North Dakota Tribal College Faculty Research Model

Guiding Undergraduate Student Research in Science • Technology • Engineering • Mathematics
A North Dakota Tribal College Faculty Model

*Guiding Undergraduate Student Research In*

SCIENCE * TECHNOLOGY * ENGINEERING * MATHEMATICS

North Dakota Tribal College Faculty
North Dakota University Faculty
North Dakota Association of Tribal Colleges

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Cover by Frances Allard Abbott, Movement with Intent, PO Box 2573, Belcourt, ND 58316
Preface

North Dakota’s five tribal colleges and two research universities (Cankdeska Cikana Community College, Fort Berthold Community College, Sitting Bull College, Turtle Mountain Community College, United Tribes Technical College, North Dakota State University and the University of North Dakota) have been working together to establish smooth pathways and seamless transitions for Native American students who seek careers in Science, Technology, Engineering and Mathematics (STEM). The coalition will do this through (1) creating a strong alliance between the universities and the state’s tribal colleges; (2) implementing an initiative of research capacity building in tribal colleges that will engage tribal college faculty and baccalaureate anticipatory STEM majors in basic scientific research; and (3) instituting a data collection and management system with the goal of discovering, integrating and analyzing best practices that foster positive outcomes for Native American students pursuing STEM disciplines. It is hoped that this work will greatly enhance the quality of the STEM infrastructure at the tribal colleges in North Dakota and yield a model for other tribal colleges.

Statistics show that tribal college students are underrepresented in STEM fields according to written testimony presented to the Secretary of Education’s Commission on the Future of Higher Education in February 2006, by the Executive Director of the American Indian Science and Engineering Society (Silas, P. 2006, p. 10). Recent educational research has shown that students who engage in research projects are more likely to enroll in and complete STEM degree programs when compared to other students who do not have a research experience. Therefore, “engaging the tribal college students in research” is adopted here as a major strategy to improve their retention in STEM programs (Society for Industrial and Applied Math, 2005 April).

Besides the student research gains, engaging tribal college students in research has the potential of becoming pedagogically beneficial to the tribal college and university faculty. In order to provide a meaningful student research experience, the faculty need to be prepared. Responsibility of the tribal college faculty is primarily teaching. However, engaging in research and developing student research projects provides an opportunity to enhance their teaching and research capability. The process will also create a sound research collaborative platform between tribal colleges and the universities. Therefore, the faculty at the tribal colleges and universities are utilizing the approach of engaging the students in research as a first step to build research capacity at the tribal colleges.

The mentoring model adopted for providing research experience for students is an inclusive circular model. As shown below, the model allows for an ebb and flow of knowledge and skills among the various constituents who may support the student during his or her research experience. It is predicated on a mentoring community consisting of students, tribal college faculty, native professionals and intellectuals, university faculty, tribal elders, tribal community
members and a host of other resources necessary to support students in their endeavors. The volume of activity will depend on the mutual accessibility. The many different constituents in a student's circle may move inward or outward depending on student need, stage in the research, availability, best practice, or priority. The underlying assumption, however, is that a student should have access to any or all of the resources available to him or her in order to have a successful research experience.

**Inclusive Circular Model**

The models used in this document also reflect the belief that people differ in the way they perceive the world and differ in the way they express their beliefs. A person’s world view is a construct of the observations they have of the world in which they live. For some it is a reflection of events. For others it is transfer of knowledge from family or influences that are community based. This unifying force of cultural knowledge and spirituality of the American Indian students
enrolled at tribal colleges is one of the motivating factors for the development of this guide. Efforts will be made to encourage students to understand STEM through their cultural knowledge. A native-centered approach (native research paradigm) is encouraged (Wakshul, 2003, pp. 40-42; Duran, 2007, p. 80).

As tribal college students pursue research opportunities, this guide becomes a means to integrate indigenous knowledge with multicultural inquiries that are posed through science, technology, engineering and mathematics (STEM). This document contains guidelines for the tribal college faculty to employ as they mentor student research. It is anticipated that the student, tribal college faculty, and the university faculty will work together through the entire process beginning with the formulation of the project to its completion and dissemination. Important steps in the process include:

1. Examine the indigenous science perspective;
2. Develop community relevant student research projects;
3. Provide research experience for students;
4. Establish skills and expectations for research projects; and
5. Determine the quality of research by establishing requirements for reports, presentations, and dissemination of knowledge gained.

