

## Weaving the Web: Evaluation Strategies to Help Native-American Undergraduate Research Training Programs Navigate Students to Success

Native-American cultures are characterized by strong connections to community, family, and the land. These connections are integrated into Native-American education, resulting in curricula that are different from those in Western educational systems. Differences between Native-American and Western cultures create challenges for those educated in Native-American education systems when they pursue postsecondary education in Western cultures. The under-representation of Native-Americans among those earning degrees reflects both extremely low enrollment rates and generally poor retention rates for Native-American college students (UA 2009).

Obstacles for Native-American students include inadequate academic preparation, cultural differences, vague constructs of educational or vocational goals, insufficient financial aid, and social isolation (McClellan et al. 2005). Engaging Native-American students in research is one strategy for overcoming these obstacles and improving their college experience. Here we describe a research-based training program focused on Native-American undergraduates, the evaluation model and process used to evaluate this program, and the paradigm-shifting insights that emerged from the evaluation data.

### Training Program

Our training program is situated within the Partnership for Native American Cancer Prevention (NACP), a collaboration between Northern Arizona University (NAU), and the University of Arizona (UA) Cancer Center. The collaboration is funded by the National Cancer Institute of the National Institutes of Health. The objective of the partnership is to eliminate cancer health disparities in Native American communities through training, research, and outreach activities. Since its beginning in 2002, the NACP training program has continually grown and evolved to pursue a model of excellence in undergraduate education (Hensel 2012) by adopting strategies for ensuring success of Native-American undergraduate students.

These strategies or best practices were identified at NAU and UA as a result of implementation of a variety of research programs centered on working with Native-American students (Ingram 2009). The strategies include developing relationships between Native-American communities and the academic institutions; offering research experiences to

students at early stages of their collegiate careers tailored to their skill levels; conducting research projects that directly impact Native-American students and their communities; providing funding and academic and social support services for students; providing cultural-awareness training for non-Native-American mentors; and connecting students with faculty, staff, and peer mentors.

The NACP training activities at each institution (NAU and UA) are directed and carried out by a faculty member and a program coordinator. A fundamental aspect of the program is the opportunity for Native-American students to work one-on-one with various faculty members at NAU or UA who are conducting a research project. The activities include early research exposure for incoming freshmen, summer research for students at two-year tribal and community colleges, and academic-year and summer undergraduate research for students enrolled at NAU and UA.

The training program also provides professional-development activities for more advanced NAU and UA students. These activities include assisting students with preparation for graduate-school entrance exams, navigating the application process to graduate and professional schools, and writing workshops. Native-American students thus are provided with mentoring and research experiences important to both their communities and their career development. Table 1 illustrates the number of students who participated in NACP training program activities between 2009 and 2013. Major training activities outlined in Table 1 include: (1) undergraduate research during the academic year; (2) summer research programs; (3) pre-research exposure; and (4) professional development. Students who participate in undergraduate research during the academic year are being mentored by a funded NACP researcher. The research component of the NACP program funds pilot and full research projects related to cancer and Native-American populations. Students are able to work with a mentor on these projects, which range, from bench science (cancer biology) to social science. There are a number of summer research-training programs offered through NACP. These programs offer intensive mentored research opportunities (often with NACP research projects). Summer programs are offered for undergraduates at various levels in their education. Tribal community college students are exposed to their first hands-on experience with research

while NAU and UA undergraduates work with graduate students and faculty mentors to expand their research skills in the area of interest (environmental chemistry or nursing, for example). NACP offers training for incoming freshmen to learn about what types of cancer research is going on at the universities and what health-related careers are possible. Opportunities for professional development include student poster presentations at annual NACP Program Steering Committee meetings and poster sessions in a Tribal community to disseminate their project's findings.

**Table 1. NACP Research and Professional Development Activities (2009-2013)**

Activity	Total Undergraduates	Native-American Undergraduates
Undergraduate Research (Academic Year)	74	62
Summer Research (NAU & UA students; 2-year tribal/community college students; external internships)	121	99
Pre-Research Exposure	80	21
Professional Development	102	87

## Development of a Best-Practices Approach to Evaluation

Program evaluation and assessment are essential but can be difficult to do well, particularly when dealing with multicultural programs. However, there are key program elements required for assessment and evaluation models that work with Native-American students involved in undergraduate research. Our evaluation model follows a “logic model plus” design (Figure 1), which includes feedback on partnership dynamics (for partnership metrics, see Briody and Trotter 2008; Trotter et al. 2015), in addition to traditional output metrics.

