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Exploring Antarctica: Analyzing the outcomes of a minority focused field research program

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EXPLORING ANTARCTICA: ANALYZING THE OUTCOMES OF A MINORITY FOCUSED FIELD RESEARCH PROGRAM

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Abstract

With the need to increase minority representation in science, specifically in polar research, the University of Texas at El Paso (UTEP) developed an innovative field research experience entitled International Polar Year- Research and Educational Opportunities in Antarctica for Minorities (IPY-ROAM). Supported by a National Science Foundation (NSF) grant, twenty-eight participants including undergraduate students, graduate students and teachers completed a semester long online course and performed field research in Antarctica within the areas of ecology, physical science, policy or education. The purpose of this thesis consists in determining the outcomes that individuals experienced through their participation in IPY-ROAM. Four outcome areas are explored in this investigation: Participants' self-reported career competencies, their professional and academic goals, their intent to represent minorities in science, and their involvement in activities to provide knowledge of the polar regions. Results of this study indicate that participants perceived an increase in their career competencies due to participation in IPY-ROAM (paired sample t-test; $p < 0.01$). In addition, after program completion participants continue to express and interest in obtaining a graduate degree, and have conducted formal and informal presentations to a variety of individuals in an effort to represent minorities in science and/or provide knowledge of the polar regions. Data generated from this program may serve as a measurement tool to justify further investment in field research programs for students at the poles, and to refine programs to enhance these desired effects.

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Chapter 1: Introduction

1.1 Background

Science research programs that involve the participation of undergraduate and graduate students are a common model seen in a university setting. Undergraduate research in particular, "is widely promoted by faculty, administrators, institutions of higher learning, government laboratories, private industry, professional associations, and funding agencies as an effective method of training college students pursuing careers in science, technology, engineering, and mathematics (STEM)" (Mabruok, McIntyre, Virrankoski, & Jeliffe, 2007, p. 18). Research programs can serve as a beneficial venue in which students can apply the knowledge and scientific concepts learned in the classroom to a real world context. In contrast to laboratory courses, in which students often repeat a determined experiment with known outcomes, research programs aim to have the student conduct authentic investigations that create and add new information to a particular discipline (Hakim, 1998, p. 190). It is also expected that such findings be disseminated "among the relevant community through established means such as conference presentations and peer reviewed publications" (NSF, 2003 p. 4). The opportunity to be part of such a thrilling endeavor, can serve as a fuel to motivate college students into pursuing a degree in the science fields.

In a general sense, the essential feature of a research experience involves students and faculty members working collaboratively on a particular project that aims to discover new knowledge. According to Hakim (1998), there are four key elements that are necessary for having a successful undergraduate research program. They include the participation of a mentor that interacts constantly with the student, the provision of originality to develop the student's inquiry skills, the use of acceptable research techniques for the discipline, and the dissemination

of results to peers and leaders in the field (p.190). The four characteristics described by Hakim seem to depict the most common approach in which research programs are implemented in the science disciplines. In addition, students interested in participating in research programs are frequently asked to submit an application with academic information, a personal essay and letter(s) of recommendation (Kremer, 1990, p. 2). Although the application process to such programs may seem tedious and time consuming, students should be motivated to apply to these experiences since participants can "enhance skills like determination, responsibility, communication, self-confidence, critical thinking, and problem-solving, among others" (Mabrouk et al, 2007, p. 18). In addition, Lopatto (2003, p. 141) states that skills attained as a results of doing research include applying knowledge to a real situation, learning to work independently, and improving their oral and written communication abilities. Skills such as these are not only useful in the fields of science, but also valuable for personal and professional growth, and can be transferred or used in other disciplines.

A great number of universities and science institutions all over the U. S. offer research opportunities for undergraduate students, graduate students, and teachers, to experience first-hand how scientific research is performed. These programs allow student to perform authentic research in a scientific area of their choice, and may also provide the opportunity for travel, since research can be outside of a student's home institution (Lopatto, 2007, p. 301). In the following section, at brief description of a research experience in the polar sciences will be presented.

1.2 Program overview

The International Polar Year – Research and Education Opportunities in Antarctica for Minorities (IPY-ROAM) program was a unique research experience for university students and

teachers that formed part of the International Polar Year (IPY) 2007-2009, a globally coordinated effort to gain a better understanding of the polar regions.

Hosted by the University of Texas at El Paso (UTEP) and funded by the National Science Foundation (NSF), IPY-ROAM offered a life changing opportunity for 16 undergraduates, 7 graduate students, and 5 public school teachers, from all over the United States to learn more about Antarctica by conducting original field research in this icy arena. The task of designing, organizing, and coordinating this project was granted to a team of four primary investigators (PIs) from UTEP: three from the College of Science and one from the College of Education. In addition, they were assisted by a graduate student from education who was in charge of the evaluation of this experience.

The IPY-ROAM program had two principal objectives: 1) to increase the number of underrepresented minorities continuing on to higher degrees or careers in science and 2) increase public awareness and knowledge about polar regions. In particular, there was an interest to train the next generation of polar scientist and increase the representation of underrepresented minorities in this field. With these goals established, it was necessary to search for the most adequate candidates to take part in the program. Although recruitment of candidates only lasted a couple of months, the program received over 130 applications. Participants were selected from this national pool in a triple-blind review and were assigned to one of five research teams (aquatic ecology, ecotourism, education and outreach, physical science, or terrestrial ecology). See section 3.2 for a full description of the participant selection process.

To ensure that program participants were prepared for the main research experience in the Antarctic Peninsula, it was required for them to take part in a series of activities prior to the main research trip. The first of these activities consisted of an online three-credit course in

Antarctic System Science that was delivered via U.T. Telecampus during the fall semester of 2007. This course provided students with an overview of the Antarctic environment. Topics discussed in this course included the biological aspects of Antarctica, (e.g. terrestrial and marine flora and fauna), important geophysical characteristics, (e.g. sea ice and glacier formation and atmospheric drivers), human roles in the Antarctic region (e.g. political regulations in the Antarctic treaty, tourism, and exploration), and techniques in dissemination (e.g. data collection, data analysis, and lesson plan development). In addition to the course material provided by the IPY-ROAM faculty, a series of guest speakers that focus on polar regions were invited to participate in discussions via the online class discussion board. Guest shared their experience and knowledge about the poles and offered motivation to the students on their quest to Antarctica. During the course, the students also designed their Antarctic research projects within the group they were assigned to. Each research team was composed of one or two graduate students, several undergraduates, and one teacher. Each research team worked cooperatively with one of the IPY-ROAM faculty members, to decide what research questions they would investigate during their time in Antarctica and the best methods for data collection and analysis.

Another pre-Antarctic activity of the IPY-ROAM program was a trip to Washington D.C. This trip brought together all participants into one meeting place where open dialogue was encouraged to address travel questions and to discuss logistics of team research projects. Furthermore, students had the unique opportunity to visit the NSF headquarters. Here, the group met with program officers including those that recommended the IPY-ROAM program for funding. Students also engaged in discussions that centered on participating in research programs, and the arduous process of applying for NSF grants. Participants were also invited on a tour of the U. S. Hart Senate building and listened to a presentation by Dr. Edward Ramos,

Genetics and Public Policy Fellow who worked in the office of past U.S. Senator Barack Obama. Dr. Ramos illustrated the role that scientists play in the process of creating U.S. policy and the importance of diversifying the field of science by encouraging minority students to attain higher degrees in the sciences. Other activities completed in Washington D.C. were a visit to the Smithsonian Institution to attend a conference entitled “Making Science Global: Reconsidering the Social and Intellectual Implications of the International polar and Geophysical Years”, a scavenger hunt activity in the National Mall grounds to instruct students on how to use the Global Positioning System (GPS), and various icebreaker and research planning activities.

The capstone activity of the IPY-ROAM program was a trip to Antarctica during the winter break of 2007. Student and faculty travelled from their home towns to Ushuaia, Argentina were they had a week to refine their research projects, explore the Patagonian environment, and begin an adventure of a lifetime. On board a Russian tourist vessel, the IPY-ROAM participants crossed the Drake Passage to arrive at the Antarctic Peninsula. Here the ship made eight landings where “ROAM-ers” -nickname of the IPY-ROAM participants- divided themselves into their teams and collected the necessary data for their projects. The aquatic ecology group had designed an investigation to discover the relationship between penguin colony densities and aquatic organism diversity. The ecotourism group was interested in assessing tourists’ environmental perceptions and behavior prior to and after landings in the Antarctic Peninsula. The physical science team conducted a photogrammetric analysis of glacial change in the Northern Antarctic Peninsula Region. The terrestrial group performed a rapid biological assessment of Antarctic Peninsula shore-based ecosystem. The members of the education and outreach team were in charge of creating educational materials, thus, they rotated among the different research teams to make lesson plans based on the research performed by the science

students. Participants also had sufficient time to appreciate the beauty and fragility of the Antarctic environment and interact with ship passengers that came from all over the world. The voyage lasted 10 days at which point the ship returned to Argentina. Because IPY-ROAM participants came from different parts of the U.S., it was necessary to analyze most of the data before returning to the U.S. Students worked for several days in Ushuaia on this analysis and started forming conclusions about their investigation results, writing abstract of their work, and discussing the plan to finalize their data analysis upon their return to the U.S.

1.3 Rationale

The reason for conducting this study arose primarily from the need to increase the proportion of underrepresented minorities in the sciences and to understand the role that research programs may play in encouraging underrepresented groups to consider a profession in the science disciplines. Demographic information obtained by NSF (2009) illustrates that a small percentage of minority students are obtaining graduate degrees in the fields of science or engineering in comparison to the percent they represent in the total U.S. population. It is important to figure out what are the factors that motivate these underrepresented groups to pursue a career in science, technology, engineering, or mathematics (STEM). One study indicates that factors such as SAT mathematic scores, students' perceptions of their academic abilities, and a high GPA in school are strong indicators of minority students that are interested in pursuing a STEM career. (Nicholls, Wolfe, Bestfeidl-Scre, Shuman, & Taworn, 2007). Another investigation of why underrepresented students purse a career in ecology found that family support, having an authentic research experiences, and a positive view of ecology are important decision factors. (Armstrong, Berkowits, Byers, & Taylor, 2007, p. 145). In addition, Serpa, White, & Pavlis (2007, p.566), describe that university programs such as the one in the

University of New Orleans are successful in recruiting minorities in to the geosciences because they build relationships with students and make them feel welcome and comfortable in attending their university. Methods that aid in increasing minority participation in the sciences merit attention. Assessing the opinions minority student have of research programs and investigating what they perceive as beneficial or useful can help us understand the ways in which innovative research programs like IPY-ROAM can encourage minority students to purse or continue a career in the science disciplines and prepare them for their professional life.

Another reason for conducting this study was the limited amount of research present in literature that evaluates and analyzes the outcomes of student research programs, especially at the undergraduate level (Kardash, 2000; Laundrum et al, 2002; Lopatto, 2004; & Ruckert, 2002). According to Hakim (1998, p. 189), scientists have spent most of their time figuring out how to design a successful undergraduate research experience rather than questioning whether or why the research experience is effective. Hunter (2006, p. 72) mentions that to better understand the gains student attained by taking part in research programs, further research needs to be done on the experiences that students acquired when participating in these activities. Assessment of the IPY-ROAM experience provides the opportunity to add information to the literature regarding the evaluation of student research programs especially by reporting the outcomes experienced by underrepresented populations in science. In addition, a thorough analysis can provide a detailed explanation of the outcomes of this unique research experience, outline the advantages and/or obstacles that can be experienced in research programs and generate data to determine if the IPY-ROAM program met its goals. Analysis of this last point can be utilized to justify the value of research experiences to funding agencies that finance undergraduate research, as well as validate the large amount of time that faculty and students spend in these programs.

1.4 Purpose of the study

The IPY-ROAM program represented an invaluable opportunity for minorities to conduct research in a unique and remote environment. Intuitively, one would expect beneficial results and outcomes from this experience; however, it was necessary to formally evaluate this program in order to have a clear understanding of what these outcomes were. As described previously, there is a strong need to document the end results of research programs. The intricate design of IPY-ROAM opened the possibility of evaluating a range of factors from the program; nevertheless, this can be an overwhelming task. Therefore, only a handful of factors are presented in this work.

This thesis will explore four outcome areas that individuals experienced when participating in IPY-ROAM: 1) participants' self-reported views of their career competencies, 2) their professional and academic goals, 3) their intentions to represent minorities in science, and 4) their involvement in activities to provide knowledge of the polar regions.

The first objective of this research analyzed the participants' self-reported views of career competencies. According to Troutman (2004, p. 64) career competencies are "observable, measurable pattern of skills, knowledge, abilities, behaviors, and other characteristics that an individual needs to perform work roles or occupational functions successfully." For example, career competencies analyzed in this research include critical thinking and problem solving abilities. Investigating these competencies can offer a better understanding of what characteristics the students consider important for their professional development and success. The full list of the career competencies investigated is presented in the methodology chapter of this work. This part of the evaluation will focus on determine if participants report a change in possessing these competencies before and after the IPY-ROAM experience and if they believe

that participation in IPY-ROAM helped them acquire or improve such characteristics. The benefit of understanding these self-perceptions is that it can guide principal investigators of future projects to focus on developing the skills that minority participants consider important to their professional or personal development.

The second area looked at understanding the participants' professional and academic goals. In particular, the researchers wanted to create a profile of the particular goals students wanted to achieve including the maximum level of education to be obtained, and determining if any changes occurred due to participation in the IPY-ROAM research program. A report by Seymour, Hunter, Laursen, & Deantoni (2004, p. 522) comments, "it is important to distinguish between claims that the undergraduate experiences can prompt undergraduates to choose a graduate school career path, and more qualified claims that the experience can clarify, refine, and reinforce such a choice." That is why it was also important to establish how IPY-ROAM influenced or modified the professional and academic goals of the participants in case participants reported little or no change.

The third objective of this research was to determine the participants' intentions to represent minorities in their field. This analysis will determine if, following participation in the program, IPY-ROAM participants actually perform any of the intended activities mentioned in their applications. This part of the assessment will also explore if students think that programs like IPY-ROAM can increase the participation of minorities in science. Given the short time frame of this study, we are not capable of assessing if there is a significant increase of minority participation in sciences due to IPY-ROAM, but will depict the plans and actions that participants have to address this issue.

The final aim of this study is to describe the outreach and educational activities that participants planned and presented in order to increase public and scientific knowledge of polar regions. These activities will be divided into two domains: outreach performed to the general community members and activities presented to peers and other professional members. It is important that knowledge and experiences gained by participating in IPY-ROAM be transmitted to others. By doing so, the community can have a better idea of what Antarctica is and the regional issues it's facing that can impact the global system.

1.5 Chapter conclusions

IPY-ROAM is an innovative research program that provided the opportunity for young minority scientists and teacher to conduct research in one of the most extreme and remote environments of the planet. The low number of racial and ethnic minorities studying in polar regions and receiving degrees in science and the limited amount of literature reporting the value and benefits of minority groups performing hand-on research highlight the need to conduct a rigorous evaluation of this program. As such, this thesis will report on four outcomes that individuals may have experienced from their participation in IPY-ROAM. The information provided in this study is of great importance to other researchers that are interested in learning about the benefits that minority groups underrepresented in science experience when participating in research programs. It may also shed light to the necessity of creating efficient evaluation tools for research experiences as well as the need to document the results of such evaluations to add to the literature pool.

