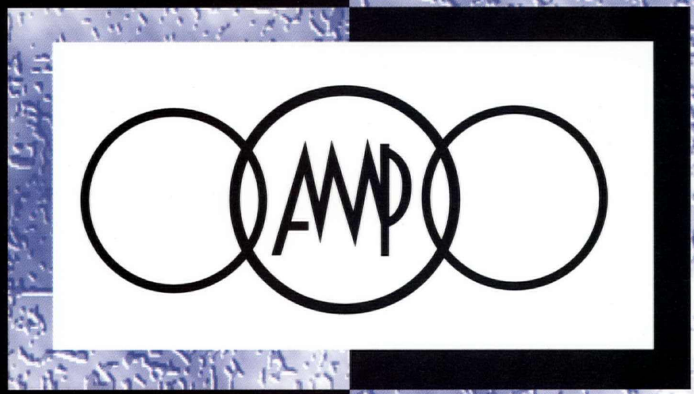
Puerto Rico Alliance for Minority Participation



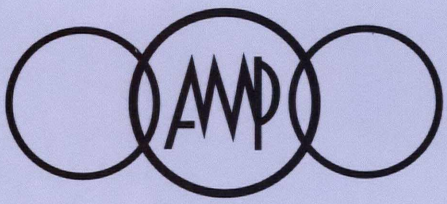
"It is necessary to promote research and development activity; to strengthen the Puerto Rican Scientific Community; to develop new human resources highly skilled and knowledgeable in science and technology; and to conduct strategic planning to make optimum use of the current and potential resources for the development of a research and development base in Puerto Rico."

— Executive Order of the Governor of Puerto Rico, The Hon. Pedro Roselló

The Governor's Policy on Science and Technology is a major component of the New Economic Model and it is a fundamental strategy to strengthen Puerto Rico's economic competitiveness in the global economy. It focuses on the development of human resources in science, mathematics and engineering.

Puerto Rico's Alliance for Minority Participation Program is the mechanism joining government policy, academia, and the business and industrial communities in a practical working plan for the implementation of these goals.

THE PUERTO RICO ALLIANCE FOR MINORITY PARTICIPATION

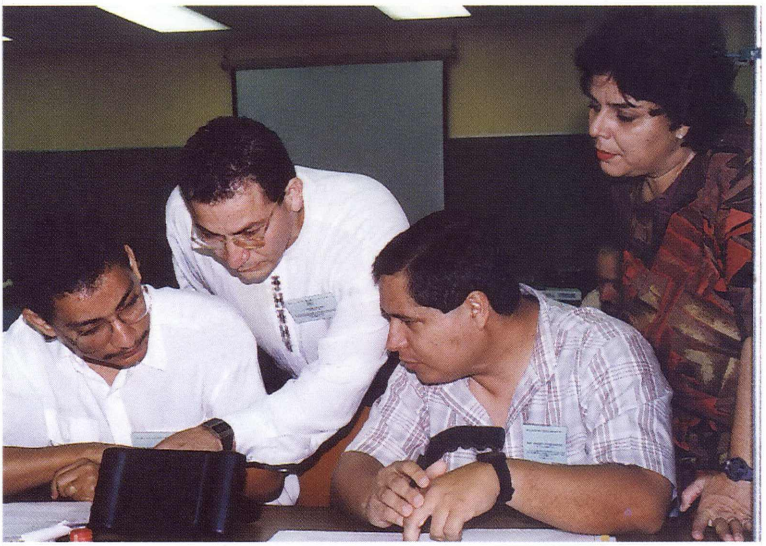


The Puerto Rico Alliance for Minority Participation (PR-AMP) was established in 1991 with a grant from the National Science Foundation. Coordinated by the Resource Center for Science and Engineering, it is an alliance of the Island's major public and private universities working toward the goal of increasing the number of students who obtain baccalaureate degrees in science, mathematics, engineering and technology disciplines, known by the acronym SMET.

PR-AMP's main strategy is to increase the effectiveness and efficiency of undergraduate SMET education by transforming the teaching/learning culture. With revision of the SMET curriculum at its core, the program develops activities to assist and motivate students, to enhance teacher preparation and to implement institutional metrics to assess the program's progress.

