THE IMPORTANT ROLE OF TWO-YEAR COLLEGES IN THE EARTH AND SPACE SCIENCES

Report from a planning workshop to create Unique Research Experiences for two-year-College faculty And Students (URECAS):
An integrated research and transfer program

AGU

April 2013

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American Geophysical Union

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Front Cover

From left-right, Isaac Martinez of El Paso Community College (EPCC), Alejandro Rios of University of Texas at El Paso (UTEP), Joshua Villalobos (EPCC), and Ashley Nauer (UTEP) conduct a site evaluation for a GPR study within an Archaic archaeological site at Keystone Heritage Park, El Paso, Texas. Photographer Joshua Villalobos (EPCC)

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EXECUTIVE SUMMARY

April 2013

The Unique Research Experiences for two-year College faculty And Students (URECAS) planning workshop was the American Geophysical Union's (AGU) first step in implementing a larger program focused on engaging and retaining two-year-college students in the Earth and space sciences. Two-year colleges are critical to the future of the U.S. workforce because they offer a pathway to four-year-college degrees and employment in STEM and other disciplines, and engaging in research can help students at these institutions succeed.

This U.S. National Science Foundation–funded workshop was held 11–13 July 2012 at the AGU headquarters. Participants included faculty from two-year and four-year colleges, as well as representatives from federal and state agencies and other professional organizations.

Throughout the two-day workshop, presentations and small-group discussions tackled issues such as challenges faced by students and faculty who are involved in undergraduate research, best practices in conducting and institutionalizing research at two-year colleges, facilitating the transfer of research students to a four-year institution, and addressing the needs of diverse students. In addition to the discussions held among faculty members, representatives from federal agencies, professional societies, and undergraduate education organizations joined the conversation and provided information about tools and opportunities available at their institutions for both faculty and students. For more information about the workshop content, including speaker presentations, see http://urecas.agu.org/workshop-program/. Outcomes from the workshop are summarized below.

Challenges faced by two-year-college faculty engaged in research include:

- Lack of value placed on research at some institutions
- Research not counting toward professional development or the tenure process at many institutions
- Lack of time to do research
- Isolation from professional colleagues

Challenges faced by two-year-college students engaged in research include:

- The perception of research as being hard
- Lack of funding
- Family and work obligations
- Lack of clarity regarding how research will help them in the workforce

Solutions proposed by AGU and workshop participants for two-year-college faculty and students include:

- A cultural shift: Successful research models require a redefinition of two-year colleges as research-capable
- Infusing research across the curriculum of an entire program
- Implementation of place-based learning
- Student and faculty attendance at professional meetings to counter isolation and lack of exposure to opportunities in the Earth and space sciences
- Strong collaborations between two-year and four-year colleges
- Addressing the needs of diverse students: mentoring, logistical support, learning communities, etc.
- Funding to support two-year-college research and facilitation of transfer to four-year colleges

Despite the many hurdles faced by two-year-college faculty and students engaged in research, participants felt strongly that exposing students to research and ultimately a professional meeting, such as AGU's Fall Meeting, would help sustain the students' interest in continuing their studies in the Earth and space sciences.

1. Introduction

The American Geophysical Union (AGU) is an international nonprofit scientific association with more than 62,000 members working on a broad spectrum of topics that span the Earth and space sciences. AGU and its members are committed to relevant and timely scientific research and the communication of those results to the public—particularly in relation to America's national security, economic competitiveness, and public health and safety.

Education and outreach play a significant role in AGU's mission. One of AGU's major strategic goals is developing and nurturing the next generation of Earth and space scientists. Particular emphasis is placed on exploring ways to expand the size and diversity of the Earth and space science workforce and on helping to strengthen Earth and space science departments and undergraduate teaching.

As the nation's preeminent association of Earth and space scientists, AGU is concerned about the current national shortage of professionals in the Earth and space sciences and is taking steps to address this need with the development and implementation of a new two-year-college program. While there are many strategies for encouraging students to pursue science, technology, engineering, and math—known as the STEM disciplines—one proven approach is to promote research projects at the undergraduate level. Undergraduate research opportunities can increase competence in and identification with STEM fields. Research experiences often translate into a career in the STEM fields [National Research Council (NRC), 2009; *Hallar et al*., 2010; *Gawel and Greengrove*, 2005; *Woltemade and Blewett*, 2002]. Education research shows that students who engage in research and present their findings at conferences deepen their commitment to their program, discipline, and profession [NRC, 2011].

The Unique Research Experiences for two-year-College faculty And Students (URECAS) program is intended to support and foster students at two-year colleges in Earth and space science disciplines, including those who choose to transfer to four-year institutions, and ultimately create pathways for them to enter the workforce. Also, because two-year colleges attract a large proportion of students from underrepresented groups, URECAS is also focused on building diversity in the Earth and space science professional workforce, another strategic priority for AGU.

Planning for URECAS began after AGU received a National Science Foundation (NSF) grant from the Opportunities for Enhancing Diversity in the Geosciences program. AGU began putting together an information-gathering workshop, which took place during the summer of 2012. Faculty from two- and four-year colleges, as well as representatives from federal and state agencies and other professional organizations, gathered for the two-day planning workshop. During the workshop, presentations and small-group discussions tackled issues such as challenges faced by students and faculty involved in undergraduate research, best practices in conducting and institutionalizing research at two-year colleges, facilitating the transfer of research students to four-year institutions, and addressing the needs of diverse students.