Chapter 2: Literature review

The purpose of this chapter is to provide a short overview of the literature use to support the basis of conducting the research described in this thesis. The literature review focuses on three key issues: 1) the state of underrepresentation that ethnic groups and women in the United States have in the various scientific disciplines, 2) the importance of assessing student performance in research programs, and 3) the benefits and advantages that students gain of taking part in scientific research programs.

There as a limited amount of literature that evaluates the outcomes of research programs such as IPY-ROAM. There is an even greater lack of literature assessing research programs for minority students. This fact provided justification and motivation for the development of this thesis to investigate and report to the public the outcomes that the IPY-ROAM program had on its participants.

2.1 Underrepresented groups in science

The United States is a unique blend of people that come from diverse racial and ethnic backgrounds. The diversity in population is exemplified in the NSF report, *Women, Minorities, and Persons with Disabilities in Science and Engineering* (2009, p. 22) which states that of the total estimated population from 2006, 33.6% are minority individuals (Asians/Pacific Islanders, Blacks, Hispanics, and American Indians/Alaskan Natives). Future estimates of minorities in the U.S. are indicating a growing trend in these groups. NSF (2007, p.3) states that "minorities are expected to be more than half (52 %) of the resident college-age (18–24 years old) population of the United States by 2050." Although statistics continue to show an increase in racial and ethnic groups, many are not represented equally in all sectors of society. Of particular concern is the number of underrepresented minority groups in the science and engineering fields. According to

Harding (1993, p. 198) “in racially stratified societies such as the United States, most African Americans, Native Americans, and other people of color have not had access to the scarce resources – educational, economic, social – that would enable them even to imagine having a career in the sciences”. The issue of underrepresentation is reflected from the number of students receiving undergraduate and graduate degrees to the actual number of individual in the science workforce.

Data provided by the National Science Foundation, Division of Science Resource Statistics (2009) shows that out of the total number of bachelor’s degrees awarded to U.S. citizens and permanent residents in 2006 in the sciences, 17.9.0% consisted of underrepresented minorities while these groups represent 27.9% of the total U.S. population. The difference becomes evident when we compare the number of Doctoral degrees awarded to these groups. See Table 2.1 for a complete description. The low obtainment of higher education degrees by minorities is not a new problem. For instance, between 1975 and 1992 the number of Ph.D. degrees earned by blacks only rose by a total of 40 diplomas (Colutta, 1993, p. 1089). Even with the aid of federal funded programs, representation of minority groups, especially at the Ph.D. level, continues to be evident (Summers, et al, 2006, p.1970).

Table 2.1 Racial/ethnic distribution of U.S. population and degrees awarded in science: 2006

Race/ethnicity	Percent			
	U.S. Population	Bachelors	Masters	Doctoral
White	66.4	67.0	64.8	77.0
Asian/Pacific Islander	4.4	9.1	7.9	9.3
Black	12.3	9.2	10.0	4.5
Hispanic	14.8	8.0	6.5	5.3
American Indian/Alaskan Native	0.8	0.7	0.7	0.3
Other or unknown race/ethnicity	1.4	5.9	10.2	3.6

Note. Data represents U.S. citizens and permanent residents only
Source: National Science Foundation, Division of Science Resources Statistics, *Women, Minorities, and* Persons with Disabilities in Science and Engineering: 2009.

This disparity is not only present in racial and ethnic minority groups; the number of female citizens in certain science careers is also low. For instance, of the total bachelor's degrees awarded in the fields of computer science, Earth science, and physical science, women obtain less than 50 percent of these. However, in other science disciplines like biology and psychology, women excel in contrast to their male counterparts (NSF, 2009, p.73). These numbers are also reflected in the number of female students that are pursuing a graduate degree in the sciences. In 2006 women constituted 76% of graduate students in psychology and 56% in biological sciences. In contrast, only 25 % of graduate students in computer sciences were women. (NSF, 2009, p. 6) Although, some gains have been accomplished to balance the inequities between men and women receiving degrees in the science fields, there still needs to be attention to this issue, as barriers continue to exist such as the male-centered approaches in labs and departmental cultures that do not provide a female-friendly approach (Rosser & Lane, 2002, p.172).

As expected, the shortage of minorities and women obtaining higher education degrees in the science fields has directly impacted the number of underrepresented groups in the workforce. Surveys conducted by the NSF (2009, p. 245) indicate that in 2006 of the total numbers of employed scientist and engineers with a bachelor's degree or higher, 33% constituted women, 4.3% were Black, 4.1% Hispanics, and less than 0.5% were from American Indian descend. This data illustrates that although minority groups are obtaining higher education degrees, there seems to be factors that prevent them from incorporating into actual careers after graduation.

Bringing diversity into the science workforce is a valuable endeavor. The NSF has noted that diversity allows participants to bring their uniqueness of thought which allows framing research questions and answers from different perspectives (2003, p.17). In this field, analyzing the problem from different perspectives is important in the discovery of new ideas and products created by research. As explained by Blickenstaff (2005, p. 370): "scientific and technical endeavors can only be improved by having a greater diversity of perspectives in the search for knowledge and solutions to human problems". In our constantly changing world, diversity of thought brought by minority groups should represent a valuable resource. In addition Hurtado, (2009. p. 190) mentions "underrepresented minority scientists are more likely than non-underrepresented minority scientist to study issues specific to minority communities." This statement provides a specific example of the importance that should be given to increase the diversity in science professions as this diversity can improve many issues that surround minority communities. But where do prospective scientists decide to evade this career path?

Drop- outs, or the 'leaks' of the educational pipeline occur at several levels. These leaks start as early as fourth grade and continue up until high school (Lewin & Rice, 1994, p.26). Jacobs and Simpkins (2005, p.3) state that "two of the largest leaks in math, science and the

technology pipeline in the U.S. are enrollment in college and earning a degree in these majors." In the case of minority students, Johnson (2005, p.28) indicates that "many institutions experience the phenomenon whereby minority students are entering into scientific and technical disciplines at the same rate as others, but, in general, are matriculating much more slowly." Often, the problem is that racially diverse students become discourage or lack the necessary encouragement to purse and continue a career in science (Lewin & Rice, 1994, p. 27). In addition, the low graduation rate of minorities in science fields is due to the "large numbers of students who leave STEM fields because they found other fields more interesting," (Johnson, 2005, p. 28). Other factors that keep underrepresented minorities from pursuing science include academic and cultural isolation, non-supportive peers, and discrimination, actual or perceived (Summers, 2006, p. 1870). Payton (2000) also mentions that barriers for entry in STEM careers include the low number of mentors that stimulate students to progress in their science career and the view of underrepresented groups that IT careers are for 'white' males.

Understanding the feelings and ideas that keep student from completing science careers is necessary to increase retention at this phase of the educational pipeline. Creating meaningful opportunities in which minority students find the support and encouragement they need, such as undergraduate and graduate research programs, may just be the solution to increase representation in science. Institutions of higher education are more often using undergraduate research experience programs as a way to support underrepresented students that are interested in science (Hurtado, 2009, p. 190). Kinkead (2003) provides several examples of research experiences that target minority populations such as the Mc Nair scholars California Alliance for Minority Participation in Science, Engineering, and Mathematics program (p. 9). A study conducted by Nagda demonstrated that students that participated in undergraduate research when

compared to non-participants had a higher level of retention (Nagda et al, 1998, p. 61). Lewin (1994) also states that minorities exposed to research experiences "could broaden the pool of individuals potentially interested in research positions" (p. 8). Although, studies indicate that minorities participating in research can benefit from this experience, there is a limited amount of studies that assess this issue in depth.

2.2 Assessing undergraduate research programs

Many programs exist to provide the opportunity for student to conduct research in an authentic scientific setting. Katkin (2003, p.24) reports that "a substantial number of universities have begun to realize that undergraduate research is a real asset" as such it has become an educational tool and important component of the science curriculum (Kardash 2002; Lopatto 2004). Although research programs have the potential to provide a number of advantages to students who participate in them, there is much to discover in terms of the elements and outcomes of performing research that make these experiences a success and examples of valid program evaluations are rare (Seymour, 2004, p. 493).

The need to evaluate research programs has been stated by several authors. In 2003, a report from the National Science Foundation stated "there are increasing pressures to assess whether educational activities, including research, actually improve student learning." (p.8). A literature review performed by Seymour (2004, p. 495) identified 9 reports of well-supported evaluations of research experiences and 45 reports in which the benefits of undergraduate research are simply stated but not adequately demonstrated. The evaluation of research programs would determine if the students are learning new concepts, and also determine what exactly is that they are learning when they engage in research. Hakim (1998, p. 189) also described the necessity to keep identifying how undergraduate research programs are accomplishing the goals

that they were set to reach; through assessment practices, data can be collected on the specific activities, initiatives, or actions that were employed in a research program and determine, which ones were successful for achieving the program goals and, which need to be modified or removed.

Assessment of research experiences is also necessary to justify the large amounts of resources that are expended in these hands-on opportunities (Hunter, 2006, p. 37). For example Felix (2008) reports that students from Saint Francis University enrolled in the National Science Foundation's Science, Technology, Engineering, and Mathematics Talent Expansion Program (STEP) received a $2,830 stipend plus $400 for textbooks, and housing. In addition, the award information for the STEP program states that institutions may receive from $500,000 to $2.0 million in the course of five years depending on the quality of the proposal and the number of students enrolled in the institution seeking the grant (NSF, 2006). Institutions that conduct research programs can spend large amounts of dollars to support research practices. Reporting the outcomes and advantages participants experience when they are involved in research programs, offer funding agencies documented evidence of the success of such programs and the importance to continue funding research experiences.

Assessment of research programs can be done in a myriad of ways. They can vary in who is being evaluated, and what ideas, elements, or skills are being measured. Some studies have a set of metrics that examine the benefits as perceived by students that take part in these experiences (Bauer 2003; Butler, 2007; Felix, 2008; Lopatto, 2004; & Page, 2004), while other studies focus on evaluating the opinions of faculty members along with that of the students (Gum, 2007; Hunter, 2006; Kardash, 2000; Lopatto 2003). Studies that evaluate both the faculty members and the students can provide a more complete focus of research experience since they

can determine and compare if students value or learn the same skills that faculty consider important for career success.

In terms of what is being evaluated to demonstrate that a research programs was successful, Kardash mentions that the most common methods to evaluate the success of an internship program involves the number of students that purse a graduate degree in science, the number of conferences in which students present their research, as well as the number of articles in which participants where co-authors (p.191). Other studies are more interested in discovering the students' perceptions of the personal abilities and skills learned or increased at the end of the program (Bauer, 2003; Landrum 2002; & Lopatto 2004, 2007). These can include gains in understanding of the research process, techniques used in the science profession, enthusiasm of the research process, enhancing critical thinking skills, the ability to integrate theory and practice, problem solving and communication abilities, among others. Investigations conducted by Alexander et al (1998), Butler (2007), and Lopatto (2007) analyze the students opinions of the components of the research programs such as mentor-student interactions, workshops provided, and their overall satisfaction with the experience.

The ideas expressed in this section encourage investigators to assess in detail programs that provide research experiences to university students. Such evaluations are greatly needed since there are limited amount of reports providing well-documented accounts on what makes research programs such a success. The evaluations that do exist provide a model that can guide researcher on how to design their own evaluation tools to determine the accomplishments of research programs.

2.3 Benefits of participation in research programs

The reports and articles collected for this literature review have provided a substantial description of the benefits that students achieve through their participation in research activities. Six categories of benefits are presented in this section. They include student perceived gains in skills and abilities, increased interest, clarification or confirmation of career choices, and increase understanding of how research is conducted and how scientist work.

Gains in skills and abilities that participants report can be divided in to those of a general category and those that are specifically useful for a career in sciences or research. Skills or abilities practical for a science profession are described by several researchers. Lopatto (2007, p. 301) describes in his research (pre-post test design) that students who participated in a summer research experience in biology report a significant difference ($p < 0.01$) in skills in science writing, interpretation of results, and learning lab techniques. A study conducted by Kremer and Bringle (1990, p. 3) shows that junior psychology majors that participated in a research experience perceived an improvement of skills in conducting a literature review, running statistical analyses, and writing the results and discussion sections of a paper in comparison to their peers that did not participate in the experience. More general abilities that are increased thorough research include critical thinking, problem solving, communication skills (Alexander, 1990, Landrum, 2002; & Seymour, 2004).

The literature also explains that research experience increase the interest, clarification, and/or confirmation of the participants' career goals. Research presented by Seymour et al (2004) identified that student who took part of an undergraduate research experience report that it has played a part in shaping their career plans. The study reports that some students were able to "confirm choices, or refine their ideas about, fields, subspecialties, or

methodologies that competed for their interest" (p. 524). An additional study performed by Hunter et al indicates faculty observe an increase in the interest and enthusiasm students display for their career after they have participated in a research program. The evaluation conducted by these researchers also indicates that "for this student group, we found that the role of UR was to increase students' interest in and probability of going on to graduate school, and to clarify or refine which field of interest to pursue"(Hunter et al, 2006, p. 61). Lopatto (2007, p. 299) also reports that participation in a research program increased or sustained an interest in students pursue of a postgraduate degree in science. Hurtado (2009, p. 199) describes on her research that in some cases minority students that are part of science research found a driving force to continue in their field.

Another benefit of research programs is that participants increase their understanding of how research is conducted and how scientist work. Hakim (1998, p. 191), comments that students how participate in undergraduate research experiences seem to have a better appreciation of the discipline, a better understanding of the language used, and learn more about the instruments and methods used in science. In the research performed by Hunter et al (2006, p. 46) to describe the gains from undergraduate research, the investigators noticed that 24% of the student they interviewed expressed they increased their knowledge in science research through their hands-on experience, they understand how to approach research problems, and have a better appreciation and how theory and concepts connect between/within sciences. The evaluation of participants of an UR by Lopatto (2007) also supports the claim that students have a better understanding of a career in science after participation. His research indicated that from 20 items rated by participants, the ones that received the highest scores were "Understanding of the research process in your field", and "Understanding how scientist work on real problems".

Seymour et al (2004), also agree that UR provide gains in knowledge and understanding of science and research work. In particular they identified that 15% of the students in their sample described a “deeper understand of aspects of their discipline, making connections between and within areas or science, and solidifying existing knowledge” (p. 515).

2.4 Chapter conclusions

Analysis of the literature points out to the problem of underrepresentation of minority groups in science. This issue is present in the number of minorities that are successfully completing degrees in the sciences as well as the number of them who are entering the workforce. Women also experience underrepresentation in several of the science areas, specifically in mathematics, and computer science. Efforts to increase the number of underrepresented groups include funding of research programs in these fields. However, in order to assert that participation in research do increase representation of minorities, it is important to evaluate this claim. Unfortunately, there is a limited amount of studies that focus on evaluating research program, and even fewer that focus on minority populations. The research that does exist points out benefits for participants in gains of skills and abilities, increased interest, clarification or confirmation of career choices, and increase understanding of how research is conducted and how scientist work. The literature also points out to the need to perform further evaluation of research programs to have a better understanding of how programs are achieving their goals.