During Phase I, between 1991 and 1996, PR-AMP increased the number of bachelor of science degrees awarded from 1,709 to 2,674. The goal for Phase II (1996-2001) is to reach 4,071 degrees.

The Resource Center also coordinates PR-SSI, the K-12 science and math education reform; School-to-Work (STW) that prepares high school students for high-technology jobs; and EPSCoR, which strengthens the island's scientific research infrastructure. These programs together constitute an integrated systemic strategy that links SMET disciplines with the ultimate goal of a competitive, high-tech workforce.



Curricular Revision

The PR-AMP Curriculum Development and Assessment Center, together with faculty from all PR-AMP institutions, spearheaded the transformation of the SMET undergraduate curriculum by shifting the focus from breadth of content to depth of understanding and by integrating knowledge within and between disciplines.

In its initial phase, curricular revision concentrated on the redesign of five "gatekeeper" courses: Introductory Physics, General Chemistry, Introductory Biology, Precalculus and Calculus, the entry-level courses that tend to push students away from SMET disciplines. Active strategies such as Cooperative Learning and Study/Learning Skills within the Context of a Course were implemented in these courses.

Other strategies include the integration of lecture and laboratory into a single course; incorporation of such technology as the hand-held graphic calculator; use of inquiry-based and discovery activities to promote the development of thinking skills; emphasis on depth of understanding; and development of broad-based mathematics skills.

Grade distribution for students in the pilot versions of revised courses during Phase I showed a marked improvement over those in traditional classes.

Courses Using PR-AMP Strategies vs. Traditionally Taught Courses

Courses/PR-AMP Strategy	Percent of Satisfactory Grades (A, B or C)	
	PR-AMP Reform	Traditional
Introductory Physics (a conceptual course that integrates lab and class)	80%	40%
Pre-Calculus / Calculus (an integrated continuum with use of a hand-held graphic calculator)	60%	40%
Organic Chemistry (curriculum that promotes depth of understanding)	73%	36%

STUDENT ACTIVITIES

PR-AMP student activities were conceptualized to optimize their effectiveness in addressing the needs of three "tiers" of students: The **First Tier** comprises students who are academically successful in SMET, but who need mentoring, role models and research experiences to direct them toward graduate studies. **Second Tier** students are likely to complete their undergraduate degrees, but have difficulties in completing courses and meeting requirements on time. **Third Tier** students lack effective study/learning skills, and many never complete their SMET degrees.

Altogether, there were 33,943 student interventions under all the following student-oriented activities between 1991 and 1996.

Undergraduate Research - One of the most critical experiences for enhancing student motivation and qualifications for pursuing graduate studies is participation in research projects. Under this program, students are provided with research experiences during the summer as well as during the academic year at local universities, national laboratories and local industries.

PRISM - The Puerto Rico Interdisciplinary Scientific Meeting provides students with an annual forum for presenting their research. In 1997 alone, 334 students presented projects, and more than 800 students participated in this islandwide interdisciplinary activity.