Mary Catherine Adams (AGU)

URECAS workshop participants discuss best practices related to student research at two-year colleges

In addition to the discussions held among faculty members, representatives from federal agencies, professional societies, and undergraduate education organizations joined the conversation and provided information about tools and opportunities available at their institutions for both faculty and students. For more information about the workshop, including speaker presentations, see http://urecas.agu.org/workshop-program/.

Despite the many hurdles faced by two-year-college faculty and students engaged in research, participants felt strongly that exposing students to research and ultimately a professional meeting, such as AGU's annual Fall Meeting, would help sustain the students' interest in continuing their studies in the Earth and space sciences. This document grew out of those workshop discussions and presentations and is supported by relevant literature. It is intended to paint a clear picture of the challenges and successes in this arena and the role of AGU in fostering two-year-college students and building the future geoscience workforce.

2. Current State of the Issue

2.1 Today's geoscientists and two-year colleges

Research conducted by the American Geosciences Institute (AGI) and the Georgetown University Center on Education and the Workforce indicates that a little more than a quarter of a million geoscientists are working in the United States today [*Carnevale et al*, 2010]. By 2021, that number will need to increase by nearly 20% to meet demand. Additionally, about half of the current workforce is within 10 years of retirement age. Given current graduation rates, the United States could be facing 150,000–200,000 unfilled geoscience jobs by 2021 [Source: AGI Workforce Program].

Fifty percent of students start their postsecondary education at two-year colleges [*Mooney and Foley*, 2011]. These institutions therefore play a vitally important role in the higher education system in the United States, serving as gateways to a four-year-college education. Two-year colleges are essential in fostering a more productive and successful workforce. With respect to the STEM fields, two-year colleges are being called upon to play an ever-increasing role in fulfilling the nation's need for more-highly trained scientists and engineers. Unfortunately, many two-year-college STEM students do not finish their degrees or succeed in transferring to and completing programs at four-year colleges [*Mooney and Foley*, 2011].

2.2 Current state of the geosciences at two-year colleges

Nationwide, approximately 17% of all two-year colleges offer geoscience degrees, with the highest concentration of programs in California and Texas. Although 33% of two-year-college students are members of underrepresented minorities, this group earned only 12% of geoscience associate's degrees in 2008 [*Gonzales and Keane*, 2011]. Thus, engaging with two-year colleges represents both a potentially rich source of diversity for the field and an area where much work remains to be done. Preparing the geoscience workforce of the future and advancing public literacy in the Earth sciences are two goals cited by the NSF Directorate for Geosciences in a comprehensive overview of its Education and Diversity Strategic Framework (2010-2015). Of particular interest and priority are those activities by which "capacity is built at community colleges and minority-serving institutions to engage students from diverse backgrounds and enable them to pursue degrees and careers in the geosciences" [NSF, 2012].

Although much work remains to be done on increasing diversity in the geosciences, the demographics of today's geoscience students are very different than they were 20 years ago. Women, for example, now earn more than 40% of bachelor's degrees in the field, up from 25% in 1985. Nevertheless, in 2010, the percentage of geoscience bachelor's degrees earned by members of underrepresented minorities was 8%, far smaller than the 25% of undergraduates who are members of underrepresented minorities. [Source: U.S. Institute of Education Sciences, National Center for Education Statistics] (Four-year-college statistics rather than two-year-college data are reported because complete two-year-college data are not available.)

Participation in STEM education at all levels should be an urgent national priority that includes increasing participation by underrepresented minorities as well as improving the quality of their education. Leadership in recruiting and retention efforts is required from all stakeholders—federal agencies, employers, industry groups, professional societies, advocacy groups, non-governmental organizations, etc. [NRC, 2011]. The key to all undertakings in the geosciences specifically is maintaining and supporting a steady pipeline of talented people to meet workforce demands and to overcome critical scientific and societal challenges of tomorrow.

2.3 Models for doing research at two-year colleges

According to several workshop participants, the ultimate goals of research with students are curiosity, professional development, and skills building. Faculty members want students to be excited about and interested in the physical world around them, and to ask and answer questions about this world using scientific processes. Many models exist for conducting research with undergraduate students at two-year colleges; a sample of these models is shown in the figure below.

Four-Year Colleges----------Two-Year Colleges				
Research conducted off-campus by two-year-college students	Two- and four-year-college collaborations within and outside of curriculum	Research with two-year-college faculty outside of class	Special classes with research emphasis	Research in class within curriculum

Figure 1 *A continuum of models for conducting research with two-year-college students*

Dr. Allison Beauregard (NWFSC) and Dr. Matthew Schwartz, University of West Florida (UWF)

Northwest Florida State College (NWFSC) Professor Dr. Allison Beauregard works with Aquatic Environmental Science class members to collect and record aquatic data in Garnier Bayou, Fla.

Successful research models differ in duration and level of effort and can span from a 30-minute exercise within an existing course to a far more involved and lengthy process. The options are on-campus while in class; on-campus outside of class; and off-campus, long-term and short-term. The nature of a student's research project can vary from one that is part of a professor's research to a completely separate project that the student has full ownership of. Two-year-college faculty suggested other options relative to workforce education and preparation—a federal work-study program on two-year-college campuses, or summer work for pay. Regionality affects the model of choice for a particular course.

