The purpose of this study was to examine the effects of the Research Apprentice Program (RAP) intervention after 4 ½ years in four areas using the research questions, (a) How did the principal participants involved perceive, understand, and value the goals and activities implemented by the program? (b) What was the participant attitude toward the program (i.e. identify the relevant factors that are related to this attitude, and conditions and circumstances influencing that attitude)? (c) What factors are associated with sustaining academic progress for undergraduate women in the targeted discipline areas? and (d) What are the effects of the intervention program model on undergraduate women’s entrée into the professional STEM workforce?

The Women’s Educational Equity Act (WEEA) Mentoring and Professional Development Equity (MPE) Project involves a mentoring and professional development equity program situated at a Hispanic Serving Institution (HSI) of higher education. The Research Apprentice Program was designed to create a replicable model to increase the number of women undergraduates graduating in the targeted academic disciplines of physics, chemistry, computer science, and mathematics through effective mentoring and professional development. Our focus was on the critical junior/senior years of these women students because the transition point from
lower to upper division status is when students often switch or drop out of specific science, technology, engineering, and mathematics (STEM) academic majors (Seymour, 1997). The intervention studied here addressed the question “How have institutional and organizational structures limited, or enhanced, young women’s participation in scientific and mathematical fields?” The RAP goal is to develop and implement a model that increases the number of women eligible to join the professional workforce in the targeted majors. The project’s aim is to achieve greater equity in education and promote equity for women who also suffer multiple forms of discrimination, namely sex, race, ethnic origin/culture, low socio-economic status, and limited English proficiency. This program will serve as an intervention model and provide a framework for similar universities who struggle to increase women’s educational equity.

**Background**

A nationwide shortage of women professionals exists in the STEM areas of chemistry, physics, mathematics, and computer science, which are the targeted program areas (NSF, 2004; Preston, 1994). Baseline data for the HSI university reported here show women in the targeted majors, once they reach junior and senior status, graduate at a lower rate (54%) than men (63%). Women made up less than one-fourth of the total population in baseline years 2000, 2001 and only about 17% (77/444) of the graduates. This disparity, as a recent report indicated (Offenstein & Sulock, 2009), impacts the STEM workforce. These low numbers clearly demonstrate the great need for a structure to sustain all women, but especially those of color, whose numbers are smaller, in these targeted majors as they move toward graduation.

While recruiting new women majors may be successful at the freshman level, during the critical junior and senior years in college, students often switch out of these STEM majors. Factors leading to switching include the economic need to work and commuting time, along with a loss of interest in the major, and/or the very high curricular demands of these majors (Burke & Sunal, 2010). Students often have a stereotypical idea of scientific personalities and careers (Seymour, 1997). Sheffield (2006) synthesized much of the history of women in science literature, finding feelings of isolation and feeling “uncomfortable in the social situations in which networking connections…are made” (p.162). She concluded, “At both the undergraduate and graduate levels, women can benefit remarkably from access to support networks for women, study groups, mentoring programs, and the choice of attending all-women tutorials and seminars” (p. 192).

In addition to mentoring, these women need to be involved in professional activities beyond coursework. Studies show these activities help motivate and retain undergraduate students (Downing, Crosby & Blake-Beard, 2005; Doyle, 2000; Light, 2001; Noe, 1988; Ragins & Cotton, 1999). Seymour’s data recognizes the need to provide additional support to sustain interest in science and mathematics (1997). Light (2001) found college students recognize there should be continuous interaction with their major faculty members and found a correlation between student success and participation in professional development activities. Doyle cites John Churchill’s belief that “Becoming a scientist, or professional in a science-based discipline, depends critically on induction into a community of scientific practice” (Doyle, 2000, p. 87).
Procedure

Setting

The MPE Research Apprentice Program (RAP) was designed to create a variety of professional experiences for upper division women that build an experience base and support network focusing more precisely on their needs (Braxton, et.al, 2001). The upper division women participants more precisely learn what careers their majors encompass as they develop relationships with professionals and their own “personal professional identity” (Johnson, 2004, p.128). Participants have many opportunities to interact and network with women role models in academe and industry. Mentoring and professional development activities included formal research symposiums, informal discussions of issues about women in science, conducting research projects, attendance/participation in professional conferences, social events, luncheons, and meetings between faculty and students. The program model was implemented at a large urban Hispanic Serving Institution (HSI) university. Many students (90%) reside within 15 miles and are reflective of state’s racial and ethnic make-up. The students are underrepresented, many are low-income, and about 14% are immigrants or refugees. They complete their BS degree in 5-6 yrs. with a 48% graduation rate. In the College of Science, women make up less than 23% of the undergraduate students and 27% of the faculty in the targeted areas. Part of the university’s mission is the goal of civic action advancing the well being of the community in the state. The WEEA program model adopted this goal but focused on women in the targeted areas.

Intervention Model

The WEEA/MPE Project, at the higher education institution under study provides an intervention model aimed at increasing women’s graduation rate in the targeted discipline areas. The MPE Research Apprentice Program (RAP) was designed to create a variety of professional experiences for upper division women that build an experience base and support network focusing more precisely on their needs (Braxton, et.al., 2001). The goal was to achieve greater educational equity and promote equity for women who also suffer multiple forms of discrimination: namely sex, race, ethnic origin, and limited English proficiency (Li, 2002).

The upper division women participants more precisely learn what the careers in their majors encompass as they develop relationships with professionals and their own “personal professional identity” (Johnson, 2004, p.128). Participants have many opportunities to interact and network with women role models, i.e., peers further along in their academic program, professors in their disciplines, as well as professionals in industry. Mentoring and professional development activities included formal research symposiums, informal discussions of issues about women in science, planning and conducting research projects, attendance and participation in professional conferences, social events, luncheons, and meetings between faculty and professionals in the work world and students.

The RAP students worked one-on-one with their faculty mentor as they planned and carried out their discipline-based research project. For many students this became their senior project. It helped them to understand a specific real-world application of their major as well as learning what it meant to be a professional scientist. At the end of each quarter they submitted a progress
report to their research mentor as well as the WEEA RAP director. In a few cases, their work resulted in publication in a professional journal.

The RAP students presented their research progress at the annual College of Science Research Symposium held each May. They learned how to prepare either a poster or oral presentation, for many, this was the first time they participated in a professional conference. Their participation enabled them to gain experience in professionally interacting with other scientists. All RAP students were encouraged to attend other national or regional professional conferences in their discipline. Most often, faculty mentors also attended these conferences and facilitated students’ navigation of the conference as well as networking. These were important experiences that will help them develop as a STEM professional.

Every quarter, the WEEA program held a "social" to which all women in the targeted fields were invited through flyers posted around campus and on the WEEA website. Personal invitations were sent to junior/senior women undergraduates, women faculty members, WEEA RAP mentors, and other faculty in each of the targeted departments. During the socials, students and faculty interacted informally in small groups; time was allotted for informal reports by RAP students and mentors. In addition, other students and faculty were encouraged to participate through questions and comments related to the WEEA RAP program and other issues of women in science. Faculty also disseminated information about summer programs, discipline seminars, upcoming national conferences, and other professional development opportunities. Smaller discipline lunches were held once per year. These lunches allowed women students and faculty in their major departments to form a stronger learning community within a specific discipline.

