP	Detroit Area Pre-College Engineering Programs
DPO	Diversity Programs Office (at MSU)
EECS	Electrical Engineering and Computer Science Department (at UM)
ERC	Engineering Research Center
GISE	Girls in Science and Engineering (at UM)
MEMS	Microelectromechanical Systems
MEPO	Minority Engineering Programs Office (at UM)
MSU	Michigan State University
MTU	Michigan Technological University
NSF	National Science Foundation
SYP	Summer Youth Programs (at MTU)
UM	University of Michigan
WIMS	Wireless Integrated MicroSystems
WISE	Women in Science and Engineering (at UM)