Several other issues related to research were discussed. Many faculty members agreed that the process of conducting research brings with it a requirement to communicate research results. Industry involvement is important to success, as is the involvement of alumni and the wider community. They also noted that teaching "pieces of the whole" (i.e. different concepts in different courses that build to a broad level of understanding), rather than trying to fit everything into one course, is preferable to traditional ways of teaching science. This is echoed in other places, such as the Next Generation Science Standards (http://www.nextgenscience.org/next-generation-science-standards), but, of course, requires that students take a complete set of courses on a particular subject.

Last, the small number of students per class is one advantage two-year-colleges have, and this format lends itself to student research. Faculty and students who find themselves too isolated can create or join learning communities—in-person or virtual. Learning communities can have several instructors for one course or multiple courses with one instructor per course but where those instructors work together.

2.4 Institutionalization of research

According to participants, the way to institutionalize research at a college is by incorporating it into the curriculum. One way that research can be funded is through tuition ("hard money"), although external funds can still be used to supplement research activities.

Below are two ways research can potentially be incorporated into the curriculum; these techniques are being used by workshop participants:

1. A research class (capstone class, thesis class, etc.), where the primary function of the class is to have students do a research project. These classes can

be from 0 to 3 credits and should have students present their findings in a research symposium at the end of their experience. Community colleges will have to work with their partner four-year institutions to ensure that these non-traditional science courses articulate.

2. A module to introduce students to research such as inquiry-based experiences incorporated into existing courses. This format may not be as fulfilling as a research class.

Administrative support is essential. There were several instances of faculty doing research without administrative support noted during the workshop. These faculty members had a harder time carrying out their research, and the scale of their activities was much smaller than those conducted by faculty with administrative support. Additionally, research must be made part of the culture. Several institutions represented at the workshop had already institutionalized undergraduate research. For them, there was no question about incorporating research into the curriculum; it was something expected of them.

An undergraduate research program cannot depend on only one or a few individuals; there must be a critical mass of faculty members engaged in doing research. Most successful projects described by participants involved doing research locally, which coincides with the mission of a community college. Further, students should receive recognition for their research as a way to foster continued participation.

The Council on Undergraduate Research (CUR) has identified many of the above points as critical elements of an undergraduate research program and notes additional best practices of long-term, sustainable programs. The criteria include but are not limited to: a supportive research infrastructure, professional development opportunities for faculty, recognition for faculty and students, dissemination of research, a student-centered approach, summer research programs, robust assessment plans, and strategic planning on the part of the institution [CUR, 2012].

3. Challenges in Undergraduate Research at Two-year Colleges

3.1 Challenges faced by research students

Two-year-college students may face many hurdles to participation in research. These include but are not limited to: students' obligations outside the classroom, such as care of children or other family members or employment, which may necessitate alternative class schedules. These schedules may make it challenging for students to participate in fieldwork associated with research or attend meetings with peers and professors. Additionally, availability of faculty may not match the times when students are free.

Funding is another challenge. If faculty members don't have funding from their institution or an outside grant, they most likely will not be able to pay students a stipend for their research or fieldwork. Some students may not be able to participate because of the need to work elsewhere. Or, they may not be able to cover the cost of transportation.

In addition to time and financial constraints, some students will have to overcome the mental barrier of seeing science as too difficult or mysterious, or research as something they can't do. Sometimes students don't feel that they have ownership of data from their own small projects or understand how their work fits into the larger context of the field or believe they are contributing something relevant. As a result, students can lose interest after the first research experience and may not continue in a STEM field. Additionally, students may not know that research can give them the skills they need for entering the workforce. Further, even though professional societies offer opportunities, students must be made aware of what the opportunities are.

Two further challenges are the online student environment and the need for transferable credits. The first can potentially be addressed through the use of online, real-time datasets. The second requires discussions with the college administration and nearby institutions about receiving course credit for research, the transferability of those credits, and their applicability to degree programs. In addition, most two-year-college course offerings meet general education requirements with strictly defined curriculum to comply with transfer articulation agreements. Changing the syllabus sufficiently to incorporate meaningful research may require a retooling of the articulation agreement.

Finally, students may face cultural, physical, and socioeconomic challenges. To overcome these issues, CUR suggests that opportunities for student research occur early and often in a student's career. Developmentally appropriate expectations should be established and communicated. Students should be provided with opportunities for peer mentoring and other engaging experiences (e.g. service learning programs, independent study) [CUR, 2012].

Mary Catherine Adams (AGU)

URECAS workshop participants discuss challenges and solutions

3.2 Challenges faced by faculty engaged in research with two-year-college students

Most community colleges were founded on the mission of teaching to the broad community, i.e. open access. Research was not part of this mission, but because studies show that research conducted by students is a key teaching tool, community college professors must show that research equals good teaching [CUR, 2012]. For this to happen, the community needs to change the cultural perception of two-year-college research in the minds of administrators, students, and faculty. Administrators must understand the importance of undergraduate research and must be made aware of its educational merits for students and faculty. The financial issues surrounding research may be the most challenging; some faculty members have found that administrators support research as long as they don't have to pay for it.