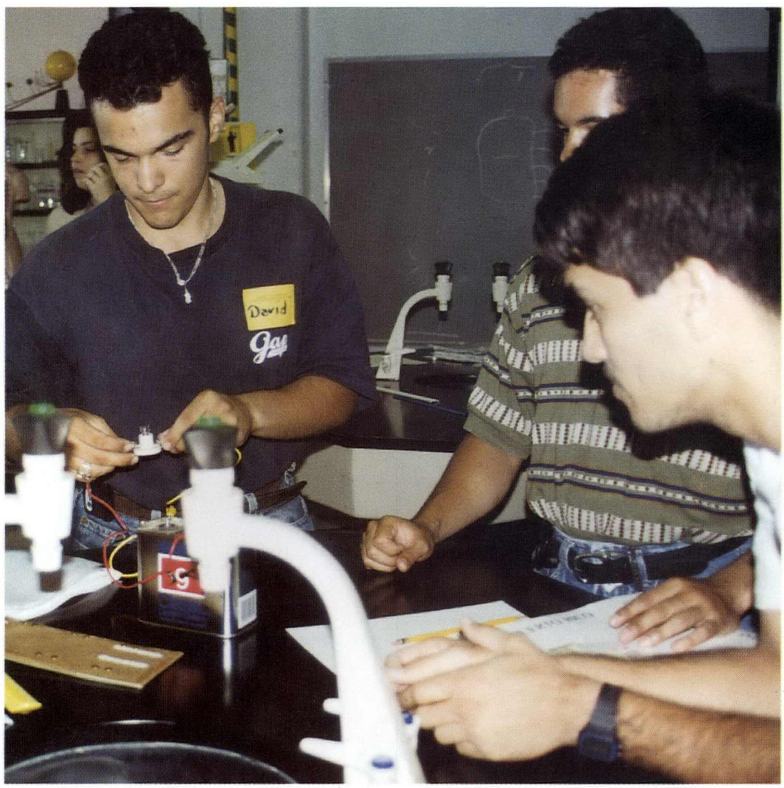
TaDDEI - The Spanish language acronym for Study/Learning Skills within the Context of a Course was originally initiated in General Chemistry courses, and the program is expanding to other SMET disciplines. Faculty and peer mentors help students develop study/learning skills within the course each is taking. This program has proven effective in improving students' academic performance: doubling A and B grades and reducing F's by a factor of three.

Cooperative Learning - Proven highly successful for improving student learning, this strategy is being implemented in SMET courses to promote depth of understanding and to develop students' ability to work collaboratively in groups, a skill they will need when they join the workforce.

Peer Mentoring - Faculty and upper level students serve as mentors to freshmen and sophomores to motivate and assist them in their SMET courses.

Stipends for Low-Income Students - Ranging from $500 to $2,000 per year, stipends are awarded on a competitive basis to students who demonstrate high financial need and who maintain high academic performance. Students who are both low-income and first generation college students are given priority.

Special Engineering Component - The thrust of this activity is to incorporate new teaching strategies and learning technologies in engineering studies. Two laboratories were developed through PR-AMP: a Self-Paced Laboratory at Turabo University School of Engineering and a Computer Assisted Instruction Delivery Laboratory (CAIDEL) at the School of Engineering at UPR-Mayaguez. In another facet of the program, a one-week residential camp is offered at both sites to attract and prepare high school students for engineering studies.



TEACHER PREPARATION

The PR-AMP Teacher Preparation Component is a comprehensive program based on linkages between the School of Education and the School of Natural Sciences to increase the number of teachers certified to teach physics, chemistry and mathematics at the secondary level, areas of identified shortage in Puerto Rico's public education system.

The following activities are offered to students participating in this program:

- Workshop on the art of being a teacher
- Introduction to the new science and mathematics curriculum through PR-SSI
- Science process skills from the standpoint of curricular content and its relation to the scientific method
- Requirements for teacher certification
- Scientific research opportunities for education majors to develop their research skills in science and mathematics
- Science and math majors participate as resources in PR-SSI teachers' professional activities so they become familiar with exemplary teaching practices.
- Science and math majors serve as peer mentors to education students.

Faculty members from the schools of education and natural sciences are working on reconceptualizing secondary education science courses as well as the introductory natural science courses.

All PR-AMP student activities are open to AMP Teacher Preparation participants.