Our integrated evaluation design addresses the need to conduct systematic and comprehensive analyses of processes, outcomes, and impacts and also the need to conduct assessment of metrics and mileposts for complex partnerships. The milestones, implementation, evaluation, and feedback plan provide tools for assessing NACP performance and for addressing issues of underperformance.

## Personnel

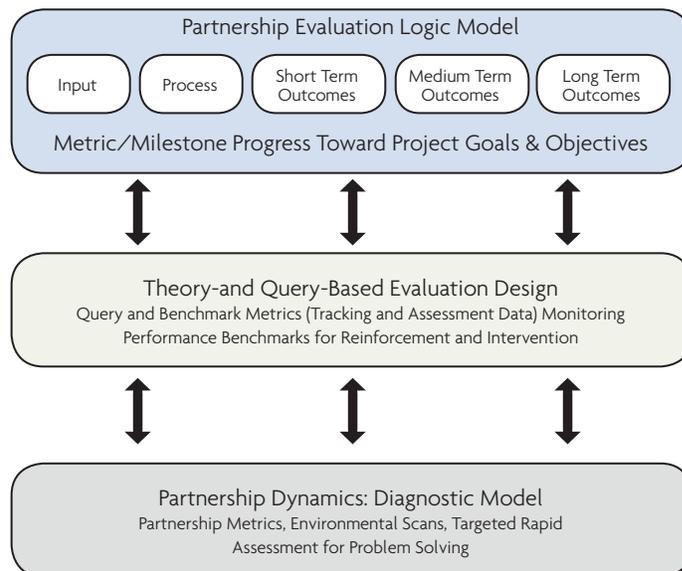
The evaluation team consists of four individuals who contribute to data design, collection, and analysis. The

program evaluator oversees the overall design of the evaluation, development of instruments, and analysis. The evaluation coordinator oversees all of the daily operations, directs the evaluation staff, and is responsible for data collection and analysis, quality control, and report generation. The rest of the staff, normally a graduate student or student intern, is responsible for data entry, some analysis, and assistance with report writing.

There is a certain amount of debate about the best structure and positioning for an evaluation team. At one extreme, some programs require independent evaluators who arrive on a quarterly, semi-annual, or annual basis and generate data and recommendations on a program, based on their “distant objective lens.” For programs focused on Native Americans, this type of evaluation often fails to generate trust, frequently ignores important context, and does not generally provide the evaluators with information on key personnel issues. At the other extreme are fully integrated evaluation teams (some call this “the fox in the hen house approach”) that are indistinguishable from the rest of the program team. In our experience, this type of embedding also produces the potential for skewed data to avoid hurt feelings and damaged relationships.

Truly effective evaluation requires that the whole project team be committed to and contribute to the assessment process during all stages of the project, but it also requires that the evaluation team assume a semi-independent (balanced insider-outsider) approach based on clear understanding of context and with the ability to “speak truth to power.”

**Figure 1. “Logic Model Plus” Evaluation Design**



This positioning requires difficult balancing, but it allows the evaluation team to develop the trust and credibility to provide for a highly effective feedback loop. This allows prompt reports on program progress and quick identification of issues as they arise.

## Data Collection

The evaluation data for NACP training programs is collected from program personnel (primary investigators/PIs, students, mentors, and collaborators) using instruments developed specifically to pinpoint progress (milestones) and impact (metrics) in order to evaluate short, medium, and long-term progress toward goals, using an online data-collection system. The overall process follows newly established procedures (Trotter et al. 2015) for conducting evaluation of complex educational, outreach, and research programs. Those procedures include: (1) identification of key program metrics (captured in the program logic model, for example, Mentoring Native-American students to succeed in undergraduate studies and give them hands-on exposure to cancer research; (2) linking those metrics with stakeholder groups to develop an appropriate loop for feedback and quality control (including the timing, content, and recommended actions for both outcomes and impact evaluation); and (3) recommendations for action based on both the metrics and process-evaluation information.