At some schools, engaging in research may be considered a distraction from the faculty's teaching mission. As a result, some professors have found that it is better to keep their research below the radar. Yet this doesn't foster sustainable research programs. On the other hand, some community colleges actually have a research requirement for their faculty.

Additionally, there are many logistical hindrances to doing research, including securing funding, finding time to conduct the research and present or publish the results, dealing with a curriculum of online-only courses, and accommodating diverse student populations (i.e. veterans, active duty military, and members of underrepresented minorities). Faculty members may not have a research framework (such as an ongoing field site) or partners to network with onsite, leading to professional isolation. Further, there are sometimes cultural challenges to finding partners, i.e. some four-year colleges and industries are unwilling to work with two-year-college faculty.

In-person partnerships between faculty members at schools in different areas are not practical, given faculty teaching loads. As a result, faculty at rural institutions have less opportunity to form relationships because of geographical limitations. Laboratory and storage space to conduct research may not be available in overcrowded facilities or teaching laboratory spaces otherwise engaged for high volumes of classes. Finally, smaller two-year colleges may not have risk management capabilities, sponsored research offices, or institutional review boards in place.

In addition, some faculty members have not done research recently or ever in areas applicable to the environment and resources available at their two-year colleges. They will need time, mentoring, and financial support to develop the necessary skills. Professional societies can play a role in this arena with programs such as On the Cutting Edge (http://serc.carleton.edu/NAGTWorkshops/index.html) and workshops at the AGU Fall Meeting and other professional meetings.

Most two-year-college faculty members cannot leave for extended periods during the semester, either for research activities or for professional meetings, due to heavy teaching loads and the lack of teaching assistants to cover missed classes. Regional meetings may be easier for faculty to attend than national meetings because they are shorter, less expensive, and geographically closer.

Finally, because of heavy teaching loads, time for research is not built into the employment model. This means that faculty members must either be given release time or take time from their teaching, which is frowned upon. Hence, this reinforces the fact that research needs to be integrated into existing teaching methods.

4. Solutions

4.1 The role of AGU

URECAS is intended to support and foster two-year-college students in their Earth and space science educational careers, including those who choose to transfer to four-year institutions, and ultimately create pathways for them to enter the workforce. The program is focused on building diversity in the Earth and space science professions, which is a strategic priority for AGU (see appendices for AGU Strategic and Education Plans).

To ensure the role of two-year-college Earth and space science students in the future workforce, AGU has developed the following synoptic view of how to stop STEM pipeline leaks and promote the continuing education of those two-year-college students interested in pursuing the Earth and space sciences at four-year colleges or universities. This view is outlined below in Figure 2 and comprises 10 essential steps that need to be sustained over a period of 5–10 years to create a viable pathway into the workforce for two-year college students enrolled in Earth and space science courses.

Steps 1-3 have already been completed. AGU is currently working on Step 4, to bring 20 students and their advisers to the AGU Fall Meeting, the largest worldwide conference in the geophysical sciences, which attracts more than 24,000 Earth and space scientists, educators, students, and policy makers annually. This meeting showcases current scientific theory focused on discoveries that will benefit humanity and ensure a sustainable future for our planet. At the Fall Meeting, the students will present their research, participate in special programming and mentoring activities, and network with one another. The importance of these activities is echoed by the National Research Council report *Expanding Underrepresented Minority Participation: America's Science and Technology Talent at the Crossroads* [NRC, 2011], which found that students who engage in research and present their findings at conferences deepen their commitment to their program, discipline, and profession.

Specifically, the steps are to:

1. Identify geoscience programs at two-year colleges in the United States. (AGI maintains such a list.)

2. Establish a special session at AGU's Fall Meeting for undergraduates to present their research in collaboration with CUR. This was done for the first time at AGU's 2012 Fall Meeting, where 24 undergraduates, including seven two-year-college students, presented their work.

3. Identify two-year-college Earth and space science faculty currently involved in conducting research with students or those two-year-college faculty who send their students to established summer research programs, and convene a planning workshop. This was the focus of the URECAS planning workshop funded by NSF's Opportunities for Enhancing Diversity in the Geosciences program.

4. Enable two-year-college students and faculty to attend AGU's Fall Meeting (all expenses paid) and participate in student events and mentoring programs to help connect students with a research adviser and undergraduate mentor for their continuing studies in the Earth and space sciences. This program would be modeled after AGU's successful, decade-long Bright STaRS program (http://education.agu.org/diversity-programs/bright-stars/).

5. Identify a cohort of two-year-college students who are strongly leaning toward transferring to a four-year program in the Earth and space sciences. (Devise a process to identify these students nationally and establish a program to be modeled after AGI's Minority Scholarship (http://www.agiweb.org/mpp/index.html) and the Association of American Geographers' Community College Scholarship (http://www.aag.org/cs/grants/hess).)

6. Provide grants for the following summer to engage these students in research. (Establish a research grant competition for the former two-year-college students who successfully transfer to a four-year program.)