Suggestions to assist students include:

1. Be prepared to introduce research and scientific methods to students
   a. Inform students of the individual and community-based benefits of getting involved in research;
   b. Recruit students and get them involved in research;
   c. Identify research opportunities (tribal college, NDSU, UND, industry, federal/state agencies);
   d. Acquire necessary equipment and instrumentation;
   e. Determine whether to include the project in the curriculum or if it should be used as an enrichment activity for selected students only;
   f. Be prepared to instruct and mentor using the Native science paradigm throughout the research process;

2. Work with the student and the university faculty to develop and conduct the student research project and determine elements the project should contain;
3. Decide what the expected student outcomes will be from such an experience (this will be very helpful in evaluation);

4. Explain the skills students are expected to achieve;

5. Provide guidance for development of expected products, e.g., reports, presentations, papers, participation in conferences, etc;

6. Prepare students to present their research. Require students to prepare a poster that can be presented at conferences or at their home institution for other students and/or faculty to see. It will help students to learn to present their research; and

7. Decide what measures will be used for assessing outcomes such as skill level attained (this will be very helpful in evaluation).

While all students will benefit from participation in scientific inquiry, students selected to engage in STEM research are required to indicate a major in one of the STEM disciplines and maintain a minimum cumulative GPA of 2.5.

The rest of this document describes the suggested outline of activities to provide a successful undergraduate research experience for tribal college students.

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The Native Science Paradigm and Process
The Native Science Paradigm

As cultural ‘outsiders’ most teachers and other educators express concern about teaching the culture of American Indian people. Mainstream education provides very little, and in some cases no preparation for teaching a Native science paradigm which leaves most educators ill-equipped to build upon the cultural strengths of American Indian students. With this in mind, this section provides some information regarding the aspects of Native science that are most critical to understanding science from a Native cultural perspective. Tribal college faculty are strongly encouraged to utilize these precepts throughout the research experience with students.

Process of Native Science

(This section is used with permission of Dr. Gregory Cajete and is a direct quote from the book *Native Science: Natural Laws of Interdependence*, 2000, pp 66-71). Dr. Cajete, a Tewa Indian from Santa Clara Pueblo, is an assistant professor at the University of New Mexico’s College of Education.)

The perspective of Native science goes beyond objective measurement, honoring the primacy of direct experience, interconnectedness, relationship, holism, quality, and value. Its definition is based on its own merits, conceptual framework, and practice and orientation in the tribal contexts in which it is expressed. Concerned with the processes and energies within the universe, it continually deals in systems of relationships and their application to the life of the community. Science cannot divide its application into departments; it is integrated into the whole of life and being and provides a basic schema and basis for action.

For instance, the traditional Yupiaq people based their philosophy and lifeways on maintaining and sustaining relationships among human, natural, and spiritual worlds. The balance of nature, or ecological perspective, was of utmost importance to the Yupiaq. To understand the Yupiaq worldview it is necessary to understand the multiple meaning of a word that epitomizes Yupiaq philosophy. This word is “ella,” which is a base word that can be modified to change its meaning by adding a suffix or suffixes. Examples include “Qaill’ ella auqa?” (How is the weather?); “Qaill’ élan auqu?” (How are you feeling?); “Ellapak nunii” (The world’s land); “Ellagpiim yua” (Spirit of the Universe); “Ellapak” (Universe); and “Ella amigligtuq” (The sky is cloudy). Variations of this one root word can be made to refer to weather, awareness, world, creative force or god, universe, and the sky. The key word here is awareness of consciousness. Consciousness is the highest attainment of the human being; the human being must be able to make sense out of values and traditions as juxtaposed with the “objects” of the universe. As a manifestation of their “ella,” the Yupiaq developed a body of values and traditions that would enable them to maintain and sustain their ecological worldview (Kawagley 1995, p. 15).
Native science stems from a deeply held philosophy of proper relationship with the natural world that is transferred through direct experience with a landscape, and through social and ceremonial situations that help members of a tribe learn the key relationships through social and ceremonial situations that help members of a tribe learn the key relationships through participation and the "ella," as the Yupiaq would say. Methodological elements and tools of Native science that have traditionally facilitated such learning included:

**Observation.** Careful observations of plants, animals, weather, celestial events, healing processes, the structures of natural entities, and the ecologies of nature.