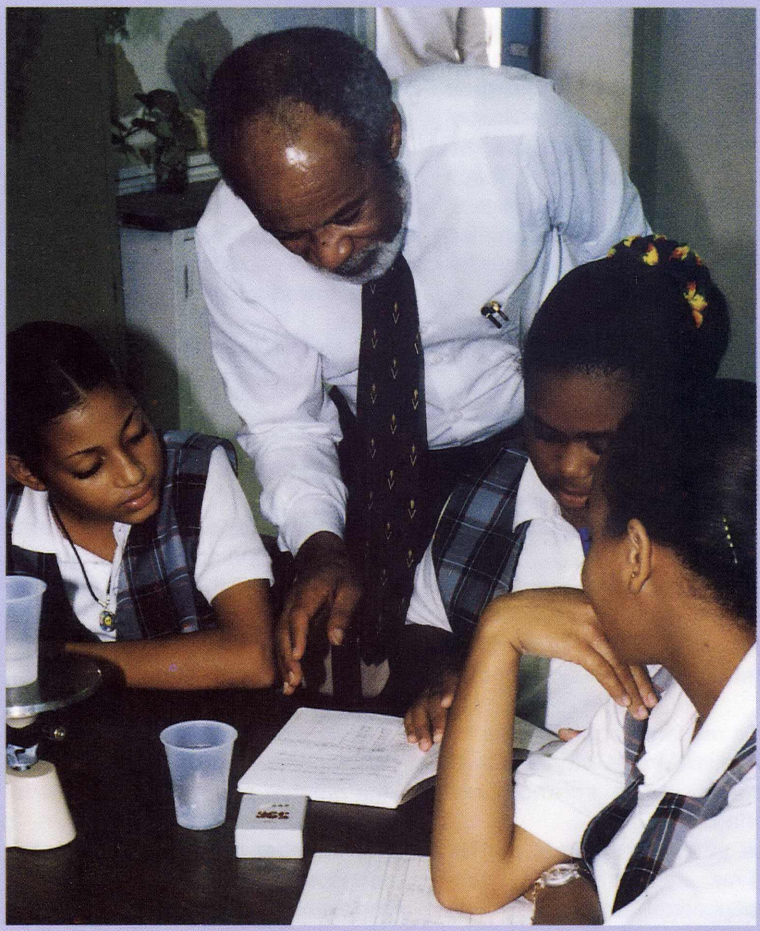
Accomplisments:

- 27 science and math graduates were certified to teach physics, chemistry and mathematics in 1996.
- 42 current science and math teachers who have been teaching physics courses without the required certification underwent preparation to be certified, more than doubling the number of certified teachers in physics.
- The number of science and mathematics education majors engaged in research went from none to 22.

Number of Science and Math Education Graduates Certified in Physics, Chemistry and Mathematics

Major	1994-1995 Baseline	1995-1996	1996-1997	1996-1997 Increase Over Baseline	Percent Increase
Physics	2	5	7	5	250%
Chemistry	1	1	12	11	1,100%
Mathematics	19	21	22	3	16%
Total	**22**	**27**	**41**	**19**	**86%**

PR-AMP STAFF



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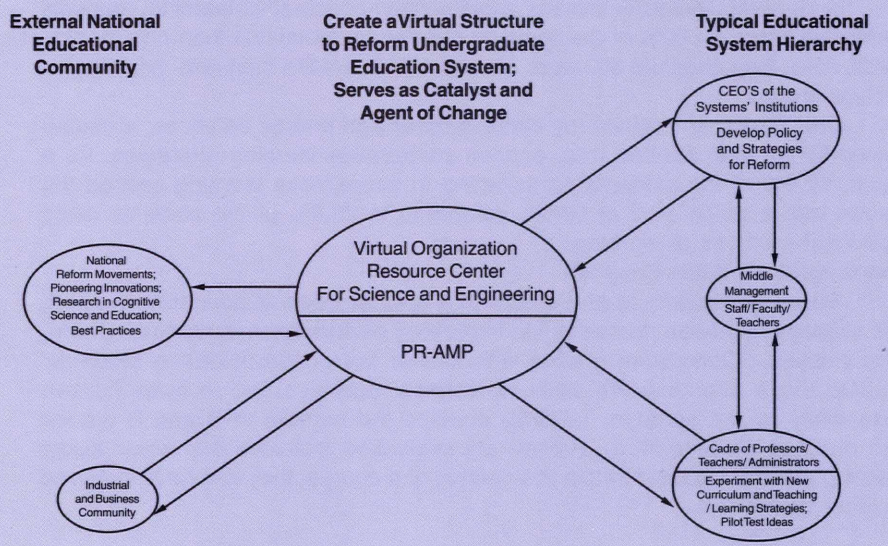
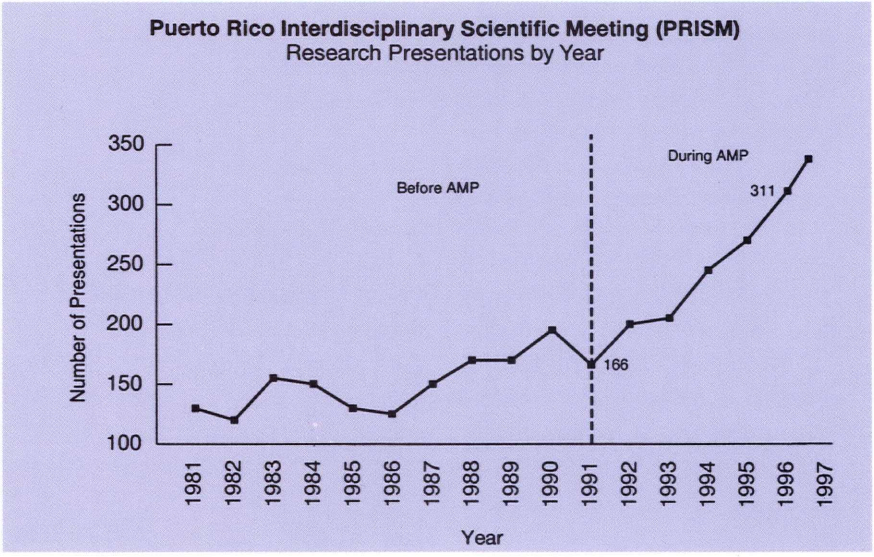
Three-Prong Approach to Undergraduate Educational Reform