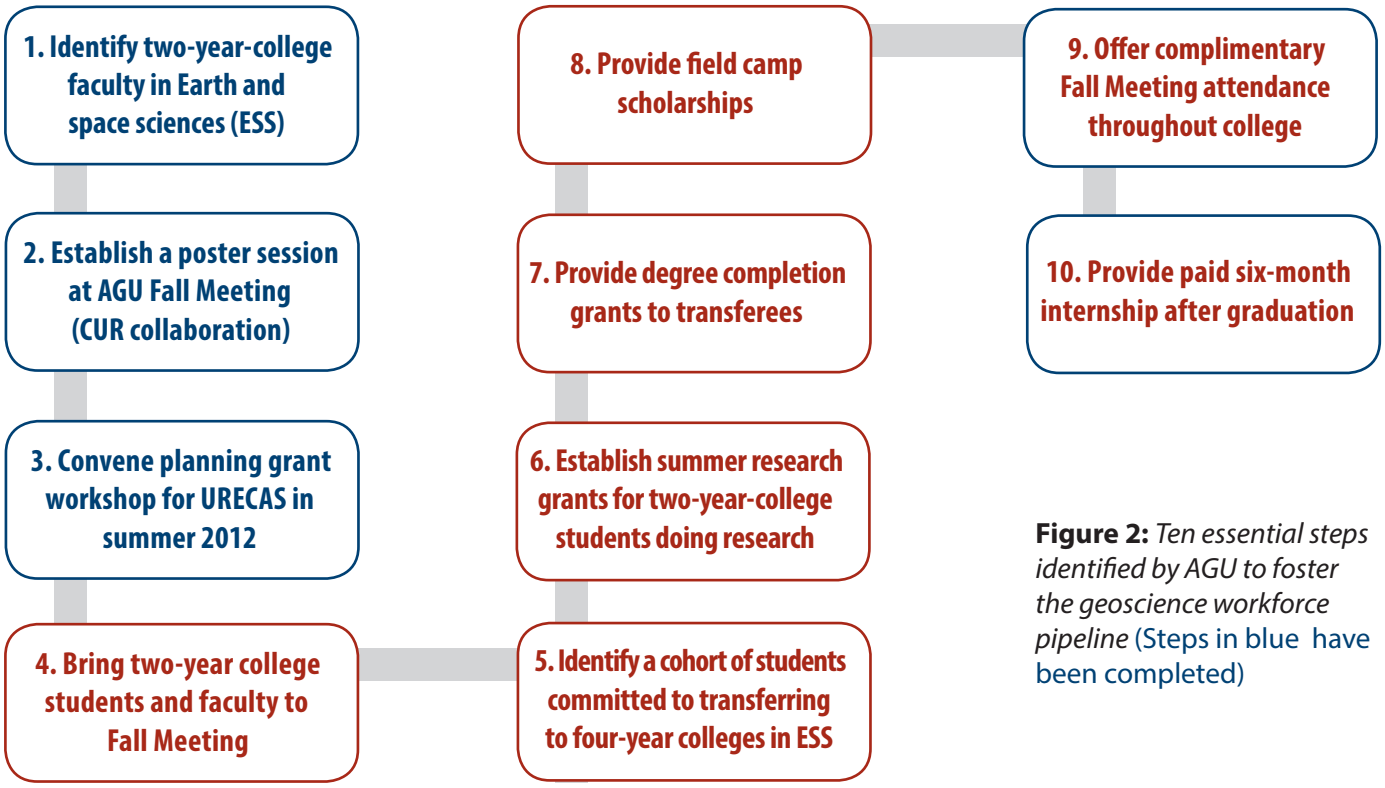

Figure 2: *Ten essential steps identified by AGU to foster the geoscience workforce pipeline* (Steps in blue have been completed)

7. Provide degree completion grants for the remaining two years of college for each student pursuing a bachelor's degree in the Earth or space sciences.

8. Pay for field camp experience for each student if required for degree completion.

9. Pay all expenses associated with attendance at AGU's Fall Meeting during the final two years of college. Provide opportunities to present research and participate in student programs during the meeting.

10. Provide a paid internship in a geotechnical company, an oil and gas company, a national lab, or a federal agency for 6-12 months upon graduation for each student.

4.2 Implementation of research programs at two-year colleges

AGU and other professional societies such as CUR realize that while faculty members are key to maintaining a successful research program, administrative support and commitment are also required. This commitment includes budget support, startup funding for faculty members who want to do research, credit for supervising undergraduate research, reassigned time for research-related activities, support for faculty interested in writing grants, and finally, student travel grants for research dissemination [CUR, 2012].

Two-year-college faculty workshop participants pointed out that in many cases implementing a successful research program requires a cultural shift; successful research models require a redefinition of two-year colleges as research-capable. Many research programs at two-year colleges involve collaboration with four-year colleges, and these relationships should be encouraged and fostered.

Faculty members agreed that successful models should include research across the curriculum of an entire program. Specifically, all Earth and space science courses should include a research component. At the simplest level, students can be exposed to the research process in class through an exercise where a research project is modeled without actually bringing in data. Students can go through the process of designing a research project, perhaps reviewing research articles with the discussion section omitted so that they derive their own conclusions. In sum, institutionalization of two-year-college research activities builds confidence, legitimizes research, and helps with applications to four-year colleges and graduate school.

4.3 Facilitating the transfer of two-year-college students to four-year colleges

To facilitate the transfer of two-year-college students to four-year colleges, two-year-college faculty should

cultivate contacts at institutions with cultures and programs where transfer students will be successful. Faculty-to-faculty contact is essential to enable transfer students to be adequately prepared. Two-year-college faculty members are generally aware and capable of creating appropriate transfer plans for individual students. They can be assisted by statewide transfer models that are designed to have general education and basic science core courses completed prior to transfer.