**Experiment.** In Native science, there is no deliberate attempt to distort a natural event beyond observation. Native people have traditionally applied practical experimentation at all times to find efficient ways to live in their various environments, and ingenious and ecologically appropriate technologies were developed.

**Meaning and understanding.** These were the priorities of Native science, rather than a need to predict and control. Meaningful relationship and an understanding of one’s responsibilities to those entities in nature that people depended on were the reasons for a Native science, which invited a desired result through entering into specific relationships with the energies of the natural world.

**Objectivity.** Native science reflects the understanding that objectivity is founded on subjectivity. There is a stress on direct subjective experience, predicated on a personal and collective closeness to nature, which will lead to an understanding of the subtle qualities of nature.

**Unity.** Native science stresses order and harmony but also acknowledges and honors diversity and chaos as creators of reality. "Relationships and renewable alliances take the place of fixed laws, and Indigenous science accepts the possibility that chance and the unexpected can enter and disturb any scheme. Thus, the circle is left open and chance as represented by the clown, the trickster, and gambling games, occupies an important role (Peat 1994: 257)."

**Models.** Native science also has models. Teaching revolves around high context models in which information is communicated at many levels, and which are highly representational and elicit higher order thinking and understanding. An example of such a ritual process model is the Plains Sun Dance, which may include symbols such as the circle, numbers, geometric shapes, special objects, art forms, songs, dances, stories, proverbs, or metaphors, all of which unify experience with meaning and facilitate the mind’s conscious process of connecting with the energies and animating power of nature. Native symbols go
beyond simple archetypes when they represent the universe itself, as with a ceremonial structure such as the Navajo Hogan.

**Causality.** Native science reflects a belief in causes that affect and go beyond the physical, principles such as synchronicity and the action of natural energies and entities. Other such principles include the transformation of energy to other forms and resonance with the order of the universe, as reflected in the adage, “as above so below”.

**Instrumentation.** Native science relies on preparation of the mind, body, and spirit of each person as the primary vehicle of “coming to know.” The mind and body can be used for careful, disciplined, and repeatable experimentation and observation. Knowledge is gathered through the body, mind, and heart in altered states of being, in songs and dance, in meditation and reflection, and in dreams and visions.

**Appropriate technology.** Because social value is gained by honoring mutual reciprocal relationships, spin-offs of Native science in technology are carefully applied. Adoption of technology is conservative and based on intrinsic need, and care is taken to ensure that technologies adopted and applied do not disrupt a particular ecology. Such care is grounded in the belief that it is possible to live well through adhering to a cosmology and philosophy honoring balance, harmony, and ecologically sustainable relationships.

**Spirit.** Native science incorporates spiritual process: no division exists between science and spirituality. Every act, element, plant, animal, and natural process is considered to have a moving spirit with which humans continually communicate.

**Interpretation.** Native science bases its interpretation of natural phenomena on context. Therefore, meaning is based on the context of the events and reflection of Native philosophy.

**Explanation.** Native science works with a multiplicity of metaphoric stories, symbols, and images to explain events in nature.

**Authority.** Native science gains its authority partly through the society, elders, direct experience, and dream or vision, and on the sanctity of the relationship established over time with particular environments. “Authority, if we are to use that word at all in the context of Native science, resides in individuals and their direct experience rather than some social establishment (Peat 1994: 265).”

**Place.** Particular places are endowed with special energy that may be used but must be protected. This sentiment extends from the notion of sacred
space and the understanding that the Earth itself is sacred. The role of people is to respect and maintain the inherent order and harmony of the land.

Initiation. There are both formal and informal pathways to certain levels of Native science. For instance, in the Midewiwin Society of the Ojibwe, there are four stages of initiation, each involving extensive training, learning of songs, ceremonies, stories, interpretation of special scrolls, and petroglyphs (Peat (1994: 267-68).

Cosmology. All philosophies are founded on an elemental idea of how the universe was created along with humankind’s emergence into the world, and Native science is connected to the origins and migrations of people through the American landscape and to notions of time-space, sacred cycles, astronomy, art, myth, ritual, and dance. Cosmology is reflected in the cycles of community celebrations, rites of renewal, and stories, and serves the important function of validating Native peoples’ way of life, core values, and social ecology.