MAJOR ACCOMPLISHMENTS

Student Research Activities

During Phase I, a total of 912 students benefited from research experiences at local universities and national laboratories, many of them obtaining recognition at national meetings. Students presenting their research projects at the annual Puerto Rico Interdisciplinary Meeting (PRISM) increased from 166 in 1991 to 334 in 1997.



Cooperative Learning Strategies

In General Chemistry classes implementing cooperative learning, students performed better on 80% of the items on the departmental test than non- participants. Also, they obtained 5% more A's and 10% more B's than non- participants in class grades.

One Chemical Engineering class in mass and energy balances, a course known for its high attrition rate, applied cooperative learning strategies. As a result, 77.4% of the students participating in cooperative learning passed the course with a grade of C or better, compared to 28.6% of the students using traditional methods of learning.

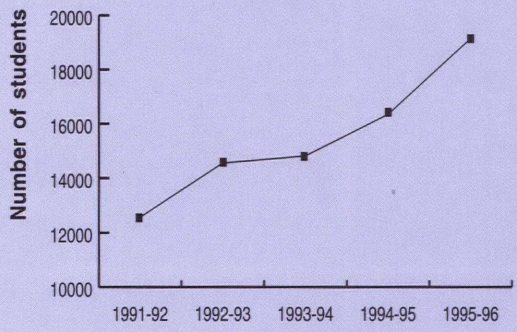
Learning/Study Skills Program

Aimed particularly at students with a greater need of academic support, this strategy has been successful in improving performance in General Chemistry classes. Comparing grades with similar but nonparticipating students' grades, those attending the skills workshops, activities and lectures (known collectively by the acronym TaDDEI) doubled the number of A and B grades and reduced F's to a third. Preliminary evaluation indicates that when study/learning skills are learned within the context of a course, they can be transferred to other disciplines.

SMET Enrollment

During Phase I (1991-1996), PR-AMP institutions increased their SMET Enrollment from 12,572 to 19,139, a 52% increase.

Increase in SMET Enrollment 1991-1996

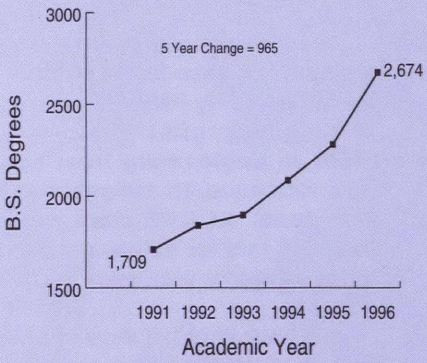


1991- 12,572
1992 - 14,557
1993 - 14,818
1994 - 16,344
1995 - 19,139

SMET Degrees

During Phase I, the number of baccalaureate degrees awarded by PR-AMP institutions increased from 1,709 in 1991 to 2,674 in 1996, surpassing the five-year goal of 2,646. According to the National Research Council, from 1989 to 1993, twentytwo percent of Hispanics receiving a Ph.D. in a SMET field nationwide obtained their undergraduate degrees in a PR-AMP institution, an average of 47.6 doctorates per year.