Dr. Allison Beauregard (NWFSC) and Dr. Matthew Schwartz (UWF)

NWFSC Aquatic Environmental Science students collect and process surface water samples for chlorophyll a

Connections with four-year institutions are also important for two-year-college students. This allows the students to meet faculty and be familiar with programs and the four-year environment. Rather than trying to connect to all of the four-year colleges that students may attend, faculty members should create one or two strong collaborations that will introduce the students to the four-year environment. It is important that this effort not be a burden solely for two-year-college faculty. The motivation for the four-year-college faculty to engage with two-year-college faculty and students is the broader impact for the four-year-college research faculty and graduate student mentoring and teaching at the two-year level. The two-year-and four-year-college faculty and students should be considered equal partners in any collaboration, even if their contributions are not equal.

Mentoring of lower-level students by those who have completed a research experience can also help with acquisition of basic math, science, and communication skills early on and encourage students to engage in research. When a student transfers, research done at the two-year college should be brought in the form of a portfolio so that there is a record of achievement, even if no credit is given on the student's transcript. This is also helpful for students who have not earned high grades, in that research experience may offset a weak GPA when students apply for admission into advanced programs.

Professional societies such as AGU, the Geological Society of America, the Society for the Advancement of Chicanos and Native Americans in Science, the American Indian Science and Engineering Society, and CUR recognize the importance of regional conferences for two-year-college students to present their research, get exposure, and build confidence. Additionally, internships at marine labs and other research groups have been a good vehicle for encouraging persistence. Participants also suggested that large research programs, such as Integrated Research Institutions for Seismology, could drive an online initiative that brings two- and four-year research activities to the same problem. This would be helpful for those who are geographically isolated.

Similarly, four-year research programs could engage two-year schools to help with the analysis of large amounts of data. A need was also identified for a Web-based resource to find the many opportunities and examples of how best to enable two-year-college research students to experience a four-year research environment and ways to show mutual benefits that result from two- and four-year research collaborations.

4.4 Best practices for addressing the needs of diverse students

All students need advising and mentoring, but students who are members of underrepresented minorities may need especially strong advising and mentoring programs. These might include tutoring and ESL classes, as well as logistical components such as daycare for students' children. Social aspects (learning communities, student clubs, interest groups, etc.) are also key in keeping students engaged and are part of

mentoring [CUR, 2012; NRC 2012]. Some faculty members said they work closely with students throughout their first science class, then expect the students to take more personal responsibility for success.

Place-based learning is particularly appropriate to the two-year-college environment, as community colleges have a mission to serve the local population. Place-based learning also resonates with students who haven't traveled much but know their home region well. Place-based research is often successful in engaging students, as it allows them to see the connection between science and social issues. Finally, a cautionary note: as needs are met, new needs emerge. Faculty must find a balance between meeting the needs of diverse learners and meeting curriculum goals and encouraging self-efficacy.

5. Conclusions

Two-year colleges are critical to the future of the U.S. workforce because they offer a pathway to four-year-college degrees and employment in STEM and other disciplines. The Earth and space sciences are strategic elements of the overall STEM community and offer today's students an employment opportunity of a lifetime. Students can uncover the Earth's deepest mysteries, unlock the secrets of outer space, or set their sights on anything and everything in-between. Their work could help predict severe weather episodes such as earthquakes or hurricanes, protect national security, or ensure economic competitiveness through access to little-known natural resources.

AGU is committed to helping nurture the next generation of Earth and space scientists through URECAS and other initiatives. The July 2012 URECAS planning workshop was a productive meeting filled with discussions of challenges and best practices in using research as a tool to enhance the STEM education of two-year-college students and foster their future success. As we continue to work in this arena, we look forward to continued collaboration with two- and four-year-college faculty and students, other professional societies, and the education research community.

We deeply appreciate and wish to acknowledge the work of the URECAS planning workshop participants. We are especially grateful to J. Scott Sires, Laura Guertin, Dean Moosavi, Paul Marchese, Wendy Harrison, Todd Radenbaugh, and Heather MacDonald, who led discussion groups at the workshop and/or provided helpful comments on this document.

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7. Appendices

7.1 AGU Strategic Plan

Strategic Plan

Approved by Council 7 June 2010

Core Mission

The purpose of the American Geophysical Union is to promote discovery in Earth and space science for the benefit of humanity.

Core Principles

As an organization, AGU holds a set of guiding core values:

- The scientific method
- The generation and dissemination of scientific knowledge
- Open exchange of ideas and information
- Diversity of backgrounds, scientific ideas, and approaches
- Benefit of science for a sustainable future
- International and interdisciplinary cooperation
- Equality and inclusiveness
- An active role in educating and nurturing the next generation of scientists
- An engaged membership
- Unselfish cooperation in research
- Excellence and integrity in everything we do

When we are at our best as an organization, we embody these values in our behavior as follows:

- We advance Earth and space science by catalyzing and supporting the efforts of individual scientists within and outside the membership.
- As a learned society, we serve the public good by fostering quality research in the Earth and space-sciences and by publishing the results of research.
- We welcome all in academic, government, industry, and other venues who share our interests in understanding the Earth, the planets, and the space environment, or who seek to apply this knowledge to solving problems facing society.
- Our scientific mission transcends national boundaries.
- Individual scientists worldwide are equals in all AGU activities.
- Cooperative activities with partner societies of all sizes worldwide enhance the resources of all, increase the visibility of Earth and space science, and serve individual scientists, students, and the public.
- We are our members.
- Dedicated volunteers represent an essential ingredient of every program.
- AGU staff work flexibly and responsively in partnership with volunteers to achieve our goals and objectives.