Representation. Signs and formulas of thought appear in many forms, records in stone, clay, birch bark, hides, structures, and hundreds of other forms. These representations record key thoughts, understandings, and stories important to remembering aspects of Native science.

Humans. People play a key role in facilitating knowledge about the natural world in conscious thinking and tool making. Given this role, humans have special responsibilities to the natural world and to other living things. Native science is the study of learning and carrying out these responsibilities. Native science is about stewardship and the practice of deep ecology.

Ceremony. Ceremony is both a context for transferring knowledge and a way to remember the responsibility we have to our relationships with life. Native ceremony is associated with maintaining and restoring balance, renewal, cultivating relationship, and creative participation with nature.

Elders. Elders are respected as carriers of Native knowledge, wisdom, and experience. Therefore, they are utilized as the first line of teachers, facilitators, and guides in the learning of Native science.

Life energy. Life energy is acknowledged throughout the expressions of knowledge, understanding, and application. All things have life force. There is a natural energy that moves all things that must be understood and respected.

Dreams and visions. Dreams and visions are a natural means for accessing knowledge and establishing relationship to the world. They are encouraged and facilitated.
Paths. Predetermined systematic activities of learning are viewed as ways to search for and find knowledge. All of nature has these inherent patterns of trajectories, “right paths,” which reflect the unfolding of natural pathways through which it may be understood. The “Good Red Road,” “Dream-Time Path,” “Earth Walk,” and “Pipeway” are some of the ways Native peoples have referred to the directed path in the quest for knowledge, meaning, and understanding.

A North Dakota Tribal College Faculty Model

**Guiding Undergraduate Student Research In**

**SCIENCE * TECHNOLOGY * ENGINEERING * MATHEMATICS**

By

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Tribal College Faculty Model for Undergraduate Research

This model is a basis for STEM research conducted within the tribal college setting. Components of the Western-based model of scientific inquiry can be found within the model; however, this model is premised on essentially Native concepts of science and the interrelatedness of science and the natural world, as well as Native processes based on those beliefs. By integrating a Western-based model of scientific inquiry with a Native-based model of scientific inquiry, students will acquire skills that will enable them to conduct successful research either in, or away from, their respective reservation communities.

The model is a suggested outline of activities for implementing undergraduate student research. The suggestions are aimed at research projects that are student centered and designed for undergraduate students to give them an exposure to scientific methods of inquiry. Tribal college faculty, with involvement of the university professors who are mentoring the student research, should approve each project.

- **Inquiry**
  - Prayer, reflection, ceremony, discussion with elders or extended relatives

- **Exploration**
  - Discussion with elders or community members, literature review, clarifying the issue and its impact on the People

- **Causality**
  - Reflection on the interrelationships impacted by the issue, the intended line of inquiry, the possible outcomes of the research and the role of humans in it

- **Approach or Methods**
  - Reflection and review of historic and future path guiding the approach; review of relevant stories and traditions; review of possible methods and their implications

- **Action**
  - Conducting the research in a respectful manner

- **Determining Place**
  - Reflection and discussion of the place in the community for the findings and results; whether they are appropriate, valid, reliable and useful/harmful

- **Analyzing the Data**
  - Reflection on traditional interpretations and meanings of the results using Native epistemology, axiology and ontology

- **Sharing**
  - Use of both Western and Native protocols for presenting information, e.g. publishing the findings, if appropriate; talking to and with the community regarding the implications; possible use of ceremony
Explanation of Model for Native-based Student Research Protocols

1. Inquiry: Prayer reflection, ceremony, discussion with elders or extended relatives
   (See Meaning and Understanding in *Process of Native Science*)

   This step both begins and ends a fundamentally Native research process. This step involves asking reflective questions such as: Why should this research be conducted? What is the purpose or intended outcome of the research? How will it help the People? Will it be good for the People? Who will benefit? How will they benefit? Is it proper to ask the general question(s) I intend to ask? The process involves personal reflection, prayer, and, in some cases, ceremony. The process also recommends discussions with elders or extended relatives to gain their perspectives of these questions. This step is predicated on Native beliefs in the interconnectedness of all life. Research does not exist in a vacuum, nor is it a process unto itself. Native-based research must have a purposeful meaning for the community and must be mindful of potential harms. The step also acknowledges the wisdom of elders and the importance of ethics in the research process.