Chapter 3: Methodology

3.1 Overview

Chapter two offered a synopsis of the concerns related to underrepresented minorities in scientific careers, the importance of evaluating undergraduate research programs, and the multiple benefits that students can gain by participating in research experiences. The ideas expressed in that chapter served as motivation for conducting this study which focuses on determining the outcomes that individuals may have experienced from their participation in IPY-ROAM. Four outcome areas are explored in this investigation: participants' career competencies, their professional and academic goals, their intentions to represent minorities in science, and their involvement in activities to provide knowledge of the polar regions

Opening the chapter is a detailed description of the recruitment and selection process of the individuals that participated in this program as well as a depiction of their demographic profile. The next section presents the research design used to address the purpose and objectives of this investigation along with the tools used to gather data from the participants. The final section of this chapter discusses the process in which the data was organized and the statistical approaches used to analyze this information.

3.2 Participant selection

Recruitment of participants for the IPY-ROAM program began in the spring of 2007 through several initiatives. The program's website (www.ipyroam.org) served as the primary method for advertising this polar research opportunity. Here, interested individuals could obtain detailed information regarding the components of the program, the application process and the eligibility requirements. In addition, emails promoting the program were sent to listservs of

various professional organizations such as the American Society for Limnology and Oceanography (ASLO) Multicultural Program, the Society for the Advancement of Chicanos and Native Americans in Science (SACNAS), and the Minorities Striving and Pursuing Higher Degrees of Success in Earth System Science (MS PHD'S) program. Announcements were also posted in the Ecological Society of America's SEEDS (Strategies for Ecology Education, Diversity and Sustainability) and SACNAS newsletters. Finally, program flyers were displayed throughout buildings of the UTEP campus to attract candidates from this institution.

Participation in the IPY-ROAM program was open to undergraduate and graduate student as well as middle or high school science teachers from around the U.S. However, eligibility to enter the program required that undergraduate applicants be entering their sophomore, junior, or senior years in the fall of 2007, graduate student had to be enrolled in a graduate program at a U.S. university and teachers needed to be employed in a minority-majority serving school. In order to bring diversity of thought and skills, participation in the IPY-ROAM program was open to individuals from all disciplines not just scientific fields. Still, each person interested in applying had to pass a thorough application process which included answering a five item questionnaire that requested participants to express the reasons for applying to the program, state their research interest area and why they are interested in this field, a description of previous experience or their personal strengths, ways in which participation would help them meet their academic and professional goals, and how they plan to impact others after their experience. Applicants also had to provide an official academic transcript to verify applicants' classification and GPA, and present one letter of reference. Teachers were asked to provide a copy of their teaching license. The recruitment process ended in early May of 2007 at which point the program

had received a total of 137 applications from all over the U. S. Of these applications, 61% came from undergraduate students, 24% from graduate students and 15% from teachers.

To ensure anonymity, each application was assigned a number based on the order in which they were received. Application details, including demographics, contact information, and GPA was entered into an Access database for organizational purposes. A committee consisting of twenty-three UTEP faculty and staff members was then assigned with the task of completing a blind review of the submitted questionnaires using an evaluation rubric created by the IPY-ROAM faculty members. The rubric was designed to keep a consistent measure among reviewers and provide a quantifiable score to classify the applicants in terms of the qualities that were desired for the program. This instrument was a series of 5-point Likert-scale items that evaluated a number of aspects from the answers provided in the candidates' questionnaires. Most of the items in the rubric consisted in assessing if the applicants were interested in developing their personal and/or professional goals through participation in the IPY-ROAM program and if they expressed an interest in providing outreach or educational activities upon their return. Other aspects present in the rubric consisted of evaluating if candidates clearly expressed their research area of interests, described a specific way they would impact minorities, displayed enthusiasm, portrayed an ability to work in groups, depicted if this would be a life changing opportunity, and if they were able to use proper grammar and language in the answers they provided. Each application was reviewed at least twice by the reviewers listed above, and once by an IPY-ROAM faculty member. Refer to Appendix A for a copy of the evaluation rubric.

An overall score for each applicant was calculated by determining their average score from the triple-blind evaluation rubric, and adding scores based on their GPA and on their potential to impact underrepresented minorities in the sciences. Their potential to impact

underrepresented minorities in the sciences was based on either their inclusion in an ethnic minority group or any statements from their questionnaire that indicated their desire to impact underrepresented minorities through the IPY-ROAM experience. Any candidate with a GPA below 3.0, with a low potential to impact underrepresented minorities (see above) or that received a rank from the ROAM faculty reviews in the lower 50% of applicants were automatically eliminated from selection. Furthermore, graduate student applicants whose thesis would not benefit from the experience were removed from competition. Applications were then, subdivided by undergraduate, graduate, and teacher applicants, and by desired focus group (aquatic ecology, terrestrial ecology, physical science, policy and education) and were ranked within these groups based on their evaluation score. The top ranking candidates in each group were accepted. In total twenty eight participants were selected, 16 undergraduates, 7 graduates, and 5 teachers. The majority of participants were female (71.4%) and the most common reported ethnicity was Hispanic (53.6%). See Figures 3.1 for a demographic profile of the selected candidates.

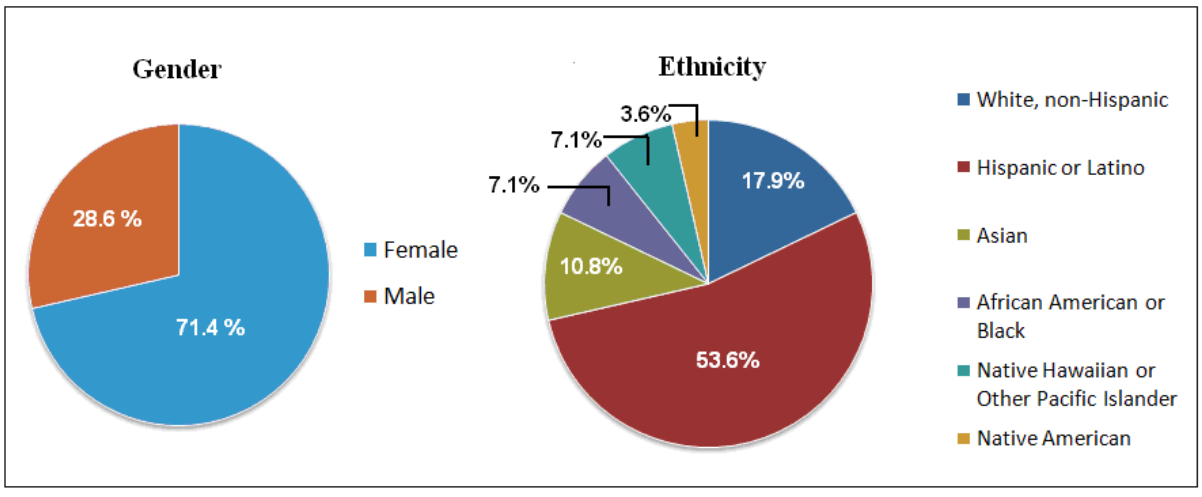

FIGURE 3.1 GENDER AND ETHNICITY OF IPY-ROAM PARTICIPANTS

3.3 Research Design

The design of this research employed an exploratory study model which consisted in one group pre-post test design with a one year follow-up. The subjects of this study (*n*=28) consisted of the individuals that took part in the IPY-ROAM experience. As participants were recruited through specific means and selected by the characteristics previously described, the individuals represent a nonrandom sample of the population.

In contrast with an experimental model, in an exploratory design the researcher does not manipulate any variables it rather focuses on exploring outcomes that have occurred due to a specific treatment. In the case of this study, the treatment is the participation and completion of the IPY-ROAM research program. The outcomes of the treatment are determined by comparing results of the pre-survey with results from the post-survey and follow-up survey. Outcomes explored in this study are the participants' self-reported career competencies, their professional and academic goals, their intent to represent minorities in science, and their involvement in activities to provide knowledge of the polar regions.

3.4 Data collection

Data collection for this study was performed with the use of three survey or assessment tools which participants were required to answer. The first survey was conducted at the beginning of the IPY-ROAM program and was used to collect the participants' opinions regarding interpersonal skills, their professional and academic goals, polar sciences, and intentions to provide community outreach upon their return from Antarctica. The second survey was applied at the end of the research trip to Antarctica and gathered information such as participants' view of their interpersonal skills, professional goals and plans to provide community service. In addition this survey contained a course evaluation section. The final

assessment tool used in this research was applied a year after participation in the IPY-ROAM program with the purpose of obtaining specific examples on what participants described they had achieved by taking part in this program. A full description of the survey instruments is presented in the next section. Prior to any data collection, the study was submitted and approved by the Institutional Review Board at the University of Texas at El Paso (Protocol #2382) and informed consent was obtained by participants before they were administered any of these assessment tools.

The three assessment tools were designed by an IPY-ROAM faculty member (V.L. Lougheed) and the author of this thesis (C.V. Garcia) using a non-systematic protocol with the purpose of acquiring a diverse amount of data useful for this investigation and other future studies. To identify the three different assessment tools, they were labeled pre-course, post-course, and follow-up survey. Each tool is composed of two main sections. The first part is the main part of the survey and it includes exploratory items that were used to determine the outcomes of the IPY-ROAM program. The second section of each survey is composed of demographic items used to determine the participants' gender, ethnicity, age group, marital status, highest level of education completed, and their college classification. For tracking and follow-up purposes the surveys were coded by the participants.

In the following subsections a more in depth description of each of the three assessment tools will be presented along with a report of the survey items that were used in this study.

3.4.1 Pre-course survey

The pre-course assessment tool was administered at the beginning of the IPY-ROAM program. Refer to Appendix B for a copy of this assessment tool. A total of 22 items are

included in this survey of which only 7 are used for the purpose in this thesis. This includes questions 4, 5, 6, 7, 14, 19 and 20.

Questions 4, 5, and 6 were used to obtain information for the first objective of this investigation; analyze the participants' points of view regarding career competencies. The questions analyzed the self-reported perceptions of possessing the career competencies listed, the importance of the competencies for their professional and academic success, and the degree they believed that participation in IPY-ROAM enhanced these competencies. These three questions were composed of a list of characteristics that represent career competencies important for professional success. Each of these competencies was rated by the participants using a 5-point Likert scale. For example, question 4 asked students if they currently see themselves as possessing the characteristics of: critical thinking skills, awareness of other cultures, leadership abilities, an outgoing personality, consideration for the feelings of others, ability to communicate effectively, problem solving abilities, work effectively with a diverse group of people, and perform with confidence in unfamiliar situations. The students had the choice to rate themselves from 1 (strongly disagree) to 5 (strongly agree). Questions 5 and 6 follow a similar format however; the list of characteristics or competencies varied from question to question. Of the competencies presented in questions 4, 5, and 6, only six are consistent in each of these items. These competencies are: critical thinking skills, awareness of other cultures, leadership abilities, abilities to communicate effectively, problem solving abilities and considering others people's feelings. Although, all of the competencies can provide useful information, only the data from these six constant competencies were used in this investigation to provide a well-built case of which career competencies are seen by students as having the strongest value.

The items used from this survey to determine participants' outcomes in terms of their professional and academic goals were questions 7 and 14. Question 7 is an open-ended item that asks participants to describe their primary professional and/or academic goals while question 14 inquires as to the maximum level of education they hope to achieve. The purpose of using this item was to have a more complete profile of participants' goals and to offer the possibility of comparing if there are any changes to these goals after completion of the program.

Questions 19 and 20 were used to assess how participants intended to impact minorities in science and shared their knowledge of the polar regions with professionals and/or non-professionals; objectives three and four of the purpose of this thesis. Both of these questions were designed so that participants provided and open ended answer and have a deeper understanding on what participants expect to perform in theses two areas after their participation in this program.

3.4.2 Post-course survey

The post-course assessment tool was administered to participants at the end of the IPY-ROAM program, on the flight home from Ushuaia, Argentina (Appendix C). A total of 17 items were presented in this instrument ranging from questions to analyze participants' interpersonal skills to providing a course evaluation. Of these only data from questions 1, 2, 3, 5, and 6 were used for this study.

Questions 1, 2, and 3 of this survey were designed to analyze the same ideas as questions 4, 5, and 6 from the pre-course survey. They asked participants to rate themselves in the areas of possessing the career competencies, the value they placed on the competencies for their personal growth and/or professional success and if participation in this program increased the career competencies. As described in the pre-course survey section, each of these questions contained a

list of characteristics that represented the career competencies the research team considered important for professional success. As in the previous survey, the participants had to rate their opinions of the competencies on a 5-point scale. The same six career competencies were selected from these items and were used as part of the data for assessing the first objective of this research. Placing the same items on both surveys made it possible to compare the values that participant reported at the beginning of the IPY-ROAM experience and at the end and determined if any significant changes occurred.

Questions 5 and 6 were used to assess the objective of reporting participants' professional and academic goals. The first of these two items was composed of a list of statements that were used to evaluate the degree of change that occurred due to taking part of this program. Statements that were examined addressed the participants' views on the extent that the IPY-ROAM program made them consider their career plans, changed their academic or professional goals, contributed to their professional development, help them gain experience for their current field of study job or profession, help them gain experience for their future job or profession, and motivate them to apply for future research experiences. The statement were rated using a 5-point Likert scale that ranged from 1 (very low) to 5 (very high). Question 6 provided a description of the maximum level of education students want to achieve, a question asked also on the pre-courser survey.

3.4.3 Follow-up survey

The final instrument used to assess the participants was a follow-up survey administered one year after the beginning of their participation in the IPY-ROAM program (Appendix D). The questions in this instrument were designed to provide descriptive accounts of actions participants have been involved in during the year following their involvement in IPY-ROAM in regards to

outreach activities or if they still considered the experience valuable for their professional or academic goals. A total of 10 items are presented in this assessment tool most of them are in an open-ended format to gather detailed information on the goal that was previously stated. The items selected for this research are questions 2, 3, 4, 8, and 9.

3.5 Data management and analysis

The data for this thesis is arranged in four sections that align with the objectives of this study and represent values in terms of descriptive statistics or inferential statistics. The software used for data analysis was the Statistical Package for the Social Sciences or SPSS version 15.0.

The first section of the results presents the information regarding the participants' self-reported views of their career competencies. Responses from items 4, 5, and 6 from the pre-courser survey were paired with items 1, 2, and 3 from the post-assessment tool. As previously mentioned, each of these questions contains a list of characteristics or competencies that participants rated using a 5-point scale (refer to Appendix B and C for the specific survey questions and list of characteristics used). The competencies from each item were paired as follows: Item 4_{pre} - Item 1_{post}, Item 5_{pre} – Item 2_{post}, and Item 6_{pre} – Item 3_{post}. It is important to restate that only the six career competencies of critical thinking skills, awareness of other cultures, leadership abilities, abilities to communicate effectively, problem solving abilities and considering others people's feelings are analyzed in this study.

Paired-sample t-tests were used to compare the mean values from the pre-assessment tool and the post-assessment tool questions to determine if any change in mean from a competency is due to chance or if there is a significant change. A paired-sample t-test assumes that the difference of the two means is normally distributed or does not severely depart from normality (Gravetter, 2004, p. 358). To test for normality, histograms with a bell curve were constructed

along with a measurement of skewness. According to Leech (2005, p. 21) "if the skewness is more than +1.0 or less than - 1.0, the distribution is markedly skewed and it would be prudent to use a nonparametric (ordinal type) statistic." For this study, if data did not meet a normal distribution, the non-parametric Wilcoxon rank-sum test replaced the parametric paired sample t-test. Once normality was established, the appropriate parametric or non-parametric paired-samples tests were performed to determine if the null hypothesis (H_0) of no difference between the two means exists or if the alternative hypothesis (H_A) that there would be a difference between the two means occurs. Alpha was established at 0.05.