Vision Statement

AGU galvanizes a community of Earth and space scientists that collaboratively advances and communicates science and its power to ensure a sustainable future.

Description of Envisioned Future

What will it look like when we have achieved our vision?

- AGU is perceived as an authoritative source for Earth and space science.
- Members feel empowered and that AGU is representing their science well.
- Members feel a part of a larger voice, that they make a difference.
- The organization is transparent and responsive to member needs.
- AGU is a model of excellence, diversity, integrity, and equality that attracts and retains the best scientists and students.
- AGU journals are leading in terms of attracting the best science and having the greatest impact.
- AGU has a dynamic portfolio of sustainable programs—including meetings, publications, and collaborations—that address the needs of interdisciplinary science.
- AGU works in partnership with many other organizations and is viewed by its collaborators as open, welcoming, and supportive.

- In large part due to AGU's efforts, the public understands that Earth and space science affects everyday life and contributes to solving the pressing problems facing humanity today. As a result, people recognize their connection to the universe.
- As an organization, AGU is widely known and respected by individuals and organizations as a reliable source of high-quality Earth and space science information. AGU has become a household name.
- AGU offers resources for members worldwide to discuss science and exchange ideas.
- There are rapid response teams of experts to work with staff to get information out quickly when there is a need for AGU to take action or develop a public position on rapidly evolving situations related to geophysics. These well-trained science communicators can be mobilized individually and in groups to provide information.
- The AGU structure accommodates discipline-specific science and interdisciplinary, integrated groups.
- As an organization, AGU is adaptive and flexible and continually reinvents itself to remain nimble and relevant.

3-5 Year Outcome-Oriented Goals

Scientific Leadership and Collaboration

The AGU is a leader, collaborator, and sought-after partner for scientific innovation, rigor, and interdisciplinary focus on global issues.

Science and Society

The AGU engages members, shapes policy, and informs society about the excitement of Earth and space science and its role in developing solutions for the sustainability of the planet.

Talent Pool

The AGU is a diverse and inclusive organization that uses its position to build the global talent pool in Earth and space science.

Organizational Excellence

As a scientific society, the AGU operates within a new business model that is sustainable, transparent, and inclusive in ways that are responsive to members and stakeholders.

Objectives

Scientific Leadership and Collaboration

The AGU is a leader, collaborator, and sought-after partner for scientific innovation, rigor, and interdisciplinary focus on global issues.

1. Transform the future of AGU's scientific publishing in an evolving marketplace.
2. Articulate our communications, partnerships, and collaborations to position AGU and its science appropriately in the emerging landscape of societal needs.
3. Develop strategies for collaboration (joint meetings and publications) with other learned societies and develop a plan that enhances the quality of all scientific communications.
4. Develop an interface between our science and that of other disciplines—including engineering, public policy, global governance—to best inform decision making.
5. Strengthen AGU's ability to operate in an interdisciplinary manner.
6. Empower and enable AGU scientists to undertake interdisciplinary research to address key societal issues.

Science and Society

The AGU engages members, shapes policy, and informs society about the excitement of Earth and space science and its role in developing solutions for the sustainability of the planet.

1. Expand training, recognition, and reward of AGU scientists for excellence in communicating science to nonscience audiences.
2. Develop mechanisms to support interdisciplinary collaboration among members.
3. Increase awareness of the importance of Earth and space science issues for nonscience audiences.
4. Increase effectiveness and recognition of AGU among decision makers as an authoritative

source of integrated, interdisciplinary Earth and space science information.

5. Increase awareness of the reality and consequences of global climate change among scientists and the public.

6. Increase the role of Earth sciences in informing policy and mitigating impacts of natural disasters.

7. Raise awareness of natural resource limitations and increase the application of Earth sciences in developing solutions for the sustainability of the planet.

Talent Pool

The AGU is a diverse and inclusive organization that uses its position to build the global talent pool in Earth and space science.

1. Increase our understanding of the real barriers to gender and ethnic diversity and involvement within AGU and within Earth and space science.

2. Enhance engagement and involvement in AGU of students and early career scientists.

3. Identify career alternatives within Earth and space science and the subsequent career paths available.

4. Enhance mutual support and networking opportunities for students and early career scientists.

5. Increase participation of underrepresented populations.

Organizational Excellence

As a scientific society, the AGU operates within a new business model that is sustainable, transparent, and inclusive in ways that are responsive to members and stakeholders.

1. Increase awareness among members about AGU's full scope of activities and opportunities and that AGU is more than meetings and publications.