   In this beginning stage, students will be encouraged or guided to select a topic or problem for study that is of interest and is relevant to them. This will obviously increase their motivation and curiosity in their research project. “The research problem identifies your destination: it should tell you, your research supervisor and your readers ‘what’ you intend to research (Kumar, 2005, p. 20)”.

   The student should be guided by engaging tribal college and university faculty as they select a narrow enough problem or topic that can be successfully completed within a two-year time frame. They must also be informed of the protocols and legalities involved with vertebrate subjects research. Students conducting studies involving humans especially if potentially publishable should complete the NIH Human Participant Protections Education for Research Course and complete any Institutional Review Board procedures required by their college or reservation. If
a student’s topic will involve qualitative methods of data collection and analysis, the student should be mentored in conducting qualitative research.

Selecting the topic is obviously an extremely important and “tricky” step for any and all student research projects. Considerations must include costs, equipment requirements, institutional capabilities, institutional/reservation research requirements, student capability, and probably most important – time. And again, the student must be interested and connected to their research. Additional information about the undergraduate research process can be found at WebGURU:  [http://www.webguru.neu.edu](http://www.webguru.neu.edu) (See Appendix A)

2. **Exploration: Discussion with elders or community members, literature review, clarifying the issue and its impact on the People**

(See Interpretation, Authority, Initiation, Cosmology, Representation, Humans, Ceremony, and Elders in *Process of Native Science*)

This step builds on the previous step and involves actively researching the topic in a scientific yet culturally-congruent manner. This step would involve a formal **literature review**. All students will be required to conduct a literature review about their chosen topic. This will include electronic and library archival research of scientific peer reviewed journals and other public sources. Students will be trained in research instrument reliability (see Appendix B for information on research instrument reliability). After conducting their literature review they will submit an appropriate document discussing what research has already been done in the area of their intended research. The “literature review” document should also contain understandings as acquired through discussions with elders, community members, or other Native representatives as to the cultural perspective, history, implications, and impact of the issue to be researched. The questions to be asked in this step would include: What does [a/the/my] Tribe say about the issue? Are there any local traditions, stories, understandings that contribute to the overall knowledge about this issue? Am I asking the question(s) in a culturally-congruent manner? How might the answer(s) impact the People? Is it proper to ask the specific question(s) I intend to ask?
3. **Causality: Reflection on the interrelationships impacted by the research problem, the intended line of inquiry, the possible outcomes of the research and the role of humans in it**
   (See Objectivity, Unity, Models, Causality, Instrumentation and Appropriate Technology in *Process of Native Science*)

   This stage of research will help to clarify and determine the research question. This step involves creating a written document that outlines the stakeholders involved in the issue, the relationships impacted by the line of inquiry and outcomes of the project, and the role of the researcher(s) in addressing the issue. The questions asked in this step would include: Who is impacted by this issue? Who has been impacted historically? Who may be impacted in the future? How will the relationships be impacted by the results and/or recommendations of the research? This step would be a critical step in addressing the “black box” dilemma of research. It would refine and establish the actual **hypothesis.** The student predicts what they anticipate will be their research outcome.

   Ideally, students conducting independent research should have completed a statistics and/or a research methods course. If this is not the case, they will be mentored to obtain the necessary skills involved to state a hypothesis and alternatives. They should be familiar with the steps involved in designing a standard hypothesis testing procedure including confidence levels, null and alternative hypothesis, and acceptance intervals. If the student is utilizing qualitative research methodologies, assistance and guidance should be provided to assist in creating a flexible research design as well as qualitative research procedures. “The students will state a clear, specific problem that is easy to test (Kumar, 2005, p. 75).”

4. **Approach or Methods: Reflection and review of historic and future path guiding the approach; review of relevant stories and traditions; review of possible methods and their implications**
This step will analyze the best possible method(s) to use in the research. This path includes a written analysis, based on the cultural knowledge gained through the previous steps, of the different types of approaches that have been taken in addressing the issue, and the type of approach that would be culturally-relevant and congruent. It would include discussion with faculty mentors or a written document that would include a pro/con list of possible approaches and a short analysis of the cultural implications of the approach taken.