Puerto Rico Alliance for Minority Participation
BS Degree Production Curve
1991-1996



Top Baccalaureate Institutions of U.S. Hispanic PH.D.'s In Natural Sciences and Engineering 1989 -1993

Institutions	Degrees awarded
UPR Rio Piedras	163
UPR Mayagüez	47
UC Berkeley	38
UT Austin	39
MIT	17
Cath. U. of PR	14
UC Irvine	8
UPR Cayey	6
Interamerican U	6
UPR Humacao	2
Total Degrees U.S. Institutions	**1,089**
Total Degrees PR-AMP Institutions	**238**

Samples of Metrics Used at Various Participating Universities

Retention Rates

Engineering Program at UPR-Mayaguez
(Sample Size 150 Cohort Entering in 1990)

	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6
Students Leaving Before Graduation	11 (7.3%)	4 (2.7%)	2 (1.3%)	3 (2.0%)	6 (4.0%)	0
Retention Plus Students that have Graduated	139 (92.7%)	135 (90.0%)	133 (88.7%)	130 (86.7%)	124 (82.7%)	124* (82.7%)

* 37 students are still in the sytem; 80% have a GPA> 2.0 and are expected to graduate

Science and Mathematics Programs at UPR-Mayaguez
(Sample size 130 Cohort Entering in 1990)

	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6
Students Leaving Before Graduation	15 (11.5%)	16 (12.2%)	15 (11.5%)	7 (5.3%)	5 (3.8%)	1 (0.8%)
Retention Plus Students that have Graduated	116 (88.5%)	100 (76.3%)	85 (88.7%)	78 (59.5%)	73 (55.7%)	72* (54.9%)

* 16 students are still in the sytem; 80% have a GPA> 2.0 and are expected to graduate

Science and Mathematics Programs at UPR-Humacao
(Sample Size 100 Cohort Entering in 1991)

	Year 1	Year 2	Year 3	Year 4	Year 5
Students Leaving Before Graduation	5 (5.0%)	13 (13.0%)	9 (9.0%)	11 (11.0%)	4 (4.0%)
Retention Plus Students that have Graduated	95 (95%)	82 (82.0%)	73 (73.0%)	62 (62.0%)	58* (58.0%)

* 33students are still in the sytem; 29 have a GPA> 2.0 and 80% are expected to graduate

These retention rate studies showed significant increases at these two institutions due to the whole-campus reform strategies implemented by their chancellors.

Graduation Rates

Engineering Program at UPR-Mayaguez **

	Cohort Entering From 1983 to 1986	Cohort Entering in 1990
Combined Graduation Rate BS in SMET	980 (53.0%)	114 (76%)*
Population/Sample Size	1848	150

* Graduation Rate in 1995 was 56%, however since 80%t of the students still in the system have a GPA of 2.0 or higher and are expected to graduate, the projected graduation rate is 76%
** Engineering at UPR-Mayagüez is a 5-year program

Science and Mathematics Programs at UPR-Humacao

	Cohort Entering From 1984 to 1986	Cohort Entering in 1990
Combined Graduation Rate BS in SMET	118 (39.6%)	61 (46.6%)*
Population/Sample Size	298	131

* Graduation Rate in 1995-96 was 37.4%, however since 80% of the students still in the system have a GPA of 2.0 or higher and are expected to graduate, the projected graduation rate is 46.6%.

Graduation rate studies show a significant increase in the student cohorts impacted by PR-AMP.

UPR-Mayagüez presents increases in Engineering from 53% to 76%, a rate equal to national flagship institutions. At UPR-Humacao the graduation rate for science and mathematics students increased from 38% to 42%.

PR-AMP Phase II aims at graduation rates averaging 60% for all PR-AMP institutions, which is above the national average of 53%.