The NACP evaluation instruments were developed through the creation of a document that includes the NACP training program's aims and milestones and the NACP's logic-model outcome metrics. This allowed us to create data-collection instruments tied to the overall goals and objectives of the program. Each instrument was vetted by the training staff for appropriateness, validity, and utility. The initial instruments included: a student-tracking system, mentor/mentee assessments, pre/post-program skills assessments, evaluation of training-specific activities, research progress (indicated by grants and publications), student focus groups and exit interviews for students who participated in a national internship, and our relationship-dynamics instrument, designed to show the structure and the programmatic relationships among all the participants.

Since we wanted to simultaneously conduct a theory-based evaluation and to make the evaluation program a part of the overall NACP research endeavor, all elements of the NACP evaluation are approved by the institutional review board (IRB) at NAU and subsequently approved at UA through an IRB reciprocity agreement. IRB approval is required in order to use the evaluation data for publications that inform best practice in evaluation. As the partnership evolved, we adjusted the evaluation instruments based on feedback provided by our participants (researchers, students, and staff

members). We initially used instruments consisting primarily of open-ended questions. It was extremely difficult to analyze these data due to the variability in quality and poor response rates as we discovered mentors tended to provide minimal information when asked to complete evaluation surveys with many open-ended questions. We addressed this issue by redesigning the instruments to make them less time-consuming for mentors. Developing evaluation instruments that are user-friendly contributed to our successful evaluation process. For example, the integration of skip logic or branch logic in online surveys, developed in Lime Survey (an open-source online platform), enables respondents to use a customized path through the survey that varies based on the respondent's answers (Schmitz 2012). Furthermore, the incorporation of legacy data as dropdown responses (rather than open-ended questions) increased response rates as it decreased the time to complete a survey.

Our evaluation team designed a data-request calendar to organize which training data should be collected when. The collection of training data is structured around a combination of the universities' academic calendars and the timeframe of the training programs. For example, scheduling requests for mentor and mentee evaluations occur during the middle of the semester (November and April) so as to not interrupt finals and to allow sufficient time for mentoring to occur. A majority of the requests for evaluation data are made via e-mail, sending online survey links to respondents. The students' evaluations of their summer training programs are completed on paper to ensure high response rates. Mentors are engaged in the data-collection process and asked to remind students to submit the requested evaluation survey(s).

With most of the data collected in the Lime Survey format, our team can export the data as Excel files in order to analyze the data for reporting purposes. Both quantitative data and qualitative data are included in the evaluation reports in order to address several dimensions of the training programs: programmatic, mentoring, professional development and student outcomes, and the impact of the program. Quarterly evaluation reports are produced for NACP, with special training reports disseminated upon the completion of each training program.

A successful evaluation plan requires the flexibility to make changes in the evaluation process and during implementation (Scarinci, et al. 2009). Each year, the training programs have "shape-shifted" to fit the students' needs. For example, students needed bridge programs to link undergraduates to graduate opportunities, so the Graduate Programs Primer was developed at UA. This is a two-day workshop with speakers from the graduate college, financial-aid office, and representatives from various graduate programs making

presentations. Programs were also modified as collaborations with other training programs at both institutions developed.

The organic but well-structured organization of the training program is critical to meeting students' needs. In the past four years, no summer training program has been exactly the same. There is a base structure stressing mentored undergraduate research, with additional opportunities for students to participate in conferences and poster sessions. Although the organic nature of these programs can be a challenge for comparative evaluation, our approach allows for a set of programs that evolve for the students (a web), rather than trying to fit them into a cookie-cutter mold (the traditional pipeline).

### Student Tracking

Program evaluation and assessment must provide functional mechanisms that allow tracking of students, which is challenging and often requires multi-layered approaches. NACP has trained more than 300 students over a ten-year period. No tracking system was developed during the first five-year funding cycle, and thus our evaluation and training teams later had to retroactively track students involved during the first funding cycle. There are several layers to the tracking system that has evolved over the past five years. The first component tracks current students working with mentors in our programs. This dataset is collected three times a year, keyed to the cycles of the academic year and summer training programs. Mentors are sent a brief survey asking them to name the students with whom they are working and to provide the students' status (new, continuing, left the project, graduated).

