Bowie State University

College of Arts and Sciences

Undergraduate Research Program

Building a research-rich learning environment

General Guide for Students

Revised 2015

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Preface

The vision of the College of Arts and Sciences at Bowie State University is to "… be known nationally as a Teacher-Scholar College." To this end, two of our priorities are to "Promote research and scholarship/creative acts" and to "Promote student success" in the College. The College will be known for scholarly approach to teaching and the scholarships of research and teaching. Teaching will be informed by research.

This handbook is designed to provide the student with general information about undergraduate research in our College, as well as the general guidelines for conducting research across disciplines. The information is basic and geared toward undergraduate students.

It is expected that faculty mentors would supplement the information in this manuscript as necessary. Further, different departments may have additional guidelines that are discipline-specific. Between the two sets of information, students in the College should be equipped to have a meaningful and productive undergraduate research experience at Bowie State.

Some information was obtained from several sources for preparing this manuscript. Key sources have been listed for the student to consult for additional information

George Acquaah, PhD.
Dean

Definition of Undergraduate Research

Undergraduate research may be defined as "an inquiry or investigation conducted by an undergraduate student that makes an original intellectual or creative contribution to the discipline." *(Council on Undergraduate Research).*

In the College of Arts and Sciences (CAS) we define research in a broad sense to include lab-based activities in the STEM disciplines as well as other forms of creative activities in the humanities and arts.

The key elements of research are planned inquiry, experimentation, observation, study, analysis and documentation. These activities result in the discovery of new facts, knowledge and information; new interpretation of existing facts, knowledge and information; and the discovery of new ways of application of existing knowledge.

Goals

The overarching goal of research in the College of Arts and Sciences is to make research available to all students by:

- Integrating research experiences into courses.
- Using research as a pedagogical tool to facilitate learning of students who are challenged by more abstract concepts.
- Providing intensive research experiences for students to pursue in-depth investigations under supervision of faculty.
- Encouraging and preparing students, especially minorities, for professional and graduate program.

Benefits of Research

- Facilitates learning of abstract concepts
- Increases retention of students and their attachment to their disciplines.
- Fosters the development of critical thinking and skills of inquiry
- Stimulates interest in science
- Fosters the discovery of knew knowledge
- Changes attitudes of students towards learning
- Promote career pathways

What You Will Learn in Undergraduate Research

Research is a carefully planned and executed activity. It follows certain general steps that proceed in a systematic way. The student would learn both hard and soft skills, including the following:

- How scientists think and do business
- Research being conducted by faculty members in the College
- Conduct literature surveys (searches) to learn about the problem to be investigated and how other researchers are attempting to address it directly or in related ways
- Use existing literature to assist one in planning and conducting research

- Design research according to standard procedures to obtain valid data
- Analyze and interpret data correctly and draw correct conclusions
- Present research work to an audience through various avenues (oral, written – formal and informal) and thereby hone communication skills
- Some research opportunities would allow students to learn and operate scientific instruments, and use additional techniques and technologies that are not available in the classroom work.
- For formal presentations one would learn the art of writing for professional journals and presenting at meetings
- Learn to effectively engage faculty mentors
- Learn to work with other people
- Effectively manage time so the research is conducted and completed on time, while balancing it with other academic and social demands on time.
- Meet new people – from the department, campus, or professional world

Types of Research

Research is classified into two general types as follows:

a. **Basic research** – The aim of this type of research is to add to the wealth of fundamental scientific knowledge in a discipline, or provide a more in depth understanding of a research subject. Researchers do not seek to apply the knowledge gained right away or have any immediate plans for commercializing it beyond expanding our knowledge base. No inventions result from basic research. The researcher is simply curious about his or her environment or universe, and asks how and what questions. For example: How did the universe begin? What makes leaves change color in fall? What are atoms made of?

b. **Applied research** – Applied research helps us understanding the laws of natures. This type of research aims to invent or produce new products, or improve upon existing ones, and to address real problems confronting society. Researchers may seek to improve processes or services for the benefit of industry and eventually society. How can we extend the shelf life of fresh produce? How can we increase the yield of corn? How can we improve the picture quality of TV sets? How can we cure chicken pox?

Applied researchers draw from the work of basic researchers to invent new things or improve upon existing ones. The two branches or thought processes in scientific research work together.

Research may also be classified in other ways:

a. **Qualitative research** – Sometimes called **field research**, this type of research entails observing and recording behavior of subjects and events as they unfold in their natural setting. Researchers using this approach focus on the process rather than outcomes. They do not make any conjecture (hypothesis) before they start their work. In a way, it can be said that we are all qualitative researchers in our daily lives, as we observe the behavior of others and share our perceptions and experiences with them. The common ways in which qualitative researchers collect data include the following:

- Direct observation of the subjects in their natural environments.
- Interviews
- Focus groups
- Immersion (researcher lives among the subjects to better understand them)

b. Quantitative research – In this type of research, the researcher starts with a conjecture or a potential cause of something, and then proceeds to ascertain its effect. This approach is also described as deductive or deductive reasoning (top-down logic), whereby the researcher moves from premises to reach logically certain conclusion. Put another way, researchers start from the general to the specific. The researcher examines the relationships that might exist between variables; if a strong relationship exists, it is highly likely that the cause and effect relationship is strong.