The second section examined the professional and academic goals of the participants. A frequency analysis of the given responses was used to determine the participants' primary professional and academic goals (question 7, pre-course survey), maximum level of education they hope to achieve (item 14 pre-survey, and 6 post survey), and how participation in IPY-ROAM has impacted the participants' professional and academic goals (question 5, post-course survey and question 9, follow-up survey,).

Data gather from item 14 of the pre-survey, and item 6 of the post-survey reported the maximum level of education that participants hope to achieve were analyzed by obtaining the frequency of the responses participants provided from a list of possible answers. The frequencies of the answer of the pre-survey were compared with the answers provided from the post-survey to determine if there was a substantial change in the level of education that participants hope to obtain. Question 5 of the post-survey reports the ratings from a 5-point Likert scale on several statements, the results of this question were submitted to descriptive statistical analysis that provided frequency reports, means, and standard deviations.

The remaining items of this section constituted open-ended questions. Analyzing the open ended question of the survey is a complex task. Swift (1996, p. 166) suggest that if frequency analysis of open ended responses is desired for an investigation – such as this one- it is necessary to code the data. This process entails transforming the raw data into numerical values or codes which then analyze it through the use of a computer (Kumar, 1999, p. 203).

A code list for the open-ended questions of the IPY-ROAM survey was created by reading the responses provided and re-writing the answers in a more generalized form. Each of these generalized answers was analyzed for similar meanings and combined into categories. Each category received a numerical value; a value of '0' was used to identify questions that had no response. This process was done on each open ended question. The next step consisted in coding the actually data from the responses. In many cases the participants' answers fell into several categories. A response that was unusual and could not fit into any of the assigned categories was included in a category named 'other' which represented the value of 0. Finally, the codes present in each response were entered in an SPSS data sheet and a frequency analysis was performed to report the results. The responses from these questions are nominal, meaning that this data had no specific value or order, which is why no other descriptive statistics were run.

The third section of the results present the data acquired to establish the participants' intent to represent minorities in science. Responses presented in this section include question 20 from the pre-assessment tool, and questions 3 and 4 from the follow-up tool. The fourth result section discusses the plans that individuals and the actual activities that participants did in order to provide knowledge of the polar regions to other people. Items used to collect data consist of pre-course item 19, and follow-up items 3 and 8. All of the questions employed in result section

3 and 4 provided short descriptive answers which were analyzed with the same method that was previously described for the open-ended responses of section 2.

Chapter 4 Results

The purpose of this study consisted in determining the outcomes that individuals experienced from their participation in IPY-ROAM. Four outcome areas were explored in this investigation: Participants' self-reported views of their career competencies, their professional and academic goals, their intentions to represent minorities in science, and their involvement in activities to provide knowledge of the polar regions.

The results from this investigation are presented in this chapter and organized in accordance to the four outcome areas that were explored. Section 4.1 displays the data from the participants' self-reported views of their career competencies, which were analyzed through inferential (paired-sample tests and/or Wilcoxon tests) statistics. Section 4.2 contains the responses participants provided about their professional and academic goals. Section 4.3 presents information with regard to the intentions or ideas that respondents had in order to represent minority groups in their field and section 4.4 answers concerning their involvement in activities to provide knowledge of the polar regions. The responses provided in section 4.2, 4.3, and 4.4 were examined through frequency and/or descriptive statistical analysis. Presentation of the data in this chapter consists of a series of tables that summarize the information obtained from the assessment tools. A full narration of the outcomes and their significance will be discussed in the following chapter.

4.1 Participants' self-ratings of their career competencies

Exhibited in this section are the results from a set of three 5-point Likert-scale items (asked at the beginning and end of the IPY-ROAM program) reporting the participants' opinions of their career competencies in terms of: (1) Their views of possessing the competencies, (2) the competencies they believe are important for their personal growth and/ or professional success,

and (3) the competencies they considered to improve due to participation in IPY-ROAM. The career competencies assessed by each item were: Competency 1 = critical thinking skills, competency 2 = awareness of other cultures, competency 3 = leadership abilities, competency 4 = ability to communicate effectively, competency 5 = problem solving abilities, and competency 6 = consideration of other peoples' feelings. Although other characteristics or competencies were investigated in the IPY-ROAM surveys, only the results of these are reported in this thesis.

The tables presented in each of the following subsections are arranged first by the results of the skewness statistical analysis used to determine the normal distribution of the scores, second by the results from descriptive statistics providing the group mean (*M*) and standard deviation (*SD*) of the ratings, and finally by the results from the inferential analysis performed on the data. Results tables also indicate the sample size of the population that was surveyed (n), the degrees of freedom (*df*) and provide the values for the t-test (*t*) or Wilcoxon test (*Z*) that were ran on the data.

Cases which contained missing values on either the pre-course or post-course were excluded from the evaluation process. Furthermore, the exact question asked and the values assigned to the 5-point scale will be described on each of the subsection.

4.1.1 Participants' views of possessing the career competencies

Participants responded to the pre-course and post-course survey item stating "I currently see myself as possessing the following characteristics." They rated each of the characteristics provided in the survey, including the six career competencies previously described, using a 5-point scale ranging from 1 (strongly disagree) to 5 (strongly agree). Table 4.1 indicates the skewness statistics of the distributions for the difference between the pre- and post-survey competency scores. These values were used to determine which inferential test would be used on

the results of the competencies in this question. Based on the normality results, paired-sample t-test were carried out on the responses from competencies 1, 2, 4, 5, and 6 while data from competency 3 was examined with the non-parametric Wilcoxon test.

These results were used to determine if there was a difference between the responses at the beginning and at the culmination of the IPY-ROAM program. Results from the test ran on these competencies indicate a significant difference ($p < 0.001$) between the pre-course and post-course means of all the competencies examined. Table 4.2 summarizes the descriptive statistics for each competency, and indicates that each of these significant differences involved an increase in the mean values reported for all of the six career competencies from the post-course survey in comparison to the reported means of the pre-course survey. Table 4.3 describes the specific values obtained from these tests. Table 4.4 offers the results obtained from the Wilcoxon test which was performed for the difference of means of the career competency of leadership abilities which did not displayed a normal distribution.

Table 4.1 Skewness statistics for the distributions of the differences in participants' self-ratings of possessing the competency

Competency	*n*	Skewness Statistic
Critical thinking skills	26	0.64
Awareness of other cultures	27	0.12
Leadership abilities	27	1.13
Ability to communicate effectively	26	-0.05
Problem solving abilities	27	-0.42
Consideration for other peoples' feelings	27	0.63

Table 4.2 Descriptive statistics of participants' pre-post self-ratings of possessing the competency

Competency	*n*	Pre		Post		Mean Difference
		M	*SD*	*M*	*SD*	
Critical thinking skills	26	3.27	0.67	4.62	0.57	1.35
Awareness of other cultures	27	2.81	0.83	4.33	0.73	1.52
Leadership abilities	27	3.04	0.90	4.26	0.66	1.22
Ability to communicate effectively	26	3.50	0.76	4.58	0.76	1.08
Problem solving abilities	27	3.11	0.70	4.41	0.69	1.30
Consideration for other peoples' feelings	27	3.30	0.67	4.63	0.56	1.33

Table 4.3 Paired-samples t-test of the differences in participants' self-ratings of possessing the competency

Competency	*n*	*t* value	*df*	Sig. (2-tailed)
Critical thinking skills	26	10.92	25	< 0.001
Awareness of other cultures	27	8.83	26	< 0.001
Ability to communicate effectively	26	8.75	25	< 0.001
Problem solving abilities	27	10.07	26	< 0.001
Consideration for other peoples' feelings	27	9.44	26	< 0.001

Table 4.4 Wilcoxon test of the difference in participants' self-rating of possessing leadership abilities

	n	*Z*	Sig. (2-tailed)
Leadership abilities	27	-4.62	< 0.001

4.1.2 Competencies important for personal growth and professional success

Participants provided a response to the pre-course and post-course question asking "Which of the following skills do you think are important for personal growth and/or professional success?" They rated each of the skills provided including the career competencies that are of interest for this thesis project on a 5-point scale ranging from 1 (least important) to 5 (most important). The skewness statistics for the distribution of the difference between the pre and post scores of the six competencies studied are displayed in Table 4.5. No statistical analysis could be performed for the competency of critical thinking skills because the standard error of the differences is zero. Competencies 2 and 6 display a skewness statistics with in normality and were analyzed using the paired-sample t-test while the Wilcoxon test was performed for competencies 3, 4, and 5.

The results provided by these items were used to determine if any significant change existed between the participants' views of the skills important to them for their personal and professional success at the beginning and at the conclusion of the IPY-ROAM experience. Results from the paired sample t-test and the Wilcoxon tests indicate there is a significant difference ($p < 0.001$) between the responses provided from the pre-course survey and the post-course survey on all the competencies analyzed. Table 4.6 summarizes the descriptive statistics performed on each of the competencies and illustrates that these significant results are due to an increase in the mean values of the post-course survey responses in comparison to the mean results of the pre-course survey responses. Specific results from the paired sample t-test are reported in Table 4.7 and results from the Wilcoxon test are reported in Table 4.8

Table 4.5 Skewness statistics for the distribution of the difference in participants' self-ratings regarding the importance of the competency for personal growth and/or personal success

Competency	*n*	Skewness Statistic
Critical thinking skills	26	*
Awareness of other cultures	27	-0.19
Leadership abilities	27	-1.04
Ability to communicate effectively	27	-1.44
Problem solving abilities	27	2.19
Consideration for other peoples' feelings	25	-0.33

Note. * No statistical analysis could be performed on the critical thinking competency because the standard error of the differences is zero.

Table 4.6 Descriptive statistics of participants' pre-post self-ratings regarding the importance of the competency for personal growth and/or personal success

		Pre		Post		
Competency	*n*	*M*	*SD*	*M*	*SD*	Mean Difference
Critical thinking skills	26	3.92	0.27	4.92	0.27	1.00
Awareness of other cultures	27	3.52	0.64	4.63	0.56	1.11
Leadership abilities	27	3.52	0.58	4.63	0.74	1.11
Ability to communicate effectively	27	3.78	0.42	4.85	0.46	1.07
Problem solving abilities	27	3.63	0.69	4.81	0.48	1.19
Consideration for other peoples' feelings	25	3.16	0.99	4.44	1.04	1.28

Table 4.7 Paired-samples t-test of the difference in participants' self-ratings regarding the importance of the competency for personal growth and/or personal success

	n	*t value*	*df*	Sig. (2-tailed)
Awareness of other cultures	27	7.69	26	< 0.001
Consideration for other peoples' feelings	25	6.53	24	< 0.001

Table 4.8 Wilcoxon test of the difference in participants' self-ratings regarding the importance of the competency for personal growth and/or personal success

	n	*Z*	Sig. (2-tailed)
Leadership abilities	27	-4.44	< 0.001
Ability to communicate effectively	27	-4.60	< 0.001
Problem solving abilities	27	-4.66	< 0.001

4.1.3 Career competencies improved due to participation in IPY-ROAM

Participants responded to the pre-course and post-course survey item "I believe that the opportunities provided for me by the IPY-ROAM program will help me …" Each respondent rated a list of statements including the following: Enhance my critical thinking skills, increase my awareness of other cultures, improve my leadership skills, increase my problem solving abilities, learn new ways to effectively communicate with others, and increase my consideration of other peoples feelings, which correspond to the six competencies studied. These statements were rated on a 5-point scale ranging from 1 (strongly don't believe) to 5 (strongly believe). The skewness statistics was computed for the results of the six competencies to determine the normality of the data. See Table 4.9. Data from the skewness statistic indicated that the distribution of the scores from the competencies analyzed fall with in the acceptable range for

normality; therefore, the data from each of the six competencies was analyzed throughout paired sample t-test.

The responses to these items were used to determine if there was a significant change in the participants' opinions regarding the potential of the IPY-ROAM program to help them improve the competencies listed at the beginning of the program and their opinions of actually improving these competencies after participation in the program. The results from the paired sample t-test indicate a significant difference ($p < 0.001$) in the mean values of each of the competencies studied. Descriptive statistics of the competencies summarized in Table 4.10 show that each of the significant difference is due to an increase in the mean values of the responses from the post-course survey. Table 4.11 presents the results of the paired sample t-test.

Table 4.9 Skewness statistics for the distributions of the differences in participants' self-ratings that opportunities provided by IPY-ROAM will help them improve the competency

Competency	*n*	Skewness Statistic
Critical thinking skills	27	-0.74
Awareness of other cultures	27	-0.32
Leadership abilities	27	0.58
Ability to communicate effectively	27	-0.22
Problem solving abilities	25	-0.29
Consideration for other peoples' feelings	27	-0.47

Table 4.10 Descriptive statistics for participants' pre-post self-ratings that opportunities provided by IPY-ROAM will help them improve the competency

		Pre		Post		
Competency	*n*	*M*	*SD*	*M*	*SD*	Mean Difference
Critical thinking skills	27	3.44	0.64	4.37	1.04	0.93
Awareness of other cultures	27	3.70	0.61	4.44	0.80	0.74
Leadership abilities	27	3.00	0.68	4.22	0.75	1.22
Ability to communicate effectively	27	3.41	0.64	4.41	0.93	1.00
Problem solving abilities	25	2.76	0.83	4.16	0.99	1.40
Consideration for other peoples' feelings	27	3.37	0.79	4.30	0.72	0.93

Table 4.11 Paired-sample t-test for the differences in participants' self-ratings that opportunities provided by IPY-ROAM will help them improve the competency

Career Competencies	*n*	*t value*	*df*	Sig. (2-tailed)
Critical thinking skills	27	4.65	26	< 0.001
Awareness of other cultures	27	4.08	26	< 0.001
Leadership abilities	27	7.12	26	< 0.001
Ability to communicate effectively	27	5.01	26	< 0.001
Problem solving abilities	25	6.06	24	< 0.001
Consideration for other peoples' feelings	27	4.65	26	< 0.001

4.2 Participants' professional and academic goals

Data presented in this section aims in reporting the outcomes of responses given by participants on the items that are related to their professional and academic goals. The first subsection reports the participants' primary professional and academic goals. Presented next are the maximum level of education that participants aspire to attain. This is followed by a list of descriptions on how participation in IPY-ROAM has impacted or supported the participants' personal and/or professional life. The final subsection reports the mean scores for six statements rated by the participants on a 5-point scale on how the IPY-ROAM program has made them reconsider their career plans, changed their academic or professional goals, contributed to their professional development, helped them gain experience for their current field of study, job of profession, helped them gain experience for their future job or profession, and motivated them to apply for future research experiences. The data presented in each of the following subsections is summarized in tables that report the frequency of a given response under the assigned categories as well as the percentage of participants that provided a response under the categories.

4.2.1 Goal description

In order to acquire a more in-depth profile of the IPY-ROAM program participants, they were asked at the beginning of this experience to report their primary professional and academic goals. Description of future goals was provided by the entire sample group (N= 28). Table 4.12 presents the answers given by the participants grouped into six categories: obtain a graduate degree, conduct research in my field of study, work and/or become more qualified in my profession, become a role model, become a science or polar educator, and help myself or others incorporate more science in the classroom.