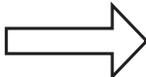
The second layer involves collecting some data (student ID number, name, ethnicity, major, planned graduation date) from the students when students complete their evaluations of the program(s) in which they participated. For the third layer of data-collection, we utilize the National Student Clearinghouse (NSC) to track students who have left our institutions; the NSC allows us to determine whether they have gone on to other institutions to earn degrees. We pair the NSC tracking with the NAU institutional system, PeopleSoft (the university software for human-capital management), in order to determine degrees earned by students and the enrollment status of current/past students.

### Selecting Measures of Performance for Evaluation

Our best-practices model includes the standard "logic model feedback system," provided on a monthly or quarterly basis. These metrics are key elements in the overall evaluation strategy and are solid diagnostics for program reinforcement

or intervention. The metrics come in two varieties. One is "process evaluation information" focused on meeting or exceeding program milestones or benchmarks. We use arrows to highlight progress or lack of it. Table 2 provides an example of this simple feedback system. This system provides program administrators with a quick status scan of each of the program milestones: A black arrow means positive progress and an increase from previous years. A white arrow means that progress has been challenged and needs to be monitored or that the milestone has not been reached according to the project timeline. A striped arrow indicates that a milestone has not been met and that there is a need for intervention.

**Table 2. NACP Milestone Progress Key**

Positive progress	Progress may have been challenged and needs to be monitored	Goal has not been met and there is a need for intervention
		

Our more-nuanced feedback system reports short-, medium-, and long-term metrics measured against benchmarks. Table 3 is an example of this form of feedback, provided by our best-practices model.

**Table 3. Progress Toward Training Program's Short- & Medium-Term Goals**

Goals	Training Outcome Measures 2009-2013	Overall Progress to Date
Short-Term Goal		
Increase number of Native-American students working on cancer research projects	Students being mentored in NACP Summer Training Programs: In a four-year period, the percentage of Native-American students participating in NACP undergraduate summer training programs increased from 48% to 73%. Students being mentored in NACP Labs/Research Projects: In a four-year period, the percentage of Native-American students participating in NACP research programs increased from 22% to 66%.	
Medium-Term Goal		
Increase graduation rates for NACP students	Baccalaureate graduation rate among Native-American students participating in NACP training programs is 63% (compared to the national average of 38%).	

## Insights from Evaluation of the NACP Training Program

Our research instrument on partnership health/relationship dynamics produced very thought-provoking results. Specifically, they challenged the traditional “undergraduate pipeline” thinking that is pervasive in undergraduate STEM (science, technology, engineering, and mathematics) programs. When we visualized the data modeling our student pipeline, using social network visualization, it became clear that our students do not, in fact, move through a pipeline.