INSTITUTIONAL METRICS

PR-AMP's central academic goal is to increase the effectiveness and efficiency of the undergraduate educational enterprise by creating a more robust nurturing environment for students and transforming the institutional teaching-learning culture. To achieve this goal, and to serve as catalyst, or agent of change, PR-AMP uses the virtual structure formed by the Resource Center for Science and Engineering. The RCSE maintains constant linkages with the national reform movement in education and cognitive science as well as with the industrial/business community. The information from these links is converted by PR-AMP into educational strategies, specific objectives and benchmarks to implement and measure progress, and then transferred to the participating institutions.

Three measures provide a guide for planning, institutional research, and for establishing accountability procedures to promote systemic transformation:

- Student Retention Rate
- Student Graduation Rate and the number of years it takes a student to complete a baccalaureate degree
- Index of Course Efficiency (ICE)

ICE is the average number of times a student needs to take a course to obtain a satisfactory grade. A lower value indicates an increased effectiveness; a value of 1 means a student passes the course on the first attempt.

$$ICE = \frac{\text{Total number of times course was taken}}{\text{Number of students who obtained a satisfactory grade}}$$

The aggregate positive impact of all PR-AMP strategies, including organizational changes, curricular revision, and teaching/learning strategies, has reduced the ICE number for traditionally difficult SMET courses in the last five years. A more significant impact is expected in four to five years (the next graduation class), where an increase in the number of graduates will be seen, independent of changes in enrollment.

ICE for Most Difficult Science and Math Courses at UPR-Mayaguez

Course	ICE Number 1984-1986	ICE Number 1990
General Biology	3.4	1.8
Biological Sciences I	2.3	1.5
Physics I	3.6	1.7
Physics II	3.6	1.4
Pre-Calculus I	2.3	1.8
General Chemistry	2.1	1.5

ICE for Most Difficult SMET Courses for Engineering Students at UPR-Mayaguez

Course	ICE Number 1984-1986	ICE Number 1990
Physics II	2.5	1.4
Fundamentals of Electric Eng.	2.0	1.6
Eng. Mechanics Statics	2.2	1.4
Material & Energy Balances	3.1	1.4
Calculus II	2.0	1.5
Physical Chemistry I	2.5	1.6
Physical Chemistry II	2.1	1.8

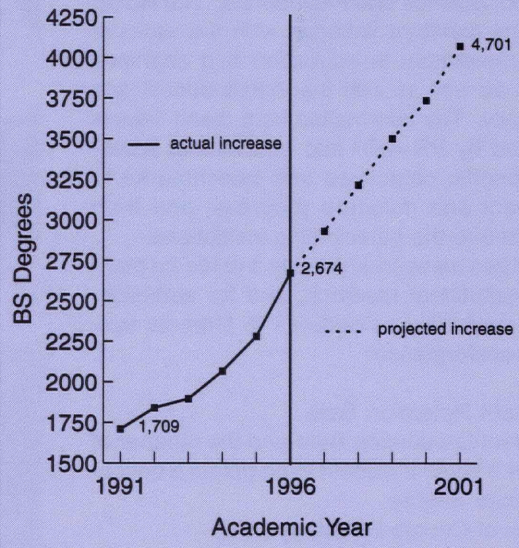
PR- AMP Advisory Board

During Phase II (1996-2001), PR-AMP aims at increasing the number of SMET baccalaureate degrees from 2,674 to 4,071.

"The members of the Advisory Board are highly impressed by the success of Phase I and are convinced that Phase II plans and proposals will succeed even more, while institutionalizing the various successful PR-AMP program components by the year 2001... We are convinced that PR-AMP will strengthen not only Puerto Rico's ability to lead the Nation in the supply of Hispanic American Ph.D's but will provide models that can easily be replicated by mainland institutions serving disadvantaged groups."

PR-AMP Advisory Board Meeting, October 1995

Puerto Rico Alliance for Minority Participation
BS Degree Production Curve



Members of PR-AMP Advisory Board met in October 1996 with Dr. Luther Williams; Dr. Bernard Charles,The McKenzie Group; Dr. Vineta Jones, National Director Project 2000; Dr. Iris Weiss, President of Horizons Research Inc. Other members include Dr. Shirley Malcom, Executive Director of the American Association for the Advancement of Science (AAAS); Dr. Bill Aldridge, former Executive Director of the National Science Teacher Association (NSTA); Dr. Uri Treisman, Professor and Director of Mathematics, The Charles A. Dana Center for Mathematics and Science Education, University of Texas, Austin, and representatives from the local industrial community.