The majority of the participants (60.7%) expressed that one of their goal was to obtain a graduate degree. Participants that expressed a specific type of degree described a desire to obtain a Masters degree, a Ph.D. or a combination of both. The second most common answer (35.7 %) provided by the participants was an interest in conducting scientific research and working or becoming more qualified in their profession. Specifically, three individuals directed stated they were interested in becoming more involve in polar research. IPY-ROAM participants also expressed and interest in becoming science educators (28.6%) including two who have the intention to become university professors. The least common responses of professional and academic goals were given in the categories of become a role model (7.1%) and help others or myself incorporate more science in the classroom (7.1%).

Table 4.12 Participants' self-reported descriptions of professional and academic goals at the beginning of IPY-ROAM

Professional and academic goals	Frequency	Percent
Obtain a graduate degree	17	60.7
Conduct scientific research	10	35.7
Work and/or become more qualified in my profession	10	35.7
Become a science or polar science educator	8	28.6
Become a role model	2	7.1
Help others or myself incorporate more science in the classroom	2	7.1
Not applicable	1	3.6
Total	50	

Note. Percent is based on the number of responses in a category divided by the total number of participants who responded to the question.

4.2.2 Maximum level of education expected to achieve

Students were asked to report in both the pre-courser and post-course survey the maximum level of education they hope to achieve. Information provided on these questions was used to determine if participants display a change in their answer at the completion of the IPY-ROAM program in comparison to the answer provided at the beginning of the program. In the survey questions, participants were given the option to choose one of the following categories: Bachelors, Professional certification, Masters, Doctorate, or other professional degree.

Frequency analysis of the answers reported at the beginning of the IPY-ROAM program indicate that out of 28 participants, the majority (75.0%) expressed that they wish to purse a Doctoral education, 21.4% a Masters degree and only 3.6% a Bachelors degree. At the end of the IPY-ROAM experience 26 participants answered this item and showed that 73.1% of respondents wish to obtain a Doctoral degree, 23.1% a Masters degree and 3.8% only a Bachelors degree. Moreover, a paired examination of the pre- and post-survey responses from each of the participants illustrated one participant who had previously reported a Masters degree changed his/her answer at the end of the IPY-ROAM program to a Doctorate degree, and a participants who had previously reported a hope to obtain a Doctorate degree changed his/her response to a Masters degree at the culmination of the program. With these two exceptions, there was no change in the maximum level of education IPY-ROAM participants expect to achieve.

4.2.3 Impact of IPY-ROAM on participants' personal and professional goals

To gain insight on how the IPY-ROAM program influenced participants' personal and professional goals, they were asked in the one year follow-up survey to describe their opinions of how participation in this program impacted their personal/professional goals. Responses from 24 participants were arranged into 10 categories and presented in Table 4.13. Participants' most

common responses indicate that participation in the IPY-ROAM program has increased their confidence to achiever their academic or professional goals (41.7%), increased their interest in their profession (29.2%), while 25.0% expressed that participation in this program motivated them to perform more research. Other impacts expressed are a gain in skills useful for the participants' profession (16.7%), useful network connections (12.5%), and an increased appreciation of the polar regions (12.5%), among others.

Table 4.13 Participants' self-reported descriptions of the impact of IPY-ROAM on their personal and/or professional life

Category	Frequency	Percent
Increased confidence to achieve academic/professional goals	10	41.7
Increased interest in their profession	7	29.2
Offered motivation to perform more research	6	25.0
Gained skills and experience for my profession	4	16.7
Provided useful network connections	3	12.5
Increased appreciation of the polar regions	3	12.5
Offered a sense of pride to family	3	12.5
Increased involvement with the community	3	12.5
Becoming more mature individuals	2	8.3
Provided a life changing experience	2	8.3
Total	43	

Note. Percent is based on the number of responses in a category divided by the total number of participants who responded to the question.

4.2.4 Participants' ratings on statements influenced by IPY-ROAM

The final item reported on this section aims to evaluate the degree of influence that the IPY-ROAM program had on six professional statements presented after the program was

completed. Specifically, participants were asked in the post-course survey "to what extent has the IPY-ROAM program …" (1) made your reconsider your career plans, (2) changed your academic or professional goals, (3) contributed to your professional development, (4) helped you gain experience for your current field of study, job, or profession, (5) helped you gain experience for your future job or profession, (6) motivated you to apply for future research experiences. Other statements were present on this question; however, only these relate to the outcomes investigated in this study. Participants rated their opinions of the statements using a 5-point scale that ranged from 1 (very low) to 5 (very high).

Results provided in Table 4.16 display the means and standard deviation of the responses provided by the participants in regard to each statement. The means displayed for statement 1 (M = 2.81) and statement 2 (M = 2.26), indicate that participants show a low degree of influence from the IPY-ROAM program on the students reconsidering or changing their academic or professional goals; in contrast, statement 3, 4, 5, and 6 report a mean value higher than 4.00. These responses show that participants have a high degree of agreement on the extent IPY-ROAM has contributed to their professional development, helped them gain experiences for their current and future job or profession, and has motivated them to apply for future research experiences.

Table 4.16 Descriptive statistics for participant' self-ratings the extent to which IPY-ROAM has influenced the statements

Statement	*n*	*M*	*SD*
Made you reconsider your career plans	27	2.81	1.62
Changed your academic or professional goals	27	2.26	1.29
Contributed to your professional development	26	4.58	0.70
Helped you gain experience for your current field of study, job, or profession	27	4.30	1.07
Helped you gain experience for your future job or profession	26	4.46	0.99
Motivated your to apply for future research experiences	27	4.52	0.85

4.3 Participants' intent to represent minorities in science

One of the goals of this investigation was to report the outcomes the IPY-ROAM program had on the participants' intentions to represent minorities in science and to determine if these intentions were accomplished. The measures used to determine this point was through the analysis of responses provided by a series of open-ended questions presented in the pre-course survey and at the follow-up survey. Results of these items are presented in the following section in the form of frequency tables.

Presented first in this section are the proposed and carried out activities that participants expressed they performed to represented minorities in science, followed by the participants' points of view describing if programs like IPY-ROAM have the possibility of increasing representation of minorities. It is important to remember that this study did not assess if the program increased the number of minorities in science, the study just reports the intentions and opinions that participants have regarding this issue.

4.3.1 Proposed and carried out intentions

Participants provided their response at the beginning of the IPY-ROAM experience to the question “How do you intend to impact underrepresented minorities in your field through your participation in the IPY-ROAM program?” Answers gathered by the 28 respondents were arranged into six categories. During the start of this research program, participants already expressed a deep interest in carrying out presentations to minorities (71.4 %) and/or becoming role models to other minorities (39.3%). A smaller percent of students reported they wished to participant in minority focus professional organizations, work in fields in which minorities are underrepresented, and even one individual expressed developing a similar program like this one. Refer to Table 4.17.

In order to determine if any of these intentions were actually carried out by the individuals, they were asked the following question in the one year follow-up survey: “Since your participation in the IPY-ROAM program, in what way(s) have you reached out to or represented minorities in your field?” Response categories, frequencies, and percentages are presented in Table 4.18. A total of 24 participants provided and answer to this question. One year after participation in this research program, 41.7% of the individuals that responded to the survey expressed that they had provided presentations to minorities about their personal experiences in an effort to increase representation of underrepresented groups in the sciences. In addition, 25.0% of the participants describe that they consider themselves role models to other minority science students. These two categories in both the intentions and the activities carried out to represent minorities provide the most frequent responses by students. Other activities carried out by students included informing others that there are research opportunities for minorities

(12.5%), and 8.3% of respondents indicate that they have encourage peers to apply to programs that are similar to IPY-ROAM.

Table 4.17 Participants' self-reported descriptions of the proposed intentions to represent minorities.

	Frequency	Percent
Give presentations to minorities regarding the research experience	20	71.4
Become a role model to other minorities	11	39.3
Encourage my peers to apply for similar programs	2	7.1
Participate in professional organizations that represents minorities	2	7.1
Work in fields in which minorities are underrepresented	1	3.6
Develop a similar program like IPY-ROAM	1	3.6
Total	37	

Note. Note. Percent is based on the number of responses in a category divided by the total number of participants who responded to the question.

Table 4.18 Participants' self-reported descriptions of actions carried out to represent minorities in science.

	Frequency	Percent
Give presentations to minorities regarding the research experience	10	41.7
Become a role model to other minorities	6	25.0
Inform others that there are research opportunities for minorities	3	12.5
Encourage my peers to apply for similar programs	2	8.3
Work in fields in which minorities are underrepresented	2	8.3
Participating in professional organizations that represents minorities	1	4.2
Obtain a grant to create a summer program for teen girls	1	4.2
Total	25	

Note. Note. Percent is based on the number of responses in a category divided by the total number of participants who responded to the question.

4.3.2 Opinions about research programs' ability to increase minorities in science

Participants were asked to explain in the follow-up survey if they taught programs like IPY-ROAM can increase the participation of minorities in the sciences. Out of the 24 participants that responded to this question, 91.6 % agreed that programs like IPY-ROAM have the potential to increase the representation of minorities in science. Responses were further analyzed to determine in which ways participants believed the programs could assist minority individuals that are part of a research experiences similar to IPY-ROAM.

Answers provided by the respondents were varied and no major clusters of answer were provided. The highest frequency reported in a category was five representing approximately one quarter of the individuals that answered this question. The descriptions provided indicate that participants believe that programs like IPY-ROAM can provide motivation to individuals that take part in these programs so they can achieve higher goals (20.8%), can provide a unique research experience (20.8%), offers skills necessary for their professional development (20.8%), persuade students to purse a career in science (16.7%), can encourage other minorities to apply to similar programs, among others. See Table 4.19

Table 4.19 Participants' self-reported descriptions of what programs like IPY-ROAM can provide to increase minorities in science.

Category	Frequency	Percent
Gives participants motivation to reach higher goals	5	20.8
Provides a unique research experience	5	20.8
Offers skills necessary for the profession development	5	20.8
Persuades students to pursue a career in science	4	16.7
Encourages other minorities to apply to similar programs	4	16.7
Offers financial support that makes possible the participation of minorities	4	16.7
Creates role models for other minorities	3	12.5
Grants and opportunity to share this experience with others through outreach	3	12.5
Total	33	

Note. Percent is based on the number of responses in a category divided by the total number of participants who responded to the question.

4.4 Activities to provide knowledge of the polar regions

This section reports the information from the pre-course and one year follow-up survey items that investigate the ways in which participants provided knowledge of the polar regions to others. This information provides a detail account of what activities were carried out and to who they were presented, particular examples will be included in the discussion section of the following chapter.

Answers analyzed in this section are the reports from three open-ended questions. Results are displayed in the form of frequency tables that represent the participants' responses to a particular item. Presented first is a description of the participants' plans they had to carry out educational outreach at the beginning of the IPY-ROAM experience, followed by this the activities they reported to have performed in order to provide outreach to the members of their

community, and finally expresses in this section are the activities participants have taken part of to share their knowledge of the polar regions to professionals in their field.

Responses provided by the participants in regard to how they planed to share they information they gained through this experience with their community are described in Table 4.20. Results indicate that out of 28 respondents, 64.3% had the intention to provide presentation to K-12 students, 46.4% to adults in the community, 39.3% to peers and other professionals, while 14.3% wanted to share their experiences with their family and/or with the media

In the one year follow-up survey items, participants were asked to describe what educational outreach they had taken part of. They were also asked to provide the number of activities they had taken part of and an approximate number of individuals they had presented to. Although reported by the participants, the researcher decided no to run frequency analysis on the number of activities and the total number of individuals who received outreach due to the fact that participants from El Paso paired up to perform most of the presentations and duplication of the number of activities and individuals would inevitably occur. Of the 28 participants, only 24 responded to this question. The types of activities in which participants took part of to provide education outreach is described in table 4.21. One year after the completion of the IPY-ROAM more than half (58.3%) of the participants had presented their experience to K-12 students, and 41.6% had done presentations to their peers or other professionals. These two categories correlate to the intentions they had expressed at the beginning of the program. While 16.7% of the participants presented to adult members of their community, this percent does not match with the intentions (46.4%) reported in the pre-course survey.

Table 4.20 Frequency analysis for participant' self reported plans to carry out educational outreach

Categories	Frequency	Percent
Presenting at K-12 schools	18	64.3
Presenting my experience to adults in the community	13	46.4
Presenting to peers and other professionals	11	39.3
Sharing with family and friends	4	14.3
Sharing information with the media	4	14.3
Developing educational materials	3	10.7
Writing a children's book	2	7.1
Total	55	

Note. Percent is based on the number of responses in a category divided by the total number of participants who responded to the question.

Table 4.21 Frequency analysis for participant' self reported educational outreach completed one year after participation in IPY-ROAM

	Frequency	Percent
Presenting at K-12 schools	14	58.3
Presenting to peers and other professionals	10	41.6
Presenting my experience to adults in the community	4	16.7
Sharing information with the media	3	12.5
Sharing with family and friends	2	8.3
Total	33	

Note. Percent is based on the number of responses in a category divided by the total number of participants who responded to the question.

When students were asked to state if they had presented in any conference or published in a journal, 17 students provided affirmative answers and only 7 indicated that they had not participated in any conference or published. The answers were further analyzed and out of the 17

participants, 16 stated that had made presentations at least once in a conference and one participant commented publishing an article in a scientific newsletter. In addition, 7 out of 17 participants presented at more than one conference in the year 2008. Three out of these conferences were at a national level. Records from a frequency analysis indicate that 12 participants presented in the Society for the Advancement of Chicanos and Native Americans (SCANAS) national conference (Salt Lake City, UT), 8 presented posters at The Ecological Society of America (ESA) National Meeting (Milwaukee, WI), 5 presented in the SACNAS El Paso Chapter research expo, while one teacher presented in the National Science Teacher Association. (NSTA). At these conferences, participants shared the findings from their Antarctica research projects, one student described an outreach initiative he created known as promise banners, and the teacher presented the development and use of lesson plans regarding the polar regions.

4.5 Chapter conclusions

The results that were presented in this section evaluated responses from four categories: participants' career competencies, their professional and academic goals, their intent to represent minorities in science, and their involvement in activities to provide knowledge of the polar regions. Analysis of the data from each of the categories was used to determine the outcomes that individuals experience from their participation in IPY-ROAM. The data employed for this study was collected from survey tools applied at the beginning, end, and one year after participation in this unique research program.

After completion of IPY-ROAM, statistical analysis indicate that participants increase their views of them possessing the competencies of critical thinking, awareness of other cultures, leadership, communicate effectively, problem solving, and consideration of other people

feelings. Furthermore, they give more value to these competencies for the personal and professional success and they view that the opportunities provided by the IPY-ROAM program has help them increase the competencies described.

Outcomes from investigating the participants' professional and academic goals determined that respondents have a diversity of objective in life; the majority (60.7%) the list obtaining a graduate degree, either a Masters, Doctorate, or a combination of both. While other common goals include performing scientific research (35.7%), and 28.6% stated that they want to become science instructors including university faculty members. This research also discovered that at the beginning of this IPY-ROAM program participants already aspired to obtain a graduate degree (96.4%) and in general they continued to express the same desire at the culmination of the experience. In addition, it appear most of the individuals that took part of IPY-ROAM had already establish their professional and academic goals, given than the majority do not state that the program has made them change or reconsider the goals they had set prior to this experience. Nevertheless, 41.7% of participants do describe that this program has increase their confidence to achieve their professional and academic goals, and in general all of the participants agree that IPY-ROAM has contributed to their professional development, helped them gain experience for their current or future profession, and has motivated them to apply to future research experiences.