One approach is not superior to the other; the choice depends on factors such as the specific questions to be answered and how practical it is to gather sufficient data to answer them.

Research Models in CAS

The College comprises of different departments that encompass disciplines in science, technology, mathematics, humanities, arts, and social sciences. Students may participate in either disciplinary or interdisciplinary research. The basic models are as follows:

a. STEM (lab-based) model

The lab-based model is suited to science, technology and engineering disciplines where research often requires the use of various pieces of equipment that must be installed in a lab.

b. Humanities and the Arts model

The humanities and arts model of research offers more opportunity for individual expression of self and creativity, and may be engaged in at less formal settings.

c. Social Sciences Model

Research in these disciplines includes analyzing social phenomena, from unfolding contemporary street events to historical data in archives.

Research Programs

All departments are encouraged to pursue research as pedagogical tools. Some courses have embedded research components. In addition, research opportunities are available to students year round for additional practical experiences as follows:

a. Department or Centralized

Given the vast diversity in the disciplines in the CAS, individual departments develop and pursue their own models of research experience for students. To this end, some departments require students to participate in credit-based research as part of graduation requirement. A faculty member may be designated to oversee and monitor this research experience for compliance with departmental guidelines. Students apply for permission to take the research experience course, usually, after completing certain prescribed courses. There may be additional requirements for the student to satisfy, e.g., mandatory presentation, publication of a paper, etc.

b. Capstone Experience

Capstone research experiences are provided to upperclassmen (juniors and seniors). This research activity may be required for graduation or be taken as an elective. The guidelines in the "Department or Centralized" program apply. The activity is called **Senior Seminar** in some departments.

c. Year round research

Some faculty members have secured grants that allow them to support students in their labs or research projects. Consequently, they are able to support students year-round, with stipends. Some other opportunities for unpaid research experience exists outside grant-funded programs.

d. Summer Research

Opportunities for intensive research-only activity are available to qualified students during the summer. Often grant-funded, these summer programs may be provided on or off campus at other institutions or research centers.

Dr. Ude teaches DNA extraction to GOU students (October 7th, 2012)

e. International Research

Opportunities are sometimes available to a few students to work with faculty members on international projects. Students may spend several weeks with their faculty mentors conducting research in other countries. These unique opportunities, among other things, broaden the horizons of students, and give them more global perspective to their education.

f. Miscellaneous

Some faculty members may have collaborative activities with colleagues at other institutions that provide opportunities for students to participate in research. Also, some faculty members at other institutions, or certain governmental agencies like NSF and NIH, provide competitive research opportunities for students during the summer months. Participation may be by recommendation from the institution or open to all students.

Finding a Research Experience Opportunity

Many opportunities for research experience go unutilized every year! Sometimes these opportunities exist on campus. Faculty members may post such opportunities on the bulletin boards or announce them in their classes. Students are urged to actively search for such experiences on their own! To increase the chance of success, the following are suggestions that the student may consider:

- **Ask**!: Take the initiative to ask professors and department chairperson about opportunities for research experience.
- **Consult the Office of Undergraduate Research**: This office has information about research opportunities, especially, outside the campus
- **Search the web**: Spend time to search the internet for opportunities.
- **Volunteer:** Volunteer to assist a professor in his or her research. Later opportunities might come with a stipend. When that happens, a volunteer in the program would have the first shot at the opportunity.
- **Be flexible:** Some opportunities are out of state and require the student to leave home for the summer.
- **Be adventurous**: International research opportunities require students to travel overseas and experience different cultures.

Research Opportunities Off Campus

Various opportunities exist in the College for students to obtain research experience off campus at other academic institutions or research entities. Some of these opportunities come as a result of faculty members securing intermural grants in partnership with colleagues at other institutions, or through internships provided by industry partners. Some departments and faculty members have long standing research experience opportunities with collaborators off campus. Students may seek off-campus research internship opportunities on their own by searching the internet or consulting with the Office of Undergraduate Research.

Making the Most of Research Opportunity

In addition to class-based research, additional research opportunities may be available, but to only a few students. When accepted to participate in a faculty member's research program, consider it a privilege and strive to make the most of the opportunity. The following suggestions are helpful:-

- Pay attention to the culture of the lab, and observe all workplace rules and regulations. Your mentor may have rules governing student conduct. Observe them all. Some of the rules are designed for the safety of students and all workers in the research space.
- Be punctual to work.
- Show enthusiasm and eagerness