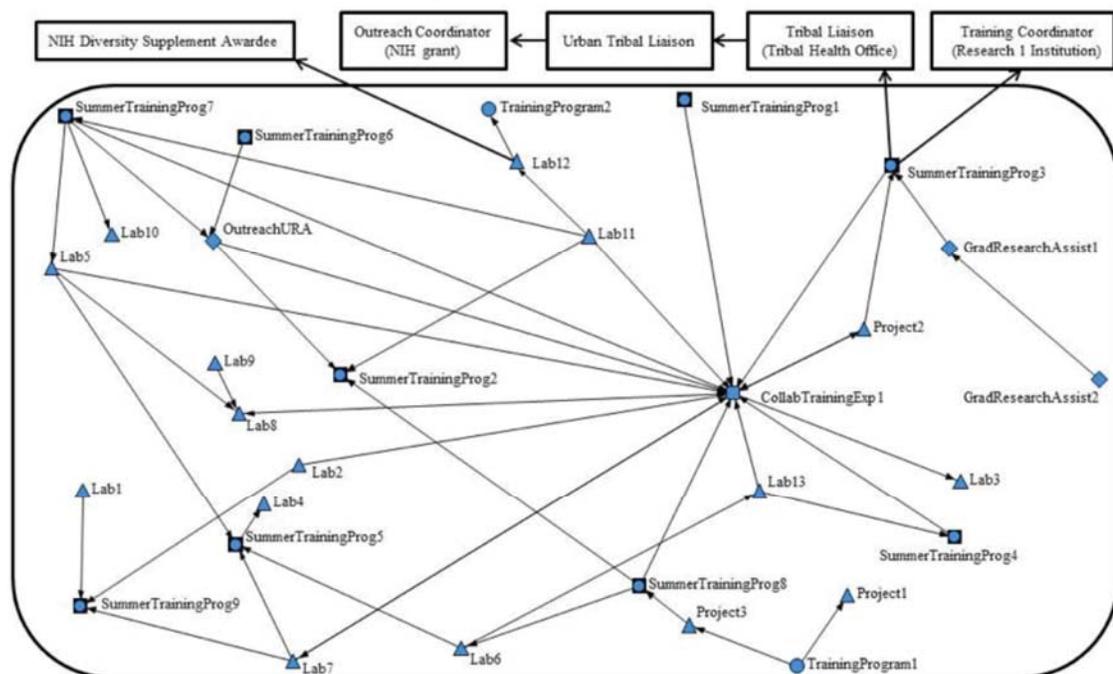
Pipelines are generally linear, flow in one direction, and tend to leak and narrow near the end point. What we found is a web of support in our model, which has multiple entry points and multiple (successful) exit points. Students can move smartly through the web from end to end, but they can also take very circuitous routes to their careers in science, going back and forth, up and down, and finally onward to success. From our perspective, this is a model of successful paths for Native-American students to take to reach careers in science. In fact, when we first visualized the web of pathways to success, staff members of the NACP training

program instantly came up with Native-American metaphors that fit the actual design of our program.

A traditional Navajo legend about Spider Woman (Hazen-Hammond 1999) clearly depicts the varied but successful paths that students take as they participate in training and research opportunities. Spider Woman was the first to weave an intricate web of the universe and in doing so taught the Navajo people to create beauty in their lives. Spider Woman’s web represents the multiple paths to beauty and pathways in life. It provides strength to those who navigate the web, and it reminds people that there is success in walking in beauty. Since a large number of the NACP students are Navajo, this appears to be a very valuable metaphor for the shape and substance of the NACP training programs.

Alternatively, other individuals in the program saw the web of success as the programmatic equivalent of a “dream catcher.” The legend or purpose of a dream catcher is to capture the “bad” dreams in life by tangling them in a web, but at the same time allowing “good” dreams to flow through to fulfillment. In either case, a web is far stronger than any single thread (or pipe), and consequently a better structure for a successful training program.

**Figure 2. Web of NACP Student Training Paths**



(Created using NetDraw, Borgotti 2002)

Figure 2 depicts the actual training-web pathways experienced by students in the NACP program. Based on this model, NACP students have exceeded average national graduation rates and have high rates of entry to graduate programs and health based careers. The paths that our students take through NACP training experiences vary greatly according to individual experience, interests, and needs. The approach has been organic in nature and relies on close communication between training coordinators and faculty mentors to

help determine the most appropriate path for each student. Each training program or research experience is shown in Figure 2. Arrows between each program show the web-like paths that students have taken. Several exemplary exit points/student outcomes are shown at the top of the figure.

Figure 2 was constructed using a basic program for social-network visualization. Each node in the diagram represents an NACP “pipeline” element or program. Similar types of training programs (for example, summer programs, hands-on lab experiences, mentoring programs) are categorized by specific shapes in Figure 2: (1) Research-based training working with a mentor in a lab or on a project focused on social science is depicted as a triangle; (2) training programs that occur in a condensed period (for example: mentored summer research experiences) are depicted as a circle inside a square; (3) doctoral-level training programs are depicted as a circle; (4) collaborative training experiences in which students come together from multiple programs for a course or a presentation on resources for graduate students are represented by a square; and (5) research-assistant positions are represented by a diamond.

The lines (connections) between the nodes in Figure 2 represent one or more actual students moving directly from one program to another, thus connecting the programs that support the web. When all of the nodes are connected, based on confirmed movement of students over the second five-year period of the training program, the actual structure of the web (including multiple entrance and exit points) can be visualized.