Analysis performed on the intentions that participants had to represent minorities in their field indicate that at the beginning of this research programs, they had planed to provide presentations to minority groups (71.4%), become role models (39.3%), among other intentions. One year after the completion of the program 41. 7% had reported doing presentations regarding their research experiences to minority groups, and 25.0% of participants already view themselves

as role models to other minorities studying science. Although this investigation was not able to report if the IPY-ROAM program increased the representation of minorities in science, participants did expressed that program like IPY-ROAM programs are able to increase the participation of minorities in the sciences by providing motivation to reach high goals, offering skills for professional development, motivating student to purse a career in science, offer financial support to minority participants, among others.

One of the goals of the IPY-ROAM program was to increase awareness and knowledge of the polar regions. Although, this particular aspect was not formally assessed due to the fact that no test were performed on the community to determine if they indeed have a higher knowledge of the polar regions, the research designed did allowed the investigator to establish the participants' intentions to provide knowledge to their community and determine the approach that was used to carry out this activity. Results from the pre-courser survey indicate that all of the 28 participants expressed one or several ways in which they were going to provide knowledge of the polar regions to others. In particular 64.3% of the 28 individuals surveyed had expressed and interest in presenting to K-12 students and 39.3% wanted to share their experience with peers and other professional members. At the end of the experience these two categories also received a high number of responses by participants. Out of 24 respondents from the follow-up survey, 58.3% commented that they had indeed presented at least once to K-12 students and 41.6% to peers and other professionals. What is more interesting is that 17 participants stated they had presented their research in local and/or national conferences and 7 of these had presented in more than one conference. In conjunction the activities provided by the IPY-ROAM participants offered thousands of children and adults an insight of what Antarctica is and what scientist study in this continent.

Chapter 5: Discussion and conclusions

The study presented in this thesis analyzed four outcome areas that individuals experienced when participating in IPY-ROAM: 1) participants' self-reported views of their career competencies, 2) their professional and academic goals, 3) their intentions to represent minorities in science, and 4) their involvement in activities to provide knowledge of the polar regions. The program evaluation was conducted by analyzing the responses from participants to a series of surveys that were administered at the beginning, the conclusion, and one year after participation in the program. The use of a one group pre-post design gave the opportunity to compare the data collected at the beginning and at the end of the IPY-ROAM program, while the one year follow-up survey gathered specific descriptions on how the program has impacted participants and reported the achievements they have accomplished. Data collected for this study was analyzed either by frequency analysis, descriptive statistics, and/or paired sample parametric (t-test) or non-parametric (Wilcoxon) tests.

The sections presented in this final chapter will discuss the results of each of the areas analyzed where you will find quotes extracted from the open ended items that provide a rich insight into the personal experiences of the participants, the limitations of this study, implications and recommendations for future research, and the conclusions of this investigation.

5.1 Participants' career competencies

A set of three different items evaluated the opinion participants had in regard to critical thinking, awareness of other cultures, leadership abilities, ability to communicate effectively, problem solving abilities, and consideration of others peoples feelings at the beginning and end of the IPY-ROAM program. The first item explored participants' views of possessing the stated competencies, the next question analyzed the self-reported opinions that these characteristics are

important for participants' personal growth and/or professional success, and the final item intended to discover if participants believed that this program improved the six career competencies.

Outcomes of this analysis indicate that at the culmination of the IPY-ROAM program, participants view themselves as having a higher their level of the six career competencies and place more value in the importance of these competencies for their personal and professional success, with the exception of the competency of critical thinking which was not possible to analyze. What is more important is that participants agree that the increase in the six career competencies was due to participation in the IPY-ROAM program.

First-hand description provided by the participants help illustrate the importance that these career competencies have for their professional success. A female graduate student stated the following:

> Critical thinking, leadership ability and communicating with others are by far the most important qualities I believe necessary to be a successful researcher. If you are able to think critically then there is no problem that cannot be solved or worked through when in the right mind set. Being a good leader is also important not only in the science but in life. Being a good leader also means that you can not only give good advice but take advice at any given time. Working with groups in harsh environments makes for quick solutions to problems in a quick manner, time not spent bickering on who is right and what to do. Your ability to communicate effectively with others makes problems like this less likely or quickly resolved.

Another undergraduate female student comments on the opportunity that this program has offered her to improve and acknowledge the importance of problem solving abilities in her field. She states:

> I have never had to plan for potential problems, in the past I have just dealt with problems as they came up. I think it was very beneficial for me to deal preemptively with problems because it gave me a better understanding of my project before beginning and it also made me more prepared. I have used that same skill in designing my Master's research project. Although I am not in the Antarctic, I have found that accounting for problems before they happen has made my research smoother and has kept me from getting so stressed out if problems do arise.

A male graduate student comments on the importance he places on cultural awareness:

> Having an awareness of other cultures has solidified my desire to increase diversity in higher education and academia. Diversity of experience and opinion is what makes learning meaningful. Talking and discussing topics with a group who has more or less had the same experiences and therefore shares the same ideas about the world as you create for a very shallow learning environment.

A female undergraduate student comments on the importance of critical thinking skills in her field:

> To be able to think critically is very important when you're trying to solve real-world issues because they have real-world consequences. In order to try to explain landscapes and how they form, I have to be able to think in multiple dimensions and think of different possibilities because landscapes are dynamic, not simple.

Evaluation of the IPY-ROAM program provided information on the competencies participants valued as a precursor for a successful career. The descriptions presented in this section point to specific ways in which participants use the career competencies in the professional or academic life. Through evaluation of the participants self-reported perceptions, it was also possible to establish that taking part in the IPY-ROAM research program significantly increased the respondents' level of critical thinking, awareness of other cultures, leadership abilities, ability to communicate effectively, problem solving ability, and consideration of others peoples feelings.

5.2 Participants' professional and academic goals

The second objected analyzed in this research was to determining the effects that IPY-ROAM had on the participants' professional and academic goals. This study explored the primary professional and academic goals of participants, the maximum level of education they want to obtain, the impacts of IPY-ROAM on their personal and/or professional goals, and established the extent in which the IPY-ROAM program has made participant reconsider their career plans, changed their academic or professional goals, contributed to their professional development, helped them gain experience for their future or current field of study, job, or profession, and motivated them to apply for future research programs.

Results from this study indicate that participants came to this program with high professional and academic goals. For example students pointed out at the start of IPY-ROAM that one of their primary goals is to obtain a graduate degree and/or conduct research. A female science teacher states "my primary educational goal is to go back to school to get my PhD in some field of curriculum and development". A male undergraduate student points out "I will attend graduate school to acquire the skills needed for the jobs in those fields (environmental planning and policy)". Another female undergraduate student reports "currently I plan to pursue

a Master's degree in zoology or ecology and then I would really like to find a job with the National Park Service or else continue my education and obtain a Ph.D. in order to become a researcher in an ecological context." An additional graduate female indicates that "after obtaining my Ph D, I would like to continue my career at a research institution, where I can have the opportunity to conduct research, interact with the non-scientific community, and teach".

When participants were directly asked, what was the maximum level of education they wished to achieve at the beginning of the program, the majority of them stated they wish to pursue a Doctoral of Masters degree. These responses remained the most common ones at the end of the IPY-ROAM research program. In addition, most of the participants disagree or neither agree or disagree, that this research program has made them reconsider or change their professional or academic goals. The data collected seems to indicate that participants have settled their academic/professional goal prior to their start in this program. However, participants do state that the IPY-ROAM program aided in several aspects of their careers. For example, students report a higher level of confidence to achieve their academic or professional goals. An undergraduate female participant mentions that:

> After participating in this program, I have felt much more compelled to achieve my goals no matter who or what may be an obstacle… I knew that this program was the start of something huge…professionally and personally, I am more confident, skilled, and driven to achieve my goals, and to become more active with the community.

A male undergraduate student states "IPY-ROAM enabled me to gain confidence in myself both as a professional and an individual". A female teacher indicates "There is a confidence you gain from being part of something this extraordinary".

Other participants have described that this program has increased their interest or enthusiasm in their profession. One female undergraduate participant affirms “This program has opened other doors for me and got me really interested into polar research” and another one states “professionally, as I mentioned earlier, it (IPY-ROAM) solidified my interest in science”. In addition, the majority of the participants agree that the IPY-ROAM research program has contributed to their professional development, help them gain experience for their current and future profession, and motivated them to apply to other research experiences. One female undergraduate states “I can say that IPY-ROAM experience has helped me gain experience and skills I never had before”. An undergraduate male student that applied and was accepted to a very competitive research experience for undergraduates comments “the IPY-ROAM program made me more ambitious in applying for such opportunities and gave me more confidence in being able to conduct field research”. In addition he states “one of the PIs told me that my research experience in Antarctica did help me to get picked for the program”.

Evaluation of the IPY-ROAM program has provided valuable information on the aspiration of its participants. It has helped in establishing that most of the students have set their personal and professional goals such as pursuing a graduate degree prior to the start of the research program, and the experience did not motivated them to change their aspiration. Instead, the assessment results identify that this research opportunity positively impacted their career by providing confidence and motivation to achieve their goals and has prepared individuals to become more successful in their profession life.

5.3 Intentions to impact minorities in science

The third area analyzed in this study was to determine if participants had any intentions to impact minorities in science at the beginning of this research experience and if they carried out

any of these intentions after the completion of this program. In addition, this study also reported the views participants have about the ability for research programs like IPY-ROAM to increase the representation of minorities in science.

At the beginning of the program, the majority of the participants reported that in order to represent minorities they would provide presentations to minority groups or become role models to them. A female teacher indicates “I would make a concerted effort to encourage girls, minorities and other special populations to make science their priority so that their voices can be heard”. A female undergraduate student reports “I hope to display that underrepresented minorities have the chance to conduct research and take part in programs like these just as much as anyone else can”. A male undergraduate student describes “I would hope to be yet another example to my culture, and others, that great things are possible”. A graduate female students view herself as a role model to other and comments “word gets around and you become noticed very quickly. Students respect me for my travels and I make a big impact that way because they want to travel to places, too”.

When participants were asked to describe the activities they had done to represent minorities in science one year after they took part of the IPY-ROAM program. The majority reported that they had done presentations or served as role models to minorities, the same intentions they had at the start of their research experience. One female undergraduate expressed that she felt that their activities may have altered the opinions that younger students had in regards to science:

> Through my presentations, I have reached out to minorities, and motivated them to have an interest in science and research. Many children I've spoken to have reversed their

> feelings on science as dull to exciting and interesting, and it has motivated me to become more active in that manner.

A graduate male student used multi-media methods, including photography, to show minority students in action:

> When I teach the Antarctica lesson I always end with a slide show of pictures I took while in Antarctica. I always show pictures of the participants in an effort to inspire the mainly minority students that I am teaching.

A female undergraduate student comments that she has become a role model to other students by stating “I actively encourage my peers to further investigate and participate in programs for minorities like IPY-ROAM. My peers within the geology department look to me as a role model and are often inquisitive about active participation in scientific research and education”.

Although, most of the people that took part in the IPY-ROAM experience provided some type of effort to impact minorities in science, four participants stated in the follow-up survey that they had not acted in this regard. Of these four, two indicate that they are interested in becoming more active in impacting minorities but have not had time to participate in any activities. One female participant explains “this program has not persuaded me to become more active in this manner because I don't think of racial diversity as a personally pressing issue”.

When participants were surveyed about their opinion that programs like IPY-ROAM can increase the participation of minorities in science, over 90% of the participants agree that these programs can be the means to increase representation. Specifically, one student reports:

> I personally feel that research mentorship is the most effective way to get students interested in science. Hands on, on site exposure to experimental design and techniques are very effective tools for introducing research science to students. Often these types of

> opportunities are not available at minority-serving schools, especially high schools. Therefore, offering more opportunities like IPY-ROAM to students of color is one of the most effective ways of increasing minority participation in science.

Another undergraduate student reports that participation in research programs can encourage others to also participate. She states:

> Others who see them (research participants) being successful at it are then encouraged to also be successful. My friends hear of the great opportunities I've had such as IPY-ROAM and the REU program and they say, "Man, I need to do something like that. That's so cool!

Although this study was not able to measure if there was a significant increase of representation in minorities in science, it was possible to determine that participants have a drive to represent minorities in their field through a variety of ways. The evaluation also pointed out that participants' genuinely believe that research programs can increase the number of underrepresented minorities in science.

5.4 Activities to provide knowledge of the polar regions

The final objective that was analyzed in this investigation consisted in exploring the ways in which participants planed to share their knowledge about the polar regions with others and which of these intentions they carried out. The most popular response that was provided in the pre-course survey was presenting at K-12 schools. One year after the program, approximately 58% of individuals that complete the follow-up survey have been involved in this type of activity. One male student narrates:

> I taught a lesson on Antarctica through my position as a science educator through CU-Boulder's Biological Sciences Initiative Science Squad. The lesson I gave was an

> overview of Antarctica, IPY, ROAM, and global climate change…. I taught in probably around 20 schools and reached between 1,500 to 2,000 students.

A local El Paso student had an original twist to presenting in K-12 schools:

> I have lived true to my words as stated in my acceptance application. I've said that I will make myself a celebrity to raise Polar Science Awareness and reasons/actions to protect them. And so I did, through the initiation of the Promise Banner Public/Educational Outreach. I, along with other IPY-ROAMers have reached an estimated 900 K-12 students and about 25 adults.

The Promise Banner Public/Educational Outreach was an original idea in which a group of participants visited local schools before the trip to Antarctica. During these visits ROAMers shared their knowledge about this polar region, explained the research they were going to conduct, and informed their audience about the importance of conserving resources to prevent global warming. They also encouraged the local students to become environmentally friendly. By signing a banner, the students promised to take care of the environment and use less non-renewable resources. In return for their promise, these banners were taken to Antarctica and photographed with penguins and the polar scenery. Upon their return, IPY-ROAM participant went back to the schools and returned the promise banners along with a picture, proof that their banner had traveled to the end of the world.

In addition to these informal presentation, 70% of survey respondents participated in professional local or national conferences in which they had an opportunity to present the research project they conducted in Antarctica to peers and professionals.

Although not reported in any of the survey responses, additional means to provide outreach was through the programs website (www.ipyroam.org) and a polar display at the UTEP

Centennial Museum. Participants, especially the ones from the education and outreach team, helped create the educational section of the program website. In this site, the public can access K-12 lesson plans regarding Antarctica, instructional videos recorded by IPY-ROAM participants, a glossary of terms, and a photo gallery of images taken during the voyage. The museum exhibition displayed information not only about the IPY-ROAM research trip but also general information about Antarctica, the Arctic, and global warming. This beautiful display attracted many school group visits. Local IPY-ROAM students volunteered to serve as guides and share their experiences with students that visited the polar displays.