**Methods**

The research questions were, (a) How did the principal participants involved perceive, understand, and value the goals and activities implemented by the program? (b) What was the participant attitude toward the program (i.e. identify the relevant factors that are related to this attitude, and conditions and circumstances that influence that attitude)? (c) What factors are associated with sustaining academic progress for undergraduate women in the targeted discipline areas? and (d) What are the effects of the intervention program model on undergraduate women’s entrée into the professional STEM workforce?

Quantitative and qualitative data were used to develop extensive case reports over a 4 ½ year period. Of approximately 600 women in the population, a total of 197 participated in travel, and/or social gatherings, and/or the RAP program. Of these, 62 joined the RAP project which entailed undertaking and completing a program of research and conference presentations. The qualitative research design involved focus group interviews with 72% of the faculty and 77% of students. Focus groups were used to understand the attitudes and perceptions of the participants relating to concepts, products, services of the RAP Project that were developed in part by interaction with other people. The use of interaction among participants in the focus groups was developed as a way of accessing data that would not emerge if other methods were used.
The basis for the focus group and interview questions was developed and checked with the grant senior personnel and the grant documents. A sample of questions used with student focus group interviews are found in Figure 1. Additional probing questions were asked to clarify participants’ responses. The senior personnel were interviewed periodically during each year of the study. The students were interviewed in multiple focus group settings of four to five participants near the end of the academic year, each year. The interviews took place over a range of 45 minutes to 120 minutes. The interviewer-researcher audio-taped all conversations and took extensive notes on the student responses with the consent of the participants. All tapes then were transcribed. The transcribed tapes and extensive interviewer notes were analyzed using the goal and purpose of the grant to guide the procedure (Krueger & Casey, 2000).

**Data Sources and Instrumentation**

Data sources were MPE/RAP faculty mentors, women program undergraduate participants, student records from the targeted academic programs, other MPE/RAP personnel, faculty not involved in the program, observations of participant activities during the program, and artifacts used and/or developed during the program (Sunal, Ogletree, & Burke, 2006, 2007; Sunal & Burke, 2008, 2009, 2010). The artifacts included program documents, student course materials, and student participant conference posters, among other items. Data were collected over the 4½ year time period the MPE project was in operation. The RAP program undergraduate participants involved a diverse sample of 62 women consisting of twenty-three (37.1%) Asian, eighteen (29.0%) Caucasian, seventeen (27.4%) Latina, two (3.23%) Black, and two (3.23%) Other. All students were in their junior or senior year of college in their major. In addition, MPE/RAP events during the 4½ year period involved a total of 197 women and 72 faculty. Forty-nine students and 31 faculty were interviewed in the focus groups.

Instrumentation included demographic data; student applications; focus group interviews with project participants and faculty mentors, and interviews with other MPE/RAP grant personnel; descriptions of grant documents and other artifacts; observations of RAP events, students’ presentation, and research experiences; and other materials produced by participants. The focus group interview questions were developed externally and based on the project goals and discussions with the WEEA/MPE project personnel (see Figure 1). These forms of data collection were used multiple times to investigate and clarify understandings focused on six areas,

1. Range of ideas or feelings participants have about the discipline
2. Perspectives between participants, non-participants, drop outs, mentors, and project staff.
3. Factors influencing opinions, behaviors, and motivation
4. Ideas and perceptions emerging from each group
5. Information to help interpret the quantitative data gathered
6. Language, personal culture, and social interaction used by the participants

Focus group data collection was conducted with groups until a saturation point was reached for each of the groups. The collected data relating to the study factors and intervention elements influencing women to graduate in the targeted discipline majors were analyzed. In this case study, an inductive data analysis was conducted in order to discern themes, patterns, and
assertions from the varied sources of data collected. The focus of qualitative research is understanding and interpretation (Merriam, 1998). The data were coded and analyzed as an ongoing process and the initial categories informed the direction of subsequent data collection. As the data were collected they were coded and sorted in an iterative process and examined for patterns (Bogdan & Biklen, 1992). Categories of social phenomena as described by Lofland (1971) include acts, activities, meanings, participations, relationships, and setting. These categories and themes, guided by a symbolic interactionist framework and sensitivity to sociocultural factors were analyzed for interpretive meaning. Triangulation of data was established using multiple data sources (Merriam, 1998).

**Figure 1**

**Questions Used in Focus Groups with Students**

1. Describe your current academic area of study here at ______________. Describe your current career goal as the result of your studies here at ______________.
2. Describe your understanding of RAP? What are RAP’s goals?
3. Are there comments and ideas you wish to discuss about the RAP, your academic area, or the life events you find yourself in that relate to the goals of RAP?
4. Describe the variety of types of experiences you have had with RAP the past year. Which were most beneficial to you? Why?
5. Describe your experiences as a researcher in your discipline. How would you describe them – satisfying, interesting, challenging, or? What were the most beneficial aspects about the research experiences?
6. What impact if any have the WEEA/MPE experiences had on staying in your major? In RAP? Your career goal you started the RAP with?
7. What have been some supportive events/people and difficulties/barriers you faced here at __________ that helped/forced you to reconsider (and stay on course or change) your academic program of study?
8. What have been some supportive events/people and difficulties/barriers you faced here at home or in your personal life that helped/forced you to reconsider (and stay on course or change) your academic program of study?
9. How important were the following in creating your current academic program of study and your career goal? (e.g. Parents, relatives, peers, role model at home, public school teachers, instructors, courses, role model at __________, RAP Advisor, RAP research mentor, others of importance)
10. Describe your current plans after graduation for your future following your Bachelors degree here at __________.
11. Is the RAP program meeting its goals? Describe your attitude about RAP at this time?
12. Other comments and ideas you wish to discuss about the program, the academic area, or the life events you find yourself in that relate to the goals of RAP.

Quantitative analysis used comparative data collected in different stages of the program. Pre-program population and sample data were compared to yearly cohort groups of women in the same academic departments. Grounded theory developed through data analysis (Creswell, 2009) was utilized to uncover salient themes and subthemes. The findings addressed the overall
emergent themes from the respondents. The qualitative analysis procedures were systematic and sequential and verifiable, with a continuing and recursive process based on the transcripts. The findings were checked by two analysts returning to sections of the detailed notes, audio-tapes, and planned question statements. During the analysis weight was given to frequency of similar responses, specificity of the responses, and extensiveness, how many different people reported similar responses (Krueger & Casey, 2000). Bias was reduced by having two independent reviewers analyzing the data and comparing results.

**Figure 2**

**Career Survey of STEM Majors**

1. Briefly describe yourself: Circle the appropriate word in a)&b); write an identifier in c)
   a) Freshman Sophomore Junior Senior Graduated Other (specify)
   b) Female Male
c) Family ethnic/cultural background -
2. What is your academic major? Why did you choose this major? How certain are you that you will graduate in this major?
3. Have you ever switched your major while a ______? When and why did you switch your major?
4. What are you most interested in doing as a career (job position) when you graduate (career path)? List as many as you can. (e.g. Chemistry- lab technician, environmental monitoring – water quality, environmental law, teaching, graduate program in chemistry, etc.)
5. What experiences and events (personal and at ______) in the past few years have been supportive in helping you reach your career goal or helped you to stay on track with your major or career goals?? In what ways have they been supportive? Describe examples of support.
6. What experiences and events (personal and at ______) in the past few years have NOT been supportive in helping you reach your career goal or forced you to reconsider (and stay on course or change) your major or career goals? In what ways have they been barriers? Describe examples of non-supportive experiences.
7. Describe additional experiences and events, that do not exist now, that would be helpful in sustaining completion of your major and graduating at _____.

A career survey was administered to students in chemistry, computer science, mathematics, and physics courses. Questions are given in Figure 2. This survey was developed to gather baseline data for students in STEM majors who were not participants in the RAP program. The purpose was to gather information on students’ rationale and events surrounding the selection of their STEM majors. The data were needed to help understand and make comparisons with the RAP program student data taken over the 4 ½ years of the study. Student data was requested in four areas, (1) reasons for major selection, (2) consistency in sustaining the major, (3) events and experiences involved with sustaining the major, and (4) career plans for the future. The survey was developed and checked for content validity by RAP staff members and for reliability with twelve students before it was administered. The survey was administered in January 2009 (the
first two weeks of the winter quarter) in eight randomly selected STEM courses in the College of Science in which upper division students are commonly enrolled. Taking the survey was voluntary.

Results

Findings

Quantitative and qualitative analyses looked for the range and common themes of ideas and perceptions participants had for the MPE/RAP program, the academic disciplines, and participation as a professional in the discipline. Sixty-two junior and senior women in the targeted majors participated in RAP as research apprentices, with 41 different tenure track faculty serving as research mentors. Of the 62 research apprentices, 74% have graduated, 23% are on track to graduate, one left the university, and one changed to a non-STEM major. Thus, 97% of the women who entered the RAP program graduated or remained on track to graduation. It is important to note that 2000 – 2005 baseline data for upper division women in the targeted majors show that, after reaching junior or senior status, 53% graduated in those majors. Of the 46 RAP students who have already graduated, 39% are enrolled in post-graduate programs and 52% are working in STEM fields. Twenty RAP students were chemistry majors, 11 computer science majors, 24 mathematics majors, and 7 physics majors. The demographics of the RAP students are: 37% Asian, 29% White, 27% Hispanic, 3.2% Other, and 3.2% Black. Additionally, 70 women participated in the social networking events and/or travel, but were not in the RAP program. Of these, 31 graduated, 19 are on track to graduate, 12 left the targeted STEM majors, and eight were not in a targeted STEM majors but interested in social networking. One can argue that the social interactions provided by the RAP program have the potential to produce a significant “ripple” effect beyond official RAP program students. Networking alone, then, appears to provide needed basic supports to sustain students. Participation in the full RAP intervention including research intervention experiences provides students with greater levels of supports and scaffolding as measured by graduation success.

The career survey population (134 respondents) was comprised of 84% upper division students, heavily male (68%), and the demographics were 33% Asian, 25% Caucasian, 21% Hispanic, and 19% Other. The disciplines of biology and engineering made up 60% of the respondents whereas chemistry, computer science, mathematics and physics made up the remaining. This is in contrast to the RAP students who all female and were entirely from the latter disciplines. When asked about their career choice after graduation, 74% answered this question and of those 30% indicated teaching, 22% engineering, 16% physician, 10% environmental science, 14% research, and 8% graduate school. Thus, most students chose service professions over research and graduate study. This is in contrast to RAP students, where 39% of the graduates are in post-graduate schools. When asked about supportive experience helping them to prepare for their career goals, 75% answered the question and the vast majority of influences (41%) were related to people/experiences/events at their university setting rather than family and friends outside the university setting (29%) or personal life experiences, motivation, and interest in the subject/discipline (20%). Ten percent reported no supportive influences. These indicators as to how students can be sustained in graduating in a STEM discipline show that investing time and resources in an intervention program involving people/experiences/events at the student’s...
university setting may be more than cost effective. The RAP program data show that the RAP student involvement in research, along with a strong faculty relationship, and social interactions with their peers and faculty, have an overwhelming positive influence on the student achievements as they pursue their goals. A considerable portion of RAP students, however, indicated they encountered significant barriers as a result of their family and other personal relationships.

**Negative and Positive Factors Associated with Sustaining Academic Progress Leading to Graduation in Target Science Fields**

Data from students, faculty mentors, and artifacts supported results that converged on several important general factors. The factors associated with sustaining or impeding academic progress for undergraduate women were as follows. (1) *Culture and family* issues related to the specific participant, stereotypical views of women in roles they play as influenced by culture and being members of a family and societal group; family, parental and sibling support; and personal and family financial issues including working as students, cost of education, and family responsibilities (economics). (2) *Personal difference and skills* of individual self-efficacy and self-esteem in their role in the discipline; individual and personality differences; and time management in organizing multiple, complex, challenging tasks including commuting time. (3) *Role models*, including presence of women career models in the targeted academic and professional fields; amount of communication with the few women students in male dominated classes, women faculty, and women professionals in the targeted academic fields; and presence of women role models successfully participating in university education or handling a career and a family in the targeted academic fields. (4) *Gender concerns* including health issues and gender behavior differences in course work (competition, relationships, and responsibility). (5) *University processes* including unsupportive policies/faculty; level of student interest in the academic field; amount of knowledge and confusing or complex requirements necessary for pursuing a field of study; and level of class load and course difficulty level, inability to pass/do well in prerequisite courses.

The undergraduate students were interviewed about possible factors that influence women to continue in their science major, participate in the RAP mentoring program, change out of the target science majors, or drop out of school before graduating. The students in each of the focus groups discussed and proposed reasons that might cause women to drop out of their science, mathematics, or computer majors late in their program, before graduation. **First,** the most significant and extensive factors these students reported about attending and graduating from these college majors concerned *family responsibilities, living at home, commuting time to college, and economic need to work.* The study university is a commuter school with students who may have to commute and hour or more each way, every day. Students living on campus said that if they had to commute, it would be extremely difficult to complete the program both in terms of time and cost. Other students, who lived at home, expressed concern that women have more responsibilities at home than men. “I know a lot of people [peer friends] are married or have children, so maybe the women have a harder time because they are expected to do certain things at home.” Another stated, “I live with my only brother and I have more things to do than him with respect to chores.” The students reported several experiences where home chores (at their parents or personal home) were either expected or required and consisted of several hours
daily. These included washing clothes for the family, cleaning house, preparing daily meals for the family, baby sitting and many other duties in caring for siblings or their own children. The necessity of working while attending the university was reported in focus groups as one of the most common reasons among women for not graduating. Several students in different focus groups reported “All of us work.” Working, commuting, and family responsibilities deter many women who try to finish their science or mathematics program major. A poll taken in each group found that 83 percent of the women worked each quarter they were in the RAP program, mostly full time.

Second, a majority of the students cited *culture and family support* as a major contributing barrier to women’s success. One student felt like her family did not understand how hard the program was and that her family put her down instead of being more supportive. “They don’t understand that it is a lot of work and they don’t understand that you are in school for this amount of time and you have to put this much time into it.” “Women our age in the twenties and thirties are supposed to be married and many women fall into that trap and they don’t finish their programs.” Another student said her dad did not support her in mathematics at all because he did not consider it a major for women. Another student felt like she had her family’s support, but they doubted whether or not she, as a woman, she could make it. She stated that lack of support makes women feel less confident and weak, and causes them to possibly back out of school. In general, family issues, money issues, and wanting to have a family constitute reasons for not completing a degree.

Third, the *way society and specific cultures view the role of women in society* emerged as a significant factor preventing women from graduating. Several comments were made in each focus group concerning this issue. Several statements were made about their college majors being “male dominated.” “People think it’s a guy role and society is playing a part.” These beliefs affect the women’s family members and are almost always negative and discouraging. One student said, “It’s a family thing.” Another said, “My father didn’t want me to continue in college because it’s not part of our culture.” Still another stated that “women are not taught to use pressure [be aggressive as in choosing a male dominated professional role] because it is not feminine.”

Fourth, the women in these focus groups reported that they felt *not being able to socialize with other females* and the *lack of other women in these male dominated fields* is a factor restricting females from completing these majors. One student stated, “When I started I felt intimidated and lonely because there were not many women in the class. When I joined this program, I felt that I was the only woman.”

Other students confirmed that it can be intimidating to be in a class with all men. One student remarked, “I don’t know a lot of women in my program…. there are so few. I know of only one other woman in my major courses this quarter.” Another said, “There just aren’t that many women. I know of only two others in my courses.” Other comments given were, “I think that possibly for the females it may be hard because there are not many females to speak to and maybe they are too shy to go up to other students and speak to them.”…. “If you are not outgoing and you don’t have as many other females in your classes you have to make an extra effort to talk to other people.”…. “We need more help with speaking and getting more social.”
Not all of the women felt this way but the difficulty was most extreme in computer science courses followed by physics and chemistry.

Fifth, students’ self-concept or self-perception was another factor that came up repeatedly. Many of these students have faced situations in which they questioned their self-efficacy.

I always loved math, but when I was in engineering I guess I didn’t know a lot of the mechanical parts of the engine. I was so lost and most of the people in there knew what they were talking about. I had to spend more time on actually looking up what something was when most of the people already knew what it was. That’s why I switched out of engineering into math.

Other adults also have affected the student’s self-efficacy. One student stated, “The counselor told me not to get into calculus and that it was too tough.” A chemistry student had a college instructor who said, “You shouldn’t be here. Chemistry is not a major for a woman.” One of the students tried to overcome self-concept issues by repeatedly telling herself, “I am capable.” Another student felt lucky to have peer friends in the mathematics department and felt that “a lot of females aren’t aware of the many opportunities that are strictly for females.”

Sixth, individual and personality differences also were mentioned as personal barriers for completing a degree. One student remarked that even some men are not as successful as others because they chose not to work at it. Another student stated that some students do not hear the voice, “You can do it, you can do it!” The student went further to state, “That is the difference between the women who are successful in this science field and the women who are not successful.” Most women that are successful say, “I can do it!” Another student declared that if someone had negative feelings toward her about being able to succeed that it gave her even more reason to keep going. “I am a really stubborn person. I want to show people that I can do it. I want to succeed and show the world that it’s not true.”

Seventh, the students in the focus groups discussed gender behavior differences. When asked why more women are not enrolled in hard sciences, students suggested that women think it is masculine and that men know more than women. “The guys can get really geeky on you and so it is like, wow, they know so much. I don’t know as much compared to them.” One student stated that society creates a “social thing” because women are supposed to do certain things. “Even if you are not thinking about it, I think subconsciously you are.” She also stated that her brother had never had to wash dishes and had more study time. Groups also concluded that women have to try harder because men are “more into it.” One stated, “It’s like men get more gratification from knowledge than women do. The more they know the more masculine they feel.” Another student remarked that men and women think differently. “I think men can concentrate on one thing. For example, as a woman I like plants. I like cooking, and I like to style my hair.” She stated that when men take physics, that is all they think about, and don’t surround their lives by more things extraneous to physics.

Eighth, there were two commonly reported experiences concerning health issues for women. The participants stated that women believed they should not be exposed to a lot of chemicals or that they had been told that they should not be exposed to a lot of chemicals. One student stated,
“Chemicals interfere with hormones” and “you just have to be cautious.” The students went further to state that their RAP mentors worked with chemicals safely, even though they worked with chemicals extensively, and had families. The mentors may have been the first tangible, concrete role models for these female chemistry majors.

**Perceived Outcomes of the Research Apprentice Program as an Intervention**

The undergraduate women focus groups were asked to discuss their experiences in the RAP program. All of the students reported positive experiences in the program. There were many aspects of the mentoring program these students considered effective. None reported or stated negative comments about the program. Students’ *self-esteem and self-efficacy* have been enhanced as a result of this mentoring program. The faculty mentor in the RAP program provides encouragement, motivation, and support. One student stated, “I would be lost if I didn’t have my mentor.” She also said, “If I have a problem; if I cannot make something more, I go to him and he tries to help me and sometimes he opens my eyes for me and I’m like, ‘Oh, I know how to do this now.’ The support is great. It is personal support.”

The program has empowered these women in several ways. “It made me realize that I could do more,” stated one student. She also stated, “I wasn’t sure what to do with my major. Now I know I can do research. I can work for a laboratory and in different areas using skills not just teaching other people.” “It expands our horizons.” One student remarked, “It makes me feel glad in a way that I am doing something meaningful in my field.” Comments were made that the women now have gotten over the fear of presenting in small groups and in public settings and have confidence to speak to peers other adults, and to professionals in the field. The program not only helped the students become more interested, more motivated, and more confident in their major field but lowered their frustration level.

Students reported that the program helps them to become independent. The women in several of the groups stated that the mentors set high expectations for them and constantly push them which encourages the students to try harder. “You know I’m not sure I can do it but I know I have support so I’m going to try.” The students want the faculty mentors to be proud of them, so they attempt challenges that they would not have done and they work harder. One stated that the mentor always has ambitious ideas about what to do with her project, but said, “I’m not sure how to do it, but I’m going to try very hard to give her what she wants.” Another student remarked that the mentor gave her guidelines, but then expected her to work by herself. She stated that it gave her confidence to be in the laboratory working by herself and not constantly worrying if she could do it or not. “I do know what I’m doing and it gives me the motivation and confidence that you are doing it by yourself. That is neat!”

The camaraderie and socialization with other women and with professors played an important role in being an effective part of this program. The women mentioned working with others, working in groups, and being able to meet other women in the targeted major fields as being extremely important. Numerous comments were made about the value of being with and being accepted by others. The program and the faculty mentors involved were described as constituting a safe environment. One student stated that the program motivated her to be a part of the “science community on campus.” Another student stated, “I definitely think working in a
group is a lot stronger because we can share our ideas. She also said, “It is really a good way to meet people.” Another commented, “I think it’s good to have women meeting other women. I’ve met a lot more females through the program that I would have never known.” Another stated that she was “much more comfortable working with somebody that I’ve had practice with and being able to be more personal and having that person close by. I can even call them at home and, if I have a problem, they will help me.” Many of the women generalized these perceptions but one person actually said, “You are not so alone.” The importance is not just having friends or peers, men and women, but having peers and being accepted by others like you, other women in the same scholarly field. In a sense, it becomes a safe learning community.

In addition to academic and professional socialization, the program structures ice cream and pizza socials, as well as other social events. The MPE program encourages the women to bring a friend. The students felt this was a way for more women to find out about RAP. But, the students particularly liked the smaller departmental luncheons because they were more likely to see those people on a regular basis. One student said the luncheons provide a time to meet with her mentor and talk about things other than work. She felt that during the luncheons she got to know her faculty mentor. “There is more of a connection, you know, because we are in a relaxed environment because there is no work to talk about, which is great.”

The female students felt the RAP program provided them with real world professional experiences through the research, conferences, and presentations, and a closer connection not only with their own mentor professor but professors at other universities. All of the students were involved in a research projects with their advisor in their individual academic fields. The students presented posters at a local university level symposium, and several have presented at national conferences. The women stated that their professional communication skills had improved because of their participation at professional conferences and presentations. On a practical note, getting to know a professor better meant there was someone to write academic and professional recommendations for them. One student commented,

In the past when I was applying for anything, I’d always get hung up on the fact that I need to approach somebody in the faculty for a recommendation and I don’t feel that I know anybody there well enough or they know me well enough to give me a really good recommendation.

She went on to discuss how supportive the faculty mentors had been in helping her to make applications for higher level opportunities. “It allows me to apply for programs that in the past I would have had problems applying for, because I need to find people to write me the recommendations.” Another student mentioned how working on a real research project will help them in the future in getting a job because it looks good on their resume to have been a part of this program conducting research and made them a better candidate.

One student described working on real research projects as having been “a challenge but it is very, very valuable.” She expressed that since her project was working with other people’s data, it was important to figure out how to make the project work without starting over as much as she would have liked. She found it a challenge to change only what was necessary. That situation was a learning opportunity for her that she felt put her ahead of others looking for jobs. She
remarked that these experiences are not found in normal classrooms. Another student said, “The research is so much greater… experience than courses alone.” One student stated that it has helped strengthen some of her skills. She said, “It has helped me strengthen things that I don’t get as much practice on; in writing abstracts.” Another commented, “I think it is a good opportunity to get a woman educated and get some experience before they even graduate because when we graduate and get further along in our fields, we are going to have to do this.” One student said that the “trouble shooting was the most valuable.” Most of the students felt that they were given experiences working with hands-on and real-life problems. One woman commented that they had never had hands-on research before. She stated, “It is a way for us to do our research and you get to know what research is from first hand experience.” Another student stated, “The RAP program provides a platform for us to do more independent research.”

Lastly, these women thought they were being prepared for the future by having the opportunities that have been afforded them by RAP. One student described that it was helpful to have a professor “willing to take time out and instruct you and help guide you through this learning process.” Another comment was, “It gives us the opportunity to work one-on-one with instructors that are more knowledgeable, that can give us guidance.” Another student said, “Being able to work with a professor really helps out.” A few students reported they would not have known what they wanted to do or where to go for help without this program, and so, it has helped prepare them for graduate school and professional work. The women now realize there are opportunities out there for them. It was best summed up with the statement, “Now that you’ve opened up the research part of it, you can actually see that there are opportunities.”

The students, in general, expressed the perception that RAP had benefited them and their education in many ways. Furthermore, RAP has given these women undergraduate students the confidence and encouragement to further their education. About half of the women were considering continuing their education through graduate studies. It was recommended that RAP be available for freshman women to help encourage them, and even would be good experience for college graduates. “It’s a really good program actually no matter what level you are at.” As one student remarked, “It has had a pretty major impact on me.”

**Effective Components of the Research Apprentice Program as an Intervention**

The women in the focus groups identified several specific program elements they thought were the most effective. The four most effective elements of the program are researching with real world research projects, presenting at a symposium, regular meetings or luncheons for women, and having a mentor for support. These elements can best be described as a process providing a positive socialization program that enhances their professional careers in physics, chemistry, mathematics, and computer science.
Figure 3

Sustaining Academic Progress: Categories Related to Student Responses

<table>
<thead>
<tr>
<th>Factors Associated with Sustaining Academic Progress Leading to Graduation in Target Science Fields</th>
<th>Outcomes of the Research Apprentice Program</th>
<th>Effective Components of the Research Apprentice Program</th>
</tr>
</thead>
<tbody>
<tr>
<td>Culture and family support</td>
<td>Student Self-Esteem, Personal Efficacy</td>
<td>Real world research projects</td>
</tr>
<tr>
<td>Lack of other women students in these science and mathematics fields</td>
<td>Independence and empowerment</td>
<td>Presenting at a symposium</td>
</tr>
<tr>
<td>Difficulty getting into the university department academic programs because she was not a citizen</td>
<td>Students want the mentors to be proud of them, so they attempt challenges that they would not have done and they work harder</td>
<td>Regular meetings or luncheons for women</td>
</tr>
<tr>
<td>Individual and personality differences as personal barriers for completing a degree</td>
<td>Camaraderie and socialization</td>
<td>Having a mentor for support and a role model</td>
</tr>
<tr>
<td>Gender behavior differences</td>
<td>Provided students with real world experiences through the research, conferences and presentations</td>
<td>Professional communication skills had improved</td>
</tr>
<tr>
<td></td>
<td>Provided connections with Cal Poly professors and professors at other universities</td>
<td>Someone available to write academic and professional recommendations</td>
</tr>
<tr>
<td></td>
<td>Professional communication skills had improved</td>
<td>Positive element of resume to have been a part of this program conducting research</td>
</tr>
<tr>
<td></td>
<td>Provided confidence and encouragement to further their education</td>
<td>Provided confidence and encouragement to further their education</td>
</tr>
</tbody>
</table>
**Real World Research Projects**

All of the women were involved in real world research projects that helped improve their self-confidence and communication skills. Several students mentioned the positive growth they experienced conducting research, and planning and preparing for their poster presentations for the symposium. They liked the challenge of writing abstracts and presenting. One stated that she enjoyed the seminar on writing abstracts because it was one of the “hardest things for me to do.” Another student talked about the difficulty she had working on her mathematics research because there was not much information available. Then, when she was finished, she had to present her research and poster at a national meeting.

**Presenting at a Symposium**

The women in the focus groups stated that presentations made at the symposium were not only exciting, but good practice. Several reported that the symposium was important and meaningful. When asked what was most beneficial, it was stated, “My big one was the symposium. That was awesome because I got to present and you get to gloat a little over what you did.” Another statement was, “I agree that the symposium was the best.” One felt it made her confident enough to be able to present again even though she had always been shy to talk in front of people. “I was a bit shaky, but I’m also excited because this is a real thing that you are going to be doing.” “This is a very big deal for me.” She felt the experience of the symposium would help her in the real world. Another liked the experience not only because she presented her research but because she met other mathematics professors and discussed their projects with them. She found out about programs at other universities and saw many women there in mathematics. “It was a very huge experience for me.”

**Regularly Held Forums for Women**

All of the focus groups discussed, and came to a consensus, that the luncheons and program meetings provide a unique experience for them to get to know other women, their own mentors, and other professionals on a more personal level. These activities were cited as a positive factor in building confidence, providing information in private conversations, and building a circle of friends, a learning community.

**Having a Mentor for Support and a Role Model**

The faculty mentors were discussed as very positive role models in the program (See Figure 3). The mentors provided an organized support system of personal support for their RAP students. The students described this role model as unique and necessary in that they saw few, and personally knew, no other professional in their field personally before they entered RAP.
Process and Effects of Mentoring: Categories Related to Mentor Responses

Sustaining Academic Progress Leading to Graduation in Target Academic Fields

The seven female, and two male mentors discussed reasons why more women are not in physics, chemistry, mathematics, or computer science and why more women are not finishing these undergraduate degrees. The mentors provided statements that related to seven categories or factors. They were family and work issues, societal issues, students not knowing their academic and career options, self-efficacy and self perfection issues, social and communication issues, and lacking the ability to think abstractly as the major reasons why female students do not graduate from the university. The categories and important elements are listed in Figure 3.

It was discussed and affirmed by others in the focus groups that a lot of the women in the upper division currently have a family and a job that requires them to work too many hours. Some of the female students are pressured by their spouses to go to work and “bring in an income.” Another mentor said that some women just “don’t get that support” from their families. It was stated that with younger students, “If they get married, they drop school.” One mentor had a student whose father-in law discouraged her from going to school because her husband worked and she needed to stay home with the baby. “In those relationships, there is probably more support for the male possibly to continue his education and that it’s not necessarily as supported for the woman to continue her education.”

In another case cited during the focus group sessions, one female student dropped out because she had to help her sister and her sister’s children, and she did not have enough money to provide support and put herself through college. One mentor stated “all the students have to work full time to earn enough money to support themselves and even during regular class quarters, students still must work part time.” “It is a major factor that most female students cannot overcome.” It was stated that students should actually see a financial benefit for putting in the time here in a science major at the university.

Society’s perception can cause the women to face many problems that men do not face. Mentor statements that are representative were, “There are still expectations that the woman has to do certain things more than men in relationships.” “It is just inconceivable that the woman could be the primary bread winner of the house.” Some professional men and as well as professors were described as having something against women in science and have told the females they “should not be in this class” and to go “get married and have a family.” Another mentor stated, “There are still so many people that think that mathematics is a man’s field.” Several mentors stated that the higher the degree goes, the more it is male dominated.

A few professors felt that another barrier was that female students do not know what their academic and career options are. It is important to “know what options are out there and that those options are obtainable.” One mentor wanted to get across to the students to consider graduate school because most have never even thought about it.
RAP students had no exposure to graduate school before entering the program. We want them to realize what their options are and to realize all the resources that they have to talk to people. Some students think they will never get a job in their field.

Self-efficacy and self-perception of female students was discussed as another barrier. Two of the mentors expressed concern over lack of confidence among students. One mentor, citing research, suggested that

women internalize problems and men will either blame the instructor or just be OK with the problems. If the guys fail a class, they just retake it. The women begin to feel that maybe I’m not good at this.

In another situation, a mentor described how a female student broke down in tears because she did not like engaging with people she did not know. They do not realize that “there is nothing wrong with not knowing.”

The mentors often described the lack of women in these chemistry, physics, mathematics, and computer science fields. The mentors stated that there were not enough women students, there was a lack of a quorum of women students, in these male dominated classes at the university, and students did not see many women faculty (lack of role models in their academic fields). Not only were the mentors concerned about the number of women in these fields, but several expressed concern about the lack of women as faculty members. They described finding mentors as difficult due the intensity and time commitments required. One mentor returned from a professional conference in her discipline where there were only three women out of 150 people in attendance. Because there are not many females, the communication between women in professional training and working as professionals is lacking in chemistry, physics, mathematics, and computer science. As one mentor described the problem, “Communication is a problem especially when we are trying to recruit women. If there were more women, it might be more comfortable.” Several mentors described the problem as difficult and solved only by increasing the number of women in college majors. One said, “Few women seem to enter into groups with men at college.” Another volunteered “Sometimes a relationship with males develop and then it ends up being a problem.” One mentor expressed “Women feel isolated and that might be the reason they might not continue in the program.” Another said, “Women are underrepresented in their majors. [In physics] It is something like 10% of the PhD’s are given to the women and so it could only help having more women.”

The mentors also were concerned that some women were struggling with their classes. One mentor stated, “There are a few excellent women students, but there are a few who really need help.” Another mentor stated, “Many of the students drop because they are not doing well in their coursework.” The mentors agreed that some students did not realize, for example, that a lot of mathematics was needed for computer science. Because “they did not take the right math in the freshman and sophomore years in the computer science program, the students decided to go into different majors” or, “they just don’t have computer experience.” In the junior and senior years, more abstract concepts are introduced in the courses. The courses are fundamentally different. One mentor suggested “When the subject moves into a more abstract level, maybe that
is preventing students from staying.” Another mentor reported, “It’s on the junior level that it really gets very hard. I think the subject matter is harder than just the year before.” Students must have a strong interest in their major field to do well.

Several other factors were discussed and factors affecting graduation. The faculty mentors also briefly discussed the issues of not being able to pass the prerequisites, time management, cultural issues (i.e. speaking in class, speaking to a professor, etc.), and students taking too many classes during a quarter while working full time.

Finally, there were examples of instances cited in most of the fields that some students were in the programs as a place holder, with little intention of graduation from the program. Chemistry majors, for example, are not required to get a Bachelor’s degree (BS) to go to pharmacy school. This contributes to students leaving before they reach a BS degree in chemistry. One mentor stated, “If a decent portion of them have no intention of getting a Bachelor’s degree or are kind of camping out as a chemistry major until they get accepted in pharmacy, and then they are gone; that is not a failure on our part if that’s their goal.” It was stated that chemistry (and other fields) students should be followed to see where they end up in school.

**Mentoring**

Even though mentors discussed the enjoyment of mentoring, they commented about the lack of time available to mentor students. All mentor focus groups’ acknowledged that time caused the biggest problems for mentoring. One older mentor felt that age might be an issue because she thought the students might want a younger mentor. A female mentor felt it was very difficult to “pull women from the department together, some are busy working, and some you don’t see, and there are so few numbers in a department.” A female mentor wondered if male faculty members felt as strongly about helping women in science and if not, then there was not enough women faculty to handle and expanded program. One of the mentors expressed concern by saying,

> I don’t know what would happen once I won’t be able to do this anymore because it is very hard to do with all our teaching roles and everything. I feel that I’m approaching my end, and I’m not sure how many years I’ll be able to maintain [this demanding schedule].

It was reported on numerous occasions, by different mentors, that faculty were busy, overbooked, have too heavy of a workload, and need more time to be able to continue or expand mentoring students. One faculty member stated, “I am really busy and it is hard to devote any time to a research student.” Another mentor said, “There are lots of benefits for the students, but there is really nothing there for the faculty and with our very busy schedule we could have been doing a much better job if we would have had the time.”

Several of the faculty members in the focus groups were mentoring in the RAP program for their second year. One professor said he had not sought to mentor in the program, but was asked to by the coordinator. “I have no misgivings about doing it, but it is not something I chose to do.” This professor thought the program was beneficial. Another mentor stated she liked working with
female students and actively sought out students to work on research projects. “I want to at least work with them and see what a new generation of female students is thinking.”

**Reasons for Mentoring**

Faculty mentors gave numerous reasons for choosing to mentor women in the WEEA/MPE student program. One mentor said, “I love being able to work with someone who is actually interested in math. It’s really rewarding to see who is actually interested and feel that you are actually doing something that makes a difference.” Similar statements were made by several other mentors. One mentor reported, “This is the thing I enjoy the most, doing students’ projects. I enjoy being creative with the students on these projects.” One mentor commented, “I like just doing physics and where else can I do physics but on the student’s projects. I like seeing the students grow. I try to find a project that I think is going to be fun for me too. It is often the most enjoyable part of the week. Another commented, “I get more adrenaline if I do something with the students. I enjoy having as many as I can.” Being a positive role model for the students was also important. The following additional comments were made concerning the reasons to mentor. A mentor stated that “It is so easy for us to have a positive impact on the students.” Another suggested, “What I get out of it is the enjoyment and fun that I see the student get when he see the light turn on.” A third mentor stated “For me, that’s the enjoyment I get out of it is them learning and gaining confidence.” Finally, another mentor reported “We are not doing it for the money.”

**Effective Elements of the MPE/RAP Program**

Faculty mentors agreed on the effectiveness of the program. They mentioned many positive aspects of the program. Three major categories emerged to demonstrate the effectiveness of the program. The program is effective because of the research students do and the conferences and meetings students attend because of their research. The factor most mentioned was that of building of a learning community among students and between students and faculty.

The women students all were involved in real research they were able to complete with the guidance of a mentor and then by themselves. One student already had published two papers. The program has increased the participation of women in research programs in mathematics and other fields. The RAP program also provides allocation for research in terms of providing some supply money.

The students have the opportunity to present their research. The college symposium offers the women the chance to do a poster presentation and discuss their research in a fifteen to twenty minute oral presentation. Since the symposium is done at local university, it provides professional experience in a less-threatening atmosphere. Students also have attended and presented at national meetings. One of the female mathematics students in the RAP program won an award in a national competition.
### Figure 4

**The Process of Mentoring: Categories Related to Mentor Responses**

<table>
<thead>
<tr>
<th>Sustaining Academic Progress Leading to Graduation in Target Science Fields</th>
<th>Mentoring Process</th>
<th>Effective Elements of MPE/RAP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Not enough women students in the these male dominated classes</td>
<td>Rationale for being a mentor varies</td>
<td>Research performed by the students</td>
</tr>
<tr>
<td>Women did not see many women faculty (role models in their academic fields) handling a career and a family</td>
<td>Several factors inhibit mentor effectiveness (lack of time, heavy teaching load, busy schedules, orientation to skills needed in the mentoring process)</td>
<td>Conferences and meetings students attend and make professional presentations at because of their research</td>
</tr>
<tr>
<td>Lack of interest a student has in their field</td>
<td>Lack of incentives such as release time limits effectiveness</td>
<td>Building of a learning community among students and between students and faculty</td>
</tr>
<tr>
<td>Not knowing the requirements necessary for pursuing the field of study,</td>
<td></td>
<td>Increased the participation of women in research programs in the fields at Cal Poly</td>
</tr>
<tr>
<td>Inability to pass the prerequisites</td>
<td></td>
<td>Symposums, the luncheons, the socials and one-on-one meetings bring affect other women not in the program</td>
</tr>
<tr>
<td>Time management</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cultural issues</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Students taking a heavy class load</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Students were in the academic programs only as a place holder for another academic program</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The symposium, luncheons, socials, and one-on-one meetings with their students all build a *sense of community* these faculty members believe is the most effective part of the program. One mentor stated, “I think the sense of community and bringing students together, even the students who are not directly part of the program coming to the luncheon, the ice cream social, or various activities is a valuable experience for both RAP students and non-RAP students”. Another
faculty member agreed, and said that there is a trickle down effect because the women bring their friends to the socials.

There is actually a real positive effect to more than just the research mentees or the people who are actually in the program. It has had a positive impact on other women but that has been through friendships. So, bringing those people together to foster those friendships is important. So, it will be research mentors, the apprentices, and then the apprentices are inviting friends so that we can just spread the word about this experience.

The mentors liked, and wanted more of, the community building activities so that these women can get in touch with each other and find out what others are doing. The program allowed students to get close to faculty members, which helps students see them as more like themselves. They also realize that they can be, and are, part of that learning community.

**Mentor’s Understanding of the Effectiveness of MPE/RAP**

Faculty mentors thought the project have been effective in several important areas (see Figure 4). The interaction between faculty and students, showing the students options for the future, improving students’ confidence, and providing time for socialization are a few of the many benefits and effectiveness of the MPE project. But, the nine faculty members all cited providing students with meaningful and real life situations has proven to be the number one effective aspect of RAP.

**Summary and Conclusions**

Using triangulation, the results converged on several important outcomes. The undergraduate women, faculty mentors, and results from other data sources demonstrated a similar understanding of the problems related to the goals of the research project;

1. determine factors associated with sustaining academic progress for undergraduate women in the targeted areas,
2. examine evidence regarding perceived outcomes and extent of effectiveness of the MPE/RAP in meeting its goal of sustaining academic progress for undergraduate women in the targeted areas, and
3. identify components of the intervention program model that have been most successful in sustaining academic progress in the targeted academic areas.

**Summary of Factors Associated with Sustaining Academic Progress for Undergraduate Women in the Targeted Academic Disciplines**

The data supported results converging on several important outcomes. Student, faculty mentor, and artifact data demonstrated similar results. Factors associated with sustaining academic progress for undergraduate women included;

*Culture and family*
• Culture issues related to the specific participant. stereotypical views of women in roles they play as influenced by culture and being members of a family and societal group
• Family, parental, and sibling support
• Personal and family financial issues: working as students, cost of education, and family responsibilities (economics)

**Personal difference and skills**

• Individual self-efficacy and self-esteem in their role in the discipline, individual, and personality differences
• Time management in organizing multiple, complex, challenging tasks including commuting time to university

**Role models**

• Presence of career models of women in the targeted academic and professional fields
• Amount of communication with the few women students in male dominated classes, women faculty, and women working as professionals in the targeted academic fields
• Presence of role models of women successfully participating in university education or handling a career and a family in the targeted academic fields

**Gender concerns**

• Health issues
• Gender behavior differences in course work (competition, relationships, and responsibility)

**University processes**

• Unsupportive policies or faculty
• Level of student interest in the academic field
• Amount of knowledge, and confusing or complex requirements necessary for pursuing a field of study
• Level of class load and difficulty level associated with junior courses; inability to pass or do well in prerequisite courses

**Summary of Perceived Outcomes of the Research Apprentice Program as an Intervention**

The data analyses supported the positive impact of the program components. Student, faculty mentor, and artifact data demonstrated similar results. Effective supports associated with sustaining academic progress for undergraduate women included;

• self-esteem and self-efficacy
• independence and self-sufficiency
• camaraderie and socialization with other women and with professors
real world research and professional experiences
preparation for the future by having the opportunities

The RAP intervention model facilitated significant growth and level of achievement for the undergraduate women students involved in the program. Students and mentors were positive in their description of RAP. The effects of the program for only partially supported women and other women involved in part of the program functions were inconclusive.

Summary of Effective Components of the Research Apprentice Program as an Intervention

Components in the RAP model perceived as most successful in sustaining academic progress in the targeted academic areas were,

- conducting real world research as undergraduates
- attending and making presentations at national professional conferences and regional and campus events related to students’ research
- building of a learning community among students and between students and faculty (Brumm & Mickelson 2002)
- increasing the participation of women (students or faculty) in research programs and as visible, ubiquitous role models
- having a mentor for support and a role model
- bringing in, and affecting, other women not directly involved in the program
- interacting regularly with a mentor for support and as a role model
- combining the program elements providing a synergetic effect on women participants in accomplishing MPE/RAP goals.
- creating significant change, concrete and psychological, for women to sustain efforts to complete their academic goals.

Summary of the Process and Effects of Mentoring: Categories Related to Mentor Responses

Additional results were found from the analysis of mentor’s interviews. These results related to the conditions affecting faculty mentor participation in the MPE Program and reasons why mentors take on the task of mentoring undergraduate women students in the targeted academic fields. Issues and concerns for development of other similar programs, sustaining a RAP program model, or future expansion of the RAP model were centered on

- extensive time required for mentoring
- age difference between mentor and mentee
- faculty and professional schedule and commitments providing little time for work with mentee
- few women faculty in academic departments to take on mentoring junior level students

Reasons why mentors take on the task of mentoring women students in their fields were given as
• mutual interest and motivation in solving problems in a discipline
• personal rewards in making a difference in another person
• professional accomplishment in being a positive role model
• challenge of research, professional writing, and making professional presentations

Based on the results of the analysis of the data sources it was concluded that the RAP intervention was making a significant impact on the lives of the undergraduate women in sustaining academic progress and that the effects of the intervention program model were a cost effective use of resources. The factors associated with the effective intervention components perceived by the women participants were similar to their mentor’s operational understanding. Both groups perceived that positive and effective elements now operating in the program were,

• Transfer Theory to Real World Research and Practice - providing students with meaningful and real life problem situations
• Student and Faculty Interaction - long term deeper interaction than with regular students
• Expanding Student’s Perceptions of the Discipline and Career - showing the students options for the future,
• Motivating Students - improving students’ confidence,
• Planned Social Events - providing time for socialization
• Challenging and Higher Expectations - of research, professional writing, and Making professional presentations
• Encouraging Friendship and working with other women peers in university activities and settings – creating a learning community.

It is well documented that efforts and resources have focused on making women aware, recruiting them, and providing diverse support to begin academic undergraduate majors in STEM areas. This context represents the beginning of the pipeline. Less effort and resources has been invested in sustaining women after they begin these academic majors. The education pipeline is not graduating women in the targeted areas in numbers that indicate parity now or in the near future, despite massive investment in gender studies aimed at recruiting women into programs (Chubin, May, & Babco 2005). Between 1993 and 2003, 211 grants were issued under the NSF Diversity in Science and Education program. Despite the fact that most of these studies focused on improving the inclination of young women to pursue a career in STEM fields, enrollment numbers for women in several areas actually declined (Mervis, 2003). This was especially the case in the four targeted areas at the institution in this study where the large majority of women do not graduate in their program major.

Few research studies have been concerned with effective strategies in and outside of the classroom for sustaining women in the pipeline in these targeted areas. The significant effects of this intervention, and analysis of elements of the model, impact the current understanding of strategies that are important for sustaining women in these undergraduate majors. The effects show that this type of intervention is a cost effective use of resources. It makes little sense to invest heavily in efforts and resources for recruiting women, while at the same time losing most of them in these critical fields as juniors and seniors (Mervis, 2003).
Sustaining undergraduate women after they begin their majors has been problematic, with the majority failing to graduate in one of the four targeted areas. This study advances a critical understanding of the characteristics and needs of women in undergraduate science if their academic progress is to be sustained (Tinto, 1993).

The factors supporting the intervention components and strategies aimed at sustaining academic progress in this model can be tested in other settings and used to advance the success of undergraduate women, as well as other underrepresented groups, at this and at other similar institutions serving diverse student populations. More broadly disseminated, these strategies should be tested and incorporated as part of intervention programs at other institutions to facilitate higher graduation rates of women in physics, chemistry, mathematics, and computer science.

Based on the results of the analysis of the data sources, it was concluded that the RAP intervention was making a significant impact on the lives of the undergraduate women in sustaining academic progress and that the effects of the intervention program model was a cost effective use of resources. The factors women participants associated with the effective intervention components were similar to their mentor’s operational understanding. Both groups perceived that positive and effective elements now operating in the program were,

- **Transferring theory to real world research and practice** - providing students with meaningful and real life problem situations
- **Increasing student and faculty interaction** - long term deeper interaction than with non-participating students
- **Expanding student’s perceptions of the discipline and career** - showing the students options for the future,
- **Motivating students** - improving students’ confidence,
- **Planning social events** - providing time for socialization
- **Challenging and higher expectations** - of research, professional writing, and professional presentations
- **Encouraging friendship and working with other women peers in university activities and settings** – creating a learning community.

**Contributions to the Teaching and Learning of Science**

Efforts and resources have focused on making women aware, recruiting them, and providing diverse support to begin STEM academic undergraduate majors. This represents the beginning of the pipeline. Less has been invested in sustaining women after they begin these majors. The education pipeline is not graduating women in the targeted areas in numbers that indicate parity in the near future, despite massive investment in gender studies aimed at recruiting women into programs (Chubin, May, & Babco 2005). Even though most previous studies focused on improving the inclination of young women to pursue a career in STEM fields, enrollment numbers for women in several areas actually declined (Mervis, 2003). This is especially true in the four targeted areas at the institution in this study where about 47% junior/senior women fail to complete their program and do not graduate in their program major.
Few research studies have been concerned with effective strategies in and outside of the classroom for sustaining women in these targeted areas. The significant effects of this intervention and analysis of elements of the model impact the understanding of strategies that are important for sustaining women in these targeted STEM majors. They also show that this type of intervention is a cost effective use of resources. It makes little sense to invest heavily in efforts and resources for recruiting women and at the same time losing most of them in these critical fields as juniors and seniors (Mervis, 2003). This study is unique in its focus on junior and senior women in mathematics and the physical and computer sciences. It represents one of the few studies examining several integrated factors for intervention.

Sustaining undergraduate women after they begin their majors has been problematic with the majority failing to complete their programs and not graduate in the four targeted areas. This study advances a critical understanding of the characteristics and needs of women in undergraduate science to sustain their academic progress.

The significant effects show this type of intervention is a cost effective use of resources. The strategies can be tested and used to advance the success of undergraduate women, as well as other underrepresented groups, at this and at other similar institutions serving diverse student populations. More broadly disseminated, these strategies should be tested and incorporated as part of intervention programs at other institutions to facilitate higher graduation rates of women in the targeted areas.

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