Once we constructed the visualization of the program based on actual student experiences, we are subsequently able to apply some basic strategies for social-network analysis to further investigate our programmatic web of success by focusing on the central (or peripheral) position of various program elements. Three types of “key player” analysis (Borgatti 2013) focused on fragmentation, reach, and distance (Borgatti 2006) are providing us with invaluable information on the role that specific programs play in our training web.

Fragmentation analysis identifies those nodes (in this case, programs) that are the glue that holds the entire network together. If one or more of the key programs are removed, the web of success fragments into disparate pieces, which would make movement from one training opportunity to the next challenging and thus would impact students’ abilities to move through the web. We found that four programs (out of 31) hold together 92.3 percent of the integrated pathways through the web. The critical programs

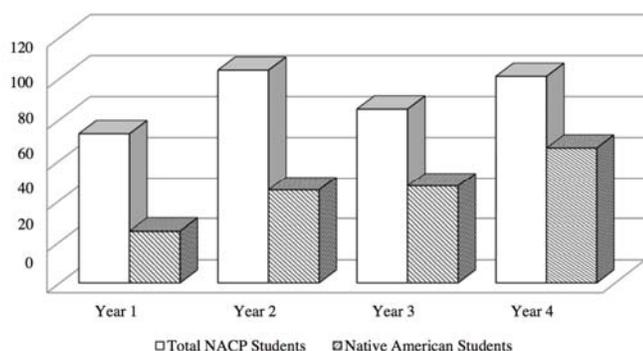
for successful movement through the web include three summer-training programs (summer-training programs 5, 7, and 8 shown in Figure 2) and the Graduate Programs Primer. Three of those programs provide students with the opportunity to work directly with a mentor during intensive summer research and then continue into a research lab during the academic year. The fourth program introduces Native-American undergraduates to post-baccalaureate, biomedical-related degree programs at the UA. Key to all four of these programs is the opportunity for undergraduates to discover the academic and career paths available to them through involvement in these programs. The practical or best-practices application of this analysis is to identify which programs in our “web based pipeline” need to be protected (at all costs) in order to insure the success of the overall program goals.

“Reach” is another pragmatic analytical measure that can be used to understand the dynamics of our web of success (Borgatti 2006). Reach is a measure of the connectedness of nodes (in this case the connectedness between elements in the student pipeline, such as labs and summer programs) in the web. The analysis demonstrates which nodes (programs) are the most directly connected with the maximum number of other programs. This allows well-connected mentors to guide their students to other programs that are within their “reach.” As an example, the reach analysis identified mentors who are extremely dedicated to working with Native-American students. In this case, two of 31 distinct training program opportunities could reach (and consequently help their students move) through 51.6 percent of the network. In this case, 8 of 31 programs have a total “reach” of 100 percent of the web. Working predominantly with those key players makes the whole system work more efficiently and effectively.

“Distance” is a social network construct that can be thought of in terms of “six degrees of separation” (Milgram 1967). It is a measurement of how individuals (or in this case programs) are connected to each other by multiple pathways made up of a series of individual (dyadic) linkages. “Distance” can be used to determine how many paths (and the number of links in those paths) a student could potentially follow to successfully move from program to program in order to navigate the web of success. It can also be an expression of how many steps are in between one program and another, and eventually how many steps to graduation. More pathways between programs would indicate more opportunities for navigation of the web, but the number of steps between opportunities would indicate that the road to success (graduation) can be longer or shorter, depending on

the path taken. The key player analysis of distance essentially identifies the programs that are crucial to keeping the steps to success as short as possible, given multiple pathways. This is particularly important with respect to the organic and web-like nature of student pathways, as Native-American students need multiple points of entry and exit into the training opportunities available. In many cases NACP labs serve as critical points in the network as they are connected to numerous training opportunities (Figure 2).

**Figure 3. NACP Student Participation in Training Programs and Research Projects (2009-2013)**



## Conclusions and Recommendations

This article outlines the NACP's evaluation approach and best-practices framed by *Characteristics of Excellence in Undergraduate Research* (COEUR) for working with Native-American undergraduates through mentored research. Several strong indicators prove the training/research strategies developed and fine-tuned by the NACP training program are effective strategies for working with Native-American students in undergraduate research settings. These indicators, tracked and monitored by the NACP evaluation team, include increases in Native-American students' involvement in mentored research (see Figure 3), and increased graduation rates among such students. Data show that 63 percent of Native-American students in NACP received bachelor's degrees compared to the national average of 38 percent.