2. Expand sources of revenue outside the current publications and meetings model.

3. Enhance existing revenue sources.

4. Optimize effectiveness (capacity) of technology and technology resources.

5. Optimize expenditures and operations in programs.

6. Improve responsiveness to members.

7. Increase transparency of governance, finance, and operations.

8. Improve governance effectiveness, efficiency, and visibility.

9. Increase environmental sustainability of operations.

10. Enhance diversity and inclusiveness.

7.2 AGU Education Plan

Strategic Communications and Outreach Plan for Primary/Secondary/Undergraduate Education
Introduction

Ann Cairns, Director, Strategic Communications and Outreach, AGU; Version 10/12/10

While AGU's Strategic Plan (approved by Council 7 June 2010) does not specifically address primary and secondary education among its objectives, outreach in this area plays a significant role in developing and nurturing the next generation of Earth and space scientists. Each of the following goals, strategies, and tactics will help AGU meet its talent pool goal related to workforce development. Particular emphasis is placed on building partnerships and collaborations that will increase the effectiveness of AGU's outreach efforts related to education.

Goal: Increase diversity within the Earth and space sciences and within AGU.

Strategy: Contribute education-related input and expertise to AGU's upcoming diversity initiative.

Tactics:

1. Utilize the expertise of AGU members who head successful diversity programs at the college/university level. Identify relevant members and their programs for participation on or input to a multi-year task force.

2. Evaluate current education activities related to diversity (e.g., Bright STaRS, support for MSPHD) for impact and scalability.

3. Identify additional sources of information and expertise outside of AGU, and selec-

tively participate in programs that will add to our understanding of the barriers to diversity.

Goal: Strengthen Earth and space science departments and undergraduate teaching at the college and university level.

Strategy: Partner and collaborate with organizations with the core purpose of strengthening undergraduate education.

Tactics:

1. Support the AGU Heads and Chairs group in their efforts to strengthen Earth and spaces science departments at the college and university level.

2. Collaborate with the National Association of Geoscience Teachers (NAGT) and other organizations focused on improving Earth and space science teaching at the undergraduate level. NAGT program opportunities include sponsorship of *On the Cutting Edge* professional development workshops at the AGU Fall Meeting and sponsorship of member-scientists to participate in the NAGT speaker series.

Goal: Strengthen professional development of primary and secondary education teachers of Earth and space science.

Strategy: Partner and collaborate with organizations that have teacher professional development as a core purpose, providing access to AGU member-scientists and their research.

Tactics:

1. Partner with the National Earth Science Teachers Association (NESTA) in:

   a. Professional development workshops based on the GIFT model at the AGU Fall Meeting and NESTA events at the National Science Teachers Association annual conference and three regional meetings.

   b. NESTA's webinar program for teachers. NESTA educators to organize workshops with interested AGU members as presenting scientists.

   c. A founding partnership in Windows to the Universe that will give AGU a seat on the advisory board and provide access to science published by AGU and presented at its meetings.

2. Monitor additional opportunities and selectively participate in other collaborative ventures supporting Earth and space science education (e.g., K-12 Ocean Sciences Education Coalition initiative) based on their potential for impact.

Goal: Provide opportunities for interested AGU members to participate in outreach activities and programs.

Strategy: Organize activities and events in partnership with Section and Focus Group education and public outreach committees.

Tactics:

1. Facilitate information exchange among outreach committees on activities, what's working and not working, and possible collaborations (e.g., Exploration Station and Public Lecture at Fall Meeting, etc.)

2. Encourage formation of new Section and Focus Group outreach committees where none exist.

3. Provide workshop manual for Section and Focus Groups that wish to offer professional development workshops for primary and secondary education teachers outside AGU.

Strategy: Support organizations offering informal Earth and space science education programs that include opportunities for AGU member-scientist participation.

Tactics:

1. Develop process and criteria for evaluating requests for AGU participation.

2. Write letters of support for those in alignment with AGU strategic priorities, with potential for significant impact, and that include rigorous assessment and evaluation components.

3. Facilitate access to scientists interested in participating in funded programs.

4. Monitor science festival activity through the Science Festival Alliance, and collaborate with other Earth and space science organizations, as appropriate, in a maximum of one festival per year.

Strategy: Encourage member involvement through the Education Special Interest Group (ESIG).

Tactics:

1. Communicate regularly with members of the ESIG regarding outreach opportunities, and solicit input and feedback on programs.

Goal: Support national STEM education initiatives

Strategy: Collaborate with other organizations on public policy initiatives.

Tactics:

1. Contribute to strategic agenda development with American Institute of Physics, AGI, and others.

2. Actively participate in the STEM Education Coalition.

3. Facilitate participation of AGU members, including ESIG members, in commenting and providing feedback on national initiatives (e.g., NAS/NRC Strategic Framework for Science Education).

Joshua Villalobos (EPCC)

Marie Gomez (EPCC) using a Portable X-ray fluorescence (XRF) to locate pollutants in desert sediments around El Paso, Texas.

Joshua Villalobos (EPCC)

From left-right, Belinda Gonzalez (EPCC), Marissa Cameron (UTEP) and Galen Kiep (UTEP) conducting a Real-Time Kinematic Survey for a groundwater study at Keystone Heritage Park, El Paso, Texas.

Dr. Allison Beauregard (NWFSC) and Dr. Matthew Schwartz (UWF)

NWFSC students practice collecting and processing GPS data for Dr. Allison Beauregard's Aquatic Environmental Science course

The URECAS workshop and report was supported by the National Science Foundation Geosciences Directorate

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Dr. Allison Beauregard (NWFSC) and Dr. Matthew Schwartz (UWF)

Northwest Florida State College student practicing with Van Dorn water sampler.