PR-AMP PHASE II: 1996-2001

Goals

- To increase the number of SMET BS undergraduate degrees awarded from 2,674 to 4071
- To increase graduation rates in PR-AMP institutions from an average of 32% to an average of 60%
- To increase the efficiency and effectiveness (ICE measurement) of SMET courses by reducing the average number of times needed to complete a course satisfactorily to 1.5
- To increase by 75% the number of BS graduates from PR-AMP institutions completing a Ph.D., increasing the Phase I average of 238 to 417.

Curriculum Revision

- Extend the strategies that promote depth of understanding, active learning and workforce skills.
- Incorporate scientific process through research activities and experimental design
- Extend the learning/study skills and cooperative learning programs to an increasing number of SMET courses.
- Develop course assessment methods to measure thinking skills, depth of understanding, integration of knowledge from all courses, and scientific inquiry skills.

Student Activities

- To attract and retain students in SMET disciplines, enhancing their academic talents and encouraging graduate studies through faculty and peer mentoring, cooperative learning and learning/study skills participation
- To match industry mentors with students through a special Industry Mentor Program to enhance career interests
- Increase participants in summer and academic year research opportunities to 350 annually, increasing the quality and number of presentations in local and national forums
- Increase activities to attract high school students into SMET disciplines, adding residential summer camp experiences at three PR-AMP engineering campuses.
- Continue and increase activities to encourage graduate studies, with emphasis on female engineering students, through orientation and mentoring programs and Graduate Record Exam workshops.

Faculty Development and Teacher Preparation

- Promote the development of faculty through changes in teaching practices and training in curricular revision.
- Provide technical assistance to faculty through a Traveling Faculty Improvement Team and Internet communications
- Provide research opportunities to science and mathematics teachers
- Encourage SMET students to enroll in education courses toward teaching certification

Educational Technology

- Implement use of multimedia technology in SMET courses
- Provide SMET students with access to the Internet
- Develop a Homepage for faculty to exchange curricular materials
- Develop teleconferencing facilities

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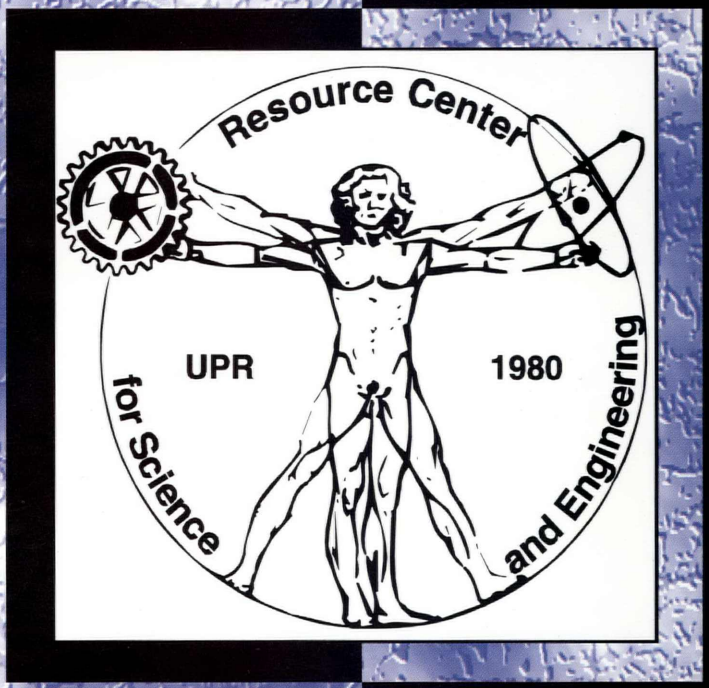
Ana G. Méndez University System
Inter American University System
Pontifical Catholic University of Puerto Rico
Sacred Heart University (Phase I)
National Laboratories
Local Industries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