We have learned that a web of support and opportunities provides a higher degree of success for Native-American undergraduates than a pipeline approach because the pool of Native-American students is small, many such students are nontraditional students (that is, older and often with family responsibilities), and Native-American students frequently start and stop their college careers or switch institutions. Thus multiple entry and reentry points into the web of opportunities accommodate the unique needs of Native-American students.

The use of social-network analysis provides a lens by which the NACP program can better define success through multiple pathways. Such analysis allows the program to identify the most important links in the web pinpointing the critical training programs and opportunities that make it possible for this set of programs to work together to benefit each student at the right time in his or her individual path. Successful movement through the web/network was found to be due to a small number of programs and individuals that have a direct impact on students' ability to move forward.

Two major factors that are present in the most critical training programs are engaged mentoring and programs or opportunities that allow students to learn about pathways to careers or graduate programs. The ability of the NACP program to adapt and allow students access to different training opportunities, combined with strong mentoring relationships and engaged training-program coordinators, are keys to success for helping Native-American undergraduates to continue on to graduate programs and successful career paths. 

## Acknowledgments

The authors acknowledge the support provided by National Cancer Institute grants (1U54CA143925/NAU & UA and 1U54CA143924/UA) and also acknowledge Christal Black and Tiffani Begay for their assistance in collecting information for our work. We thank our colleagues from the Partnership for Native American Cancer Prevention for their dedication to the evaluation process.

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### **Kelly Laurila**

Northern Arizona University, [Kelly.Laurila@nau.edu](mailto:Kelly.Laurila@nau.edu)

*Kelly Laurila is currently the evaluation coordinator at Northern Arizona University for five NIH-funded programs focused on Native-American health and resiliency, increased postsecondary graduation rates, and training for international minority health research and postdoctoral fellows. She received her BA and MA in anthropology from Northern Arizona University.*

*Jani C. Ingram is an associate professor in the Department of Chemistry and Biochemistry at Northern Arizona University. Her research focus is the study of environmental contaminants and their impact on health, particularly uranium contamination in water and soil. She is a member of the Navajo Nation and involved in training programs for Native-American students in undergraduate and graduate research. She is the director of the Bridging Arizona Native American to Bachelor Degrees and the John and Sophie Ottens Native American Undergraduate Research programs. Ingram also directs the training program for the Native American Cancer Prevention Program. Since joining NAU in 2002, she has mentored 87 students (high school, undergraduate, and graduate) on various research projects, including 37 Native-American students. Ingram received her BS in chemistry from New Mexico State University and her PhD in chemistry from the University of Arizona.*

*Margaret M. Briehl is professor in the Department of Pathology at the University of Arizona. She is vice chair of the UA Cancer Biology Graduate Program, and she has been the principal investigator on the NACP training program at UA since 2009. Her research focuses on mechanisms of treatment-resistance in cancer. As an NIH-funded investigator, she has trained 14 under-*

*graduates, five graduate students, and two postdoctoral students in cancer-related research. Three of the undergraduates were Navajo students who worked on an NACP research project co- led with Jani Ingram. Briehl received her BS in microbiology and PhD in molecular and cellular biology from the University of Arizona. She joined the University of Arizona pathology department following postdoctoral research at the Arizona Cancer Center and the Swiss Institute for Experimental Cancer Research.*

*Robert T. Trotter, II, is currently associate vice president for health-research initiatives at Northern Arizona University. He is a medical anthropologist with a strong background in qualitative methodologies, rapid-assessment strategies, and models of community-based participatory research, organizational collaboration, and community outreach models for collaboration. He has been primary investigator on several NIH grants (primarily in cross-cultural HIV and alcohol prevention and intervention studies), as well as receiving funding from other federal agencies and the World Health Organization. He currently directs evaluation for the Partnership for Native American Cancer Prevention and for the Center for American Indian Resiliency. Trotter received his BS in zoology and physiology from the University of Nebraska, Lincoln, and his MA and PhD in anthropology from Southern Methodist University.*

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