Evaluation of the IPY-ROAM program indicates participants displayed a high level of interest of providing educational outreach. This interest was converted into meaningful actions that have exposed thousands of children and hundreds of adults to information regarding the IPY-ROAM experience, Antarctica and polar research. IPY-ROAM also provided younger students in the community the opportunity to find out what real scientist do in their community and what high goals they are accomplishing. It is expected that the outreach component of IPY-ROAM will provide motivation and positive role models in science for our young members of society.

5.5 Limitations and future recommendations

The design of this exploratory research had several limitations that need to be accounted for:

1. Selection bias. Participants for this study were not randomly selected. Instead, it employed the participants who took part in the IPY-ROAM research program; therefore, bias in the recruitment and selection process need to be accounted for. Methods used for advertising the IPY-ROAM research experience were centered in one particular type of population, mostly scientist or science educators, while the majority of activities to

promote the recruitment of participants were done through online resources. This narrowed the candidates to people that had access to computers. Bias in the selection process included selecting individuals with a high GPA (> 3.00), and who received high scores in the particular categories graded in the evaluation rubric. With the restriction of a random sample caution needs to be taken when generalizing the results of this investigation.

2. Validity of the assessment tools. The validity of the assessment tools is not established since a non-systematic protocol was used in the creation of the survey instruments.
3. External influences on participants. It is possible that the changes in the responses provided by the participants may be due to external factors such as maturation of the individuals, events that participants experienced outside the program, or other factors associated with time.
4. Data scorer bias. Open ended items were analyzed only by the researcher of this investigation. It is possible that the scorer may be unconsciously biases to a particular set of responses.

Recommendations for future research include evaluating a different group of participants that are involved in a similar hands-on research program therefore results can reflect a higher number of individuals from the population. It is also important to perform test to assess the validity and reliability of the survey instruments to assure precision and yield reliable information. In regards to external influences it may be useful to shorten the amount of time between the applications of the survey instruments, or require participants to respond if they are currently involved in other academic or professional activities that may influence the responses they provide. Finally, it is

especially important to have additional researcher view the results from open ended questions to reduce any bias that the original scorer may have introduced.

5.6 Implications and conclusions

The formal evaluation of the IPY-ROAM research program was an invaluable tool that provided a much needed account of the benefits and outcomes of doing hands-on research. More importantly it supplied an insight on the gains from the perspective of underrepresented minorities in science, which constituted the majority of the participants in this experience, while it also presented a report of what participants achieved from performing research in one of the world's most unique environments, Antarctica.

Underrepresentation of minority groups in scientific disciplines in the U.S. has become an issue which requires our attention. Efforts to understand how research programs can increase the representation of minorities in science are of great importance. The evaluation performed in this work provides valuable information on this issue. Results indicate that IPY-ROAM participants considered that the program has helped them in several means to reach their desired career goals by improving competencies needed for their personal or professional life, providing motivation to achieve their goals, or by increasing their interest and enthusiasm in their field of study. Participants also consider that research programs such as IPY-ROAM have the potential to increase the representation of minority groups in science given that these programs can provide motivation for participants to reach high goals in life, offer skills that are necessary for professional development, encourage minorities to apply to similar programs, and offer financial support to minorities which would not be able to afford research experiences outside their home institution. In addition, presentations provided by the participants in an effort to increase the representation of minorities in science and/or share knowledge of the polar regions merits

attention. Although, it is not conclusive that any of the efforts realized by the IPY-ROAM participants increased the number of student pursuing a career in science or increased the knowledge of the population, it was important to discover that participants display a drive to address the issue of underrepresentation of minority groups in science and are motivated to share their research experience with others.

This research study will serve as a valuable piece of literature since it provides strong evidence that all individuals, whether or not they are from a science background, can highly benefit from their participation in science research, personally and professionally. The participants in this research study, who came from various educational, professional, and cultural backgrounds and consisted of students and teachers, consider themselves more confident and better prepared to reach their personal and professional goals. In addition, this thesis contributes to the limited amount of literature that evaluates the value of performing science research, especially at the undergraduate level, and can serve as a model for future studies in this area.

With the need to increase diversity in the scientific disciplines as well as establish which initiatives work at increasing and/or preparing the next generation of scientist, it is important to understand how the approaches implemented in hands-on research programs accomplish this task. Formal and rigorous program evaluations are needed, not only to support the research that exists on this topic, but to discover new ways in which participation in research programs prepare individuals for a career in the science fields, especially for minorities that are underrepresented in science.

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Appendix A

IPY-ROAM Questionnaire Evaluation Rubric

	Very Weak	Weak	Neutral	Strong	Very Strong
1. What was the primary factor than compelled you to apply for this program?					
1a. Does the applicant demonstrate that this opportunity, including a trip to Antarctica, is compelling due to the potential for either: Personal and/or professional development Outreach or education to a broad audience	1	2	3	4	5
2. If accepted into this program, you will be asked to focus on a topic area from one of the following: ***Aquatic biology and ecology*** ***Terrestrial biology and ecology*** ***Physical sciences*** ***Eco-tourism*** ***Education and outreach*** ***Which of these topic areas interests you most, and why?***					
2a. Has the applicant clearly identified a topic area(s) and: Undergraduates have some understanding in the topic area? Teachers have some understanding in the topic area (and deeper understanding in education) Graduate students have a deeper understanding in the topic area?	1	2	3	4	5
2b. Is there evidence that the applicant is interested in either: Personal and/or professional development through participation in the topic area? Reaching a broad audience through outreach or education activities in this topic area?	1	2	3	4	5
3. What past experiences or personal strengths do you have that support your acceptance into this program?					
3a. Is there evidence of leadership, community service or outreach? Or if no such experience, a description of other relevant personal strengths?	1	2	3	4	5
3b. Do : Undergraduates express an interest in conducting research or outreach or have some relevant experience? Graduate students and teachers have relevant research or educational experience?	1	2	3	4	5
4. How do you envision your participation in this program helping you to meet your professional or academic goals?					
4a. Is there an indication that this experience will provide opportunities for professional or academic development?	1	2	3	4	5
4b. Is there a concise and well articulated statement of a professional or academic goal or future direction?	1	2	3	4	5

4c. Is there evidence that: Undergraduates are interested in pursuing graduate school and/or research and that this program may aid them in making this decision? Teachers will design and implement curriculum materials from their experiences in this program? Graduate students will use this program to contribute directly or indirectly in the development of their thesis?	1	2	3	4	5

5. What do you envision the impact of your experience in Antarctica being on yourself and others in your community (e.g. school, clubs, family, media, professional organizations) after your participation in this program?

	Very Weak	Weak	Neutral	Strong	Very Strong
5a. Does the applicant describe how <u>a trip to Antarctica in particular</u> will have an impact on them or their community?	1	2	3	4	5
5b. Is there an indication that this individual has ideas or experiences regarding outreach to a broader audience?	1	2	3	4	5
5c. Are there specific suggestions on how the candidate will want to affect underrepresented minorities through this experience?	1	2	3	4	5

GENERAL IMPRESSIONS.

G1. Is there any indication that this person will be able to work comfortably in a group setting or that the applicant appears open to new situations?	1	2	3	4	5
G2. Does this individual display an enthusiastic or adventurous personality or a drive for success?	1	2	3	4	5
G3. Is there an indication that this experience will transform the applicant's life?	1	2	3	4	5
G4. Was there evidence of attention to detail, usage of proper grammar, spelling and language to clearly communicate responses?	1	2	3	4	5

GRADUATE STUDENT APPLICANTS ONLY

Provide a summary of your thesis or dissertation.

6a. Is there evidence that the graduate students' thesis is related directly or indirectly to this project; if they have not chosen a thesis, is there evidence that this opportunity will help them develop one.	1	2	3	4	5
6b. Is the thesis summary clearly written paying attention to detail, usage of correct grammar, spelling and language.	1	2	3	4	5

OVERALL IMPRESSION OF APPLICANT:

Compared to the other applications you have read today, this applicant is:

___ In the top 10% of all applicants

___ In the top 25% of all applicants

___ In the top 50% of all applicants

___ In the lower half of all applicants (i.e. the applicant is likely unacceptable to the IPY-ROAM

COMMENTS (good, bad and other)

Appendix B

International Polar Year – Research and Educational Opportunities in Antarctica for Minorities Pre-Course Survey

The evaluators of the International Polar Year - Research and Educational Opportunities in Antarctica for Minorities (IPY-ROAM) program are conducting this pre-course survey to:

1) Determine the potential value and benefits of participating in a field-based research program to Antarctica.
2) Identify the goals and skills participants expect to obtain from being part of this experience.
3) Better understand the participants' abilities and beliefs before and after the trip
4) Evaluate the IPY-ROAM program to improve relevancy to participants

This survey is designed so respondents' opinions will remain anonymous. All information and data collected will be used as part of a Masters thesis and to communicate with the public the educational benefits of this program.

If you have any questions you may contact Dr. Vanessa Lougheed at vlougheed@utep.edu or the IPY-ROAM Research Assistant Claudia V. Garcia at cvgarcia@miners.utep.edu. Thank you for your cooperation.

One of the goals of this research study is to compare the growth of each individual during their participation in this program. The creation of a personal code is necessary to maintain this survey anonymous and fulfill the goal of this research study. Please follow the instructions below in order to create your code. Once finished write it down in the appropriate space. Please use the same codes for all surveys you complete for IPY-ROAM.

1. Write the first letter of your mother's first name
2. Write the two digit number of the month you were born
3. Write the first letter of the high school you attended

Please enter your personal code_____

Survey Instructions: Read each question carefully and provide an answer to every item.

1. Why did you choose to apply to IPY-ROAM (check all that apply).

____ Gain experience for your future job or profession

____ Gain experience for your current job or profession

____ Unique research opportunities

____ Unique opportunities for outreach or education (of others)

____ Professor(s) or academic advisor recommended it

____ Desire to "get away" from stress in personal, family, or college life

____ Desire to keep up with family and friends who have been abroad

____ Friend(s) or colleague(s) also applied to this program

____ Academic reasons (need the courses offered, fit well with major/minor, etc.)

____ Wanted a challenge

____ Wanted an experience in a culture and society different from my own

____ Have always wanted to travel to this particular country or area

____ The focus on impacting underrepresented minorities through the experience

____ Other (specify):_____

2. Which of the following areas best describe your major or current area of expertise? (check one only)

_____ Education _____ Non-Science _____ Science

3. Which of the following areas best describe your minor or secondary area of expertise? (check one only)

_____ Education _____ Non-Science _____ Science

INTERPERSONAL SKILLS

4. I currently see myself as possessing the following characteristics. Rate yourself from 1 (strongly disagree) to 5 (strongly agree).

Critical thinking skills	1	2	3	4	5
Awareness of other cultures	1	2	3	4	5
Leadership abilities	1	2	3	4	5
An outgoing personality	1	2	3	4	5
Consideration for the feelings of others	1	2	3	4	5
Ability to communicate effectively with others	1	2	3	4	5
Problem solving abilities	1	2	3	4	5
Work effectively with a diverse group of people	1	2	3	4	5
Perform with confidence in unfamiliar situations	1	2	3	4	5

5. Which of the following skills do you think are important for personal growth and/or professional success? Rate from 1 (least important) to 5 (most important).

Developing critical thinking skills	1	2	3	4	5
Building international relationships	1	2	3	4	5

Awareness of other cultures	1	2	3	4	5
Developing leadership skills	1	2	3	4	5
Working independently	1	2	3	4	5
Having the ability to communicate effectively	1	2	3	4	5
Acquiring problem solving abilities	1	2	3	4	5
Valuing ethnic diversity	1	2	3	4	5
Knowing how to work in teams	1	2	3	4	5
Communicating my ideas and knowledge with confidence	1	2	3	4	5
Considering other peoples' feelings	1	2	3	4	5
Having working knowledge of disciplines outside your area of expertise	1	2	3	4	5
Striving to be a role model	1	2	3	4	5

6. I believe that the opportunities provided for me by the IPY-ROAM program will help me…Rate from 1(don't believe) to 5 (strongly believe).

Enhance my critical thinking skills	1	2	3	4	5
Increase my awareness of other cultures	1	2	3	4	5
Improve my leadership skills	1	2	3	4	5
Improve my interpersonal relation with colleagues and peers	1	2	3	4	5
Value ethnic diversity	1	2	3	4	5
Learn new ways to effectively communicate with others	1	2	3	4	5
Increase my problem solving abilities	1	2	3	4	5
Work better in teams	1	2	3	4	5
Comfortably work in unfamiliar situations	1	2	3	4	5
Increase my consideration for other people's feelings	1	2	3	4	5
Interact effectively with people from different backgrounds	1	2	3	4	5
Be aware of new disciplines that I currently know little about	1	2	3	4	5
Become a better role model	1	2	3	4	5

PROFESSIONAL AND ACADEMIC GOALS

7. What is/are your primary professional and/or academic goal(s)?

8. How do you think the field exposure to the polar sciences will assist you in achieving these goals?

9. Are you currently conducting or have you ever conducted any type of research?

If YES, please describe. Limit your answer to the 5 most important projects. Use 1-2 sentences for each project.

10. Have you ever applied for and received funding (e.g. grant, fellowship, or scholarship) from a foundation or other granting agency to conduct research? (This does not include applying for a job)
If YES, please describe. Limit your answer to the 5 most important projects. Use 1-2 sentences for each project.

11. Are you currently involved or have been involved in providing outreach and/or education to your community.
If YES, please describe. Limit your answer to the 5 most important projects. Use 1-2 sentences for each project.

12. Have you ever applied for and received funding (e.g. grant, fellowship, or scholarship) from a foundation or other granting agency to design and/or implement an educational or outreach product.
If YES, please describe. Limit your answer to the 5 most important projects. Use 1-2 sentences for each project

13. In order to have a successful and satisfying career or profession, I believe that the following skills are important. Rate from 1 (least important) to 5 (most important).

Gaining first hand experiences (e.g. internships, research, field work)	1	2	3	4	5
Sharing knowledge with peers, colleagues and other members of my community	1	2	3	4	5
Publishing in journals, or magazines	1	2	3	4	5
Knowing how to communicate ideas effectively to people of all educational levels, including both my peers and people outside of my field of expertise	1	2	3	4	5
Presenting new discoveries, results and ideas to my peers a conferences or symposiums	1	2	3	4	5
Teaching myself and/or others about global issues	1	2	3	4	5
Advocating action on local issues	1	2	3	4	5
Being informed about current research and technological developments in my field	1	2	3	4	5

Encouraging younger generations to become involved in my field of expertise	1	2	3	4	5
Motivate younger generations to continue in school	1	2	3	4	5
	1	2	3	4	5

14. What is the maximum level of education you hope to achieve?
Bachelors_____ Professional Certification_____ Masters_____
Doctorate_____
Other Professional Degree _____

In which field?

15. Answer only if you are working on a thesis or dissertation: How do you think you will apply the knowledge and experiences from the IPY-ROAM program to your thesis or dissertation?

POLAR SCIENCES

16. Have you ever considered a career in the polar sciences?

17. Why do the polar regions interest you?

18. What do you believe is the most significant polar issue at the moment?

COMMUNITY CONNECTIONS

19. After your participation in the IPY-ROAM program, how do you plan to share with others (e.g. school, clubs, family, media, organizations, etc.) any projects, ideas, or experiences you gained from this opportunity?

20. How do you intend to impact underrepresented minorities in your field through your participation in the IPY-ROAM program?