In this step, students will develop a written proposal of the research design with activities and timelines for conducting their research as well as measurable and obtainable objectives. Students should also be encouraged to submit a written budget estimate with supplies, materials, and man-hours included. Also included in the plan should be a data collection instrument. If students are collecting objective quantitative data, they should name independent and dependent variables, control group, and explain exact procedures with a data table that includes projected analyses techniques. If qualitative data is being collected, students should provide the design plan including what types of data will be collected, how it will be collected and how it will be analyzed for themes or overarching ideas. “The main function of research design is to explain how you will find answers to your research questions (Kumar, 2005, p. 20).”

5. **Action: Conducting the research in a respectful manner**  
   (See Place in Process of Native Science and Action in Native-based Research Protocols)

   In this step, the student will conduct the research. Students, guided by tribal college and university faculty mentors, will **select or develop a research instrument** to collect data. This includes selecting a sample that will be studied. Students will conduct their own research with guidance and oversight from tribal college and university faculty mentors. Conducting the research in a respectful manner would also entail notifying or working with tribal experts (if conducted on tribal lands), utilizing community-based expertise to enhance the quality of the data and the data-gathering techniques, using cultural frames of reference
(wherever possible) in interpretation of data, controlling access to any sensitive or proprietary cultural information, analyzing all documents and data for cultural relevance and appropriateness and using all proper protocols for accessing data among tribal lands, communities, and people. Students will submit progress reports at regularly scheduled meetings with their faculty mentor. The progress reports should include samples of the data collected and objectives attained. The mentor will offer any warranted suggestions for improving the reliability and validity of the research project. Discussions should follow regarding students’ progress and insights regarding the research project.

6. Analyzing the Data: Reflection on traditional interpretations and meanings of the results using Native epistemology, axiology and ontology

This step includes data interpretation. Students should analyze quantitative data gathered according to their experimental design plan utilizing computerized statistical software, such as Excel, Minitab, Jump, SPSS, or a statistical analysis methodology that they are comfortable using. Faculty mentors should closely oversee statistical analyses procedures to ensure validity and reliability.

Students analyzing qualitative data should be assisted through the process of analyzing results from interviews, focus groups, documentary data, or observation for emerging themes and significant outcomes. Faculty members should closely oversee the qualitative analyses as well. The data should also be analyzed using a cultural framework and applying the values, understandings and meanings of Native peoples to the findings. Questions that might be relevant in this step would include: Are there any cultural implications in the findings? If so, what are they? Are there any cultural influences in my interpretation of the findings? If so, what are they? What would be the similarities between conventional science and indigenous interpretation? What would be the differences? How might these differences be resolved? What, if any, are the cultural implications of the findings?
7. **Determining Place:** Reflection and discussion of the place in the community for the findings and results; whether they are appropriate, valid, reliable and useful/harmful
   (See Life Energy and Paths in *Process of Native Science*)

   In this step, students should be able to state whether their results warrant the acceptance or rejection of their null hypotheses and to what level. Students would also provide documentation of reflection or discussion of the meaning of the findings. In other words, are the findings helpful or useful for the community? How will the findings impact or integrate with traditional cultural knowledge? Who else will be impacted by the findings and their interpretation? What are the implications of these findings on the seventh generation? Where is the “place” for the findings in the community?

8. **Sharing:** Use of both conventional and indigenous protocols for presenting information, e.g. publishing the findings, if appropriate; talking to and with the community regarding the implications; possible use of ceremony
   (See Meaning and Understanding, Spirit, Authority, Place, Cosmology, Representation, Humans, Ceremony, Elders, Life Energy, Dreams and Visions, and Paths in *Process of Native Science*)

   In this step, students will address the following questions: What is the proper method for disseminating this information? What are the relationships that need to be addressed in reporting this information? Is there anything additional that needs to be done with the findings (e.g. ceremony, approval of elders, discussion with community, etc.)? What are the appropriate ways to present the information to the respective audiences? In this step, students should be encouraged to use the findings for a community-based and practical purpose. Students should also be encouraged to ask the question “What further research do these findings merit?” and relate their findings back to the first step of this process (Inquiry), recognizing the cyclical nature of community-based and participatory research.
Students will also be required to submit a written report of their complete research project. Reports will include:

- Abstract,
- Statement of the research question and its relevance and importance to Reservations/society in general
- Literature review
- Hypothesis
- Description of cultural content
- Methodologies
- Sample selection (such as site of experiment, sampling locations, subjects used for experimentation, etc.
- Description of the experiment or observations (research instrument, data collection, and data analysis)
- Written description, analysis, conclusions, dissemination of results and findings
- Recommendations for further research
- References
- Acknowledgments

The report should also include data tables, pictures, graphs, maps and a reference section as applicable. Students should present their research at poster sessions, meetings, seminars, and competitions utilizing PowerPoint or other presentation software, when culturally appropriate. Preparing posters that can be presented at conferences or at their home institution for other students and/or faculty to see will help students learn to present their research and findings.
References
References


Additional Sources

https://www.engineering-goforit.com/
http://faculty.ncwc.edu/toconnor/308/308lect09.htm
http://hampshire.edu/~apmNS/design/RESOURCES/HOW_READ.html
http://www.webguru.neu.edu (See Appendix A for description of site)
Appendix A

Online Undergraduate Student Research Guide
Appendix A -  Online Undergraduate Student Research Guide

The Division of Undergraduate Education of National Science Foundation funded a project that developed a web site, WebGURU, for students involved in (or contemplating being involved in) undergraduate research. WebGURU stands for Web-based Guide to Research for Undergraduates. Use of WebGURU includes topics and hints that mentors might not want to review individually or in class with students given time constraints, or for other reasons, such as providing opportunities for outside reading and reinforcement for the students.

WebGURU provides information on everything relevant to undergraduate research including laboratory safety, scientific ethics, and intellectual property and provides links to reliable web-based resources on these topics. In addition, the web site provides a listing of undergraduate research opportunities, fellowships/scholarships in support of undergraduate research experiences, and technical meetings and journals in which undergraduate students can publish the results of their undergraduate research experiences.

WebGURU is available at URL: http://www.webguru.neu.edu
Appendix B

Reliability
Appendix B - Reliability

Reliability in general means dependability or trustworthiness. Reliability is the degree to which a test or procedure consistently measures whatever it is measuring (Gay and Airasian 2000, p. 169).

Why is reliability important in a research context? It is important because we do not want the truth we discover by research to vary each time we apply a test or procedure repeatedly. Then, two things can happen:

1. We lose confidence in the discovered result.
2. We lose confidence in the test or procedure we applied.

“The concept of reliability in relation to a research instrument has a similar meaning: if a research tool is consistent and stable, and hence, predictable and accurate, it is said to be reliable. The greater the degree of consistency and stability in an instrument, the greater is its reliability. Therefore, a scale or test is reliable to the extent that repeat measurements made by it under constant conditions will give the same result (Kumar 2005, p. 6).”

By developing and using tests and procedures which will have little variability in results when applied to the same situation repeatedly, we improve our research to yield dependable and confident conclusions.

Stability of an instrument can be determined by test-retest reliability. This is the degree to which scores on the same test are consistent over time. This could be important if the researcher is attempting to use test results as a predictor such as aptitude tests, or affective and questionnaire instruments since they are based heavily on the assumption that scores will be stable over time (Gay and Airasian 2000, p. 171).

Another factor affecting the reliability comes into play when we use different scorers/raters. Subjective tests, when scored by different scorers, can yield a variance in reliability. “Subjective scoring is a major source of errors of measurement, so it is important to determine the reliability of those who score open-ended tests (Gay and Airasian 2000, p. 175).”
The concept of reliability can be considered from two perspectives:

1. How reliable is an instrument?
2. How unreliable is an instrument?

“The first question focuses on the ability of an instrument to produce consistent measurements. When you collect the same set of information more than once, using the same instrument and get the same or similar results under the same or similar conditions, an instrument is considered to be reliable. The second question focuses on the degree of inconsistency in the measurements made by an instrument—that is, the extent of difference in the measurements when you collect the same set of information more than once, using the same instrument under the same or similar conditions. Hence, the degree of inconsistency in the different measurements is an indication of the extent of its inaccuracy. This “error” is a reflection of an instrument’s unreliability. Therefore, reliability is the degree of accuracy or precision in the measurements made by a research instrument. The lower the degree of ‘error’ in an instrument, the higher is the reliability (Kumar 2005, p. 156).”
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