21. What are the three main characteristics you look for or admire in a role model?

22. What are three main characteristics that you feel that you have to offer as a role model?

DEMOGRAPHICS

The used of demographic questions in this survey is to divide the data collected in to subgroups so responses can be compared and analyzed between these subgroups.

What is your gender? _____ Male _____ Female

Do you consider your self to be

____ White, non-Hispanic
____ Hispanic or Latino
____ African American or Black
____ Asian
____ Native Hawaiian or Other Pacific Islander
____ Native American

What age group do you belong to

____ 18-21
____ 22-25
____ 26-30
____ 31-40
____ 41-50
____ 51-60
____ 60-over

What is your current marital status?

____ Single, never married
____ Married
____ Separated
____ Divorced
____ Widowed

What is the highest level of education you have completed?

____ High school
____ Some College
____ 4-Year College Degree (BA, BS)
____ Masters Degree
____ Doctoral Degree
____ Professional Degree

If you are attending a college or university, what is your currently classification?

____ Freshman (0-29 hours)
____ Sophomore (30-59 hours)
____ Junior (60-89 hours)
____ Other: _____
____ Senior (90-120+ hours)
____ Graduate Master student
____ Graduate Doctoral student

Appendix C

International Polar Year – Research and Educational Opportunities in Antarctica for Minorities Post-Course Survey

The evaluators of the International Polar Year - Research and Educational Opportunities in Antarctica for Minorities (IPY-ROAM) program are conducting this post-course survey to obtain valuable information about opinions and experiences of the IPY-ROAM participants. The purpose of this questionnaire is to:

1) Determine the value and benefits of participating in a field-based research program to Antarctica.
2) Identify the goals and skills participants have acquired during their participation in this research experience.
3) Better understand the participants' abilities and beliefs before and after the trip.
4) Evaluate the IPY-ROAM program to improve relevancy to participants.

This survey is designed so respondents' opinions will remain anonymous. All information and data collected will be used as part of a Masters thesis and to communicate with the public the educational benefits of this program.

If you have any questions you may contact Dr. Vanessa Lougheed at vlougheed@utep.edu or the IPY-ROAM Research Assistant Claudia V. Garcia at cvgarcia@miners.utep.edu. Thank you for your cooperation.

One of the goals of this research study is to compare the growth of each individual during their participation in this program. The creation of a personal code is necessary to maintain this survey anonymous and fulfill the goal of this research study. Please follow the instructions below in order to create your code. Once finished write it down in the appropriate space. Please use the same codes for all surveys you complete for IPY-ROAM.

4. Write the <u>first</u> letter of your mother's first name
5. Write the <u>two</u> digit number of the month you were born
6. Write the <u>first</u> letter of the high school you attended

Please enter your personal code_____

Survey Instructions: Read each question carefully and provide an answer to every item.

<u>INTERPERSONAL SKILLS</u>

1. I currently see myself as possessing the following characteristics. Rate yourself from 1 (strongly disagree) to 5 (strongly agree).

Critical thinking skills	1	2	3	4	5
Awareness of other cultures	1	2	3	4	5
Leadership abilities	1	2	3	4	5
An outgoing personality	1	2	3	4	5

Consideration for the feelings of others	1	2	3	4	5
Ability to communicate effectively with others	1	2	3	4	5
Problem solving abilities	1	2	3	4	5
Work efficiently in diverse groups of people	1	2	3	4	5
Perform with confidence in unfamiliar situations	1	2	3	4	5

2. Which of the following skills do you think are important for personal growth and/or professional success? Rate from 1 (least important) to 5 (most important).

Developing critical thinking skills	1	2	3	4	5
Building international relationships	1	2	3	4	5
Awareness of other cultures	1	2	3	4	5
Developing leadership skills	1	2	3	4	5
Working independently	1	2	3	4	5
Having the ability to communicate effectively	1	2	3	4	5
Acquiring problem solving abilities	1	2	3	4	5
Valuing ethnic diversity	1	2	3	4	5
Knowing how to working in teams	1	2	3	4	5
Communicating my ideas and knowledge with confidence	1	2	3	4	5
Considering other peoples' feelings	1	2	3	4	5
Having working knowledge of disciplines outside your area of expertise	1	2	3	4	5
Striving to be a role model	1	2	3	4	5

3. I believe that the opportunity to have participated the IPY-ROAM program has helped me... Rate from 1(Strongly disagree) to 5 (Strongly agree).

Enhance my critical thinking skills	1	2	3	4	5
Increase my awareness of other cultures	1	2	3	4	5
Improve my leadership skills	1	2	3	4	5
Improve my interpersonal relation with colleagues and peers	1	2	3	4	5
Value ethnic diversity	1	2	3	4	5
Learn new ways to effectively communicate with others	1	2	3	4	5
Increase my problem solving abilities	1	2	3	4	5
Work better in teams	1	2	3	4	5
Comfortably work in unfamiliar situations	1	2	3	4	5
Increase my consideration for other peoples feelings	1	2	3	4	5
Interact effectively with people from different backgrounds	1	2	3	4	5
Be aware of new disciplines that I currently know little about	1	2	3	4	5
Become a better role model	1	2	3	4	5

PROFESSIONAL AND ACADEMIC GOALS

4. In order to have a successful and satisfying career or profession, I believe that the following skills are important. Rate from 1 (least important) to 5 (most important).

Gaining first hand experiences (e.g. internships, research, field work)						1	2	3
Sharing knowledge with the peers, colleagues and other members of my community	1	2	3	4	5			
Publishing in journals, or magazines	1	2	3	4	5			
Knowing how to communicate ideas effectively to people of all educational levels, including both my peers and people outside of my field of expertise	1	2	3	4	5			
Presenting new discoveries, results and ideas to my peers at conferences or symposiums	1	2	3	4	5			
Teaching myself and/or others about global issues	1	2	3	4	5			
Advocating action on local issues	1	2	3	4	5			
Being informed about current research and technological developments in my field	1	2	3	4	5			
Encouraging younger generations to become involved in my field of expertise	1	2	3	4	5			

5. To what extent has the IPY-ROAM program... Rate from 1 (very low) to 5 (very high).

Made you reconsider your career plans						1	2	3
Changed your academic or professional goals	1	2	3	4	5			
Contributed to your professional development	1	2	3	4	5			
Helped you gain experience for your current field of study, job or profession	1	2	3	4	5			
Helped you gain experience for your future job or profession	1	2	3	4	5			
Made you consider providing outreach/education to your community	1	2	3	4	5			
Motivated you to apply for future research experiences	1	2	3	4	5			
Encouraged you to involve or represent minorities in your field of expertise	1	2	3	4	5			
Helped you become a better role model	1	2	3	4	5			
Motivated you to apply for a program that you previously thought you were unqualified for	1	2	3	4	5			
Encouraged you to apply for another study abroad experience	1	2	3	4	5			

6. What is the maximum level of education you hope to achieve?

Bachelors_____ Professional Certification_____ Masters_____ Doctorate _____

Other Professional Degree _____

In which field?

COURSE EVALUATION

When answering the following questions of this section, have in mind only the experiences relating to the trip to Washington, D.C., Argentina and Antarctica. This includes any trip- or research-related planning you participated in before the trip, as well as the trip itself.

7. The following items describe strategies that you may have used or were exposed to during the IPY-ROAM trip to Washington, D.C., Argentina/Antarctica. Grade each strategy from 1 (did not occur) to 5 (occurred very often).

Worked in teams or small groups	1	2	3	4	5
A positive environment for learning new ideas existed during the program	1	2	3	4	5
Technology (computers, field equipment, etc.) was used to support learning	1	2	3	4	5
A variety of teaching methods were used	1	2	3	4	5
Critical discussions that aided in learning were used between students	1	2	3	4	5
Worked on research techniques that made me learn about environmental change	1	2	3	4	5
Assignments were designed to make me think critically about concepts	1	2	3	4	5
I received feedback about my learning and research project from instructors	1	2	3	4	5
I had the opportunity to create a project, activity, or product that reflects the topics I have learned.	1	2	3	4	5
There was a connection between science and other disciplines	1	2	3	4	5
I was given the opportunity to explore ideas that are important to me	1	2	3	4	5
Build upon knowledge learned from the online fall course	1	2	3	4	5
Field work enhanced my knowledge of the course concepts	1	2	3	4	5
I was able to investigate real world problems	1	2	3	4	5
Learned research techniques that have real world application	1	2	3	4	5

8. Compared to your expectations of the IPY-ROAM program, how satisfied were you with this experience? Rate from 1 (extremely unsatisfied) to 5 (extremely satisfied) 1 2 3 4 5

9. Describe what was the most beneficial information you received before your trip to Argentina/Antarctica. Explain why.

10. Describe what information you wish you had known before your trip to Argentina/Antarctica. Explain why.

11. What was the greatest challenge you encountered during the IPY-ROAM program? How did you meet this challenge?

12. In your point of view what were the major strengths of the IPY-ROAM program?

13. What suggestions do you have to improve this experience for future participants?

COMMUNITY CONNECTIONS

14. After your participation in the IPY-ROAM program, how do you plan to share with others (e.g. school, clubs, family, media, organizations, etc.) any projects, ideas, or experiences gained from this program? What topics or experiences, in particular, will you focus on?

15. How do you intend to impact underrepresented minorities in your field through your participation in this program?

DEMOGRAPHICS

The use of demographic question in this survey is to divide the data collected in to subgroups so responses can be compared and analyzed between these subgroups.

What is your gender? _____Male _____Female

Do you consider your self to be?

____White, non-Hispanic
____Hispanic or Latino
____African American
____Asian
____Native Hawaiian/other Pacific Islander
____Native American

What age group do you belong to?

____18-21
____22-25
____26-30
____31-40
____41-50
____51-60
____61-over

What is your current marital status?

____Single, never married
____Married
____Separated
____Divorced
____Widowed

What is the highest level of education you have completed?

____High school
____Some college
____4-year college degree (BA or BS)
____Masters degree
____Doctoral degree
____Professional degree

If you are attending college or university, what is your current classification?

____Freshman (0-29 hours)
____Sophomore (30-59 hours)
____Junior (60-89 hours)
____Senior (90-120+ hours)
____Graduate Master student
____Graduate Doctoral student
____Other:_____

Appendix D

International Polar Year – Research and Educational Opportunities in Antarctica for Minorities Follow-up Survey

The evaluators of the International Polar Year - Research and Educational Opportunities in Antarctica for Minorities (IPY-ROAM) program are conducting this follow-up survey to obtain valuable information about opinions and experiences of the IPY-ROAM participants. The purpose of this questionnaire is to:

1) Determine the long term value and benefits participants gained from attending IPY-ROAM.
2) Identify the skills individuals acquired from a personal, professional, and academic point of view.
3) Investigate if any change in the academic, professional, and/or personal life of the participants arose from their involvement in this course.
4) Evaluate the IPY-ROAM program to improve relevancy to participants.

This survey is designed so respondents' opinions will remain anonymous. All information and data collected will be used as part of a Masters thesis and to communicate with the public the educational benefits of this program.

If you have any questions you may contact Dr. Vanessa Lougheed at vlougheed@utep.edu or the IPY-ROAM Research Assistant Claudia V. Garcia at cvgarcia@miners.utep.edu. Thank you for your cooperation.

One of the goals of this research study is to compare the growth of each individual during their participation in this program. The creation of a personal code is necessary to maintain this survey anonymous and fulfill the goal of this research study. Please follow the instructions below in order to create your code. Once finished write it down in the appropriate space. Please use the same codes for all surveys you complete for IPY-ROAM.

7. Write the <u>first</u> letter of your mother's first name
8. Write the <u>two</u> digit number of the month you were born
9. Write the <u>first</u> letter of the high school you attended

Please enter your personal code_____

Survey Instructions: Please read all of the questions before you start. Afterwards, answer each question in as concisely as possible. We suggest less than 200 words.

1. After your participation in the IPY-ROAM program, have you participated in any internships, or applied for any scholarships or grants to conduct research? If yes, briefly describe the funding you applied for, whether you were successful in your application, and how your experience with the IPY-ROAM program assisted you in this process.

2. One of the goals of the International Polar Year 2007-2009 is to increase public awareness of the polar regions. Please explain how you have contributed to achieving this goal through any education or outreach you have participated in. Please explain the specific activities, presentations, or other projects that you developed, and with whom you shared them. In your description provide an estimate of the number of people you reached through each of the activities, for example: Activity 1: 20 children, 2 adults, Activity 2: 10 adults.

3. Since your participation in the IPY-ROAM program, in what way(s) have you reached out to or represented minorities in your field? Has participation in this program persuaded you to become more active in this manner?

4. Do you think programs like IPY-ROAM can increase the participation of minorities in the sciences? Please explain.

5. Of the skills that you acquired or refined during the IPY-ROAM program, please rank the following from the ones you consider the most valuable to the least valuable.

___Critical thinking
___Awareness of other cultures
___Leadership abilities
___An outgoing personality
___Consideration for the feelings of others
___Communicate effectively with others
___Problem solving
___Work effectively with a diverse group of people
___Perform with confidence in unfamiliar situation

6. For your top three of the above list, explain how they have been beneficial to your academic or professional development.

7. From the above list, which skills do you wish you had developed in greater depth thru the program and why?

8. After your participation in the IPY-ROAM program, have you presented your research in any conference or published your findings in any journals? If yes please list the location, dates, and title of your abstract.

9. Describe in which ways participating in this program has impacted your personal and/or professional goals. If possible, provide specific examples.

10. Thought your participation in this program, which of the following characteristics do you think you have increased?

___Integrity
___Leadership
___Ability to motivate others
___Passion for my work
___Dedication
___Gain experience in my field
___Confidence
___Innovativeness
___Motivation to learn
___Determination

DEMOGRAPHICS

The use of demographic question in this survey is to divide the data collected in to subgroups so responses can be compared and analyzed between these subgroups.

What is your gender? _____Male _____Female

Do you consider your self to be?

____White, non-Hispanic
____Hispanic or Latino
____African American
____Asian
____Native Hawaiian/other Pacific Islander
____Native American

What age group do you belong to?

____18-21
____22-25
____26-30
____31-40
____41-50
____51-60
____61-over

What is your current marital status?

____Single, never married
____Married
____Separated
____Divorced
____Widowed

What is the highest level of education you have completed?

____High school
____Some college
____4-year college degree (BA or BS)
____Masters degree
____Doctoral degree
____Professional degree

If you are attending college or university, what is your current classification?

____Freshman (0-29 hours)
____Sophomore (30-59 hours)
____Junior (60-89 hours)
____Senior (90-120+ hours)
____Graduate Master student

Curriculum Vitae

Claudia Vanessa Garcia was born in Ciudad Juarez, Chihuahua, Mexico and is the eldest daughter of Rafael Garcia and Luz Maria Alvarez. In May 2006, Claudia graduated from the University of Texas at El Paso with a Bachelors of Science degree in Biology and was awarded Cum Laude honors at this institution. As the first member of her family to receive a degree from a higher education institution, she understands the value of education and has participated in activities to motive middle and high school student to continue their education and purse a college degree. Her education, employment and volunteer experience have made her aware of the underrepresentation of Hispanics in the science careers and the obstacles that discourage minority students from obtaining higher education degrees especially in science and engineering fields. These issues have motivated Claudia to work in a profession were she can positively impact and mentor this population either through research or education. Her future goals include pursuing a Ph.D. degree and becoming a university faculty instructor.

This thesis was typed by Claudia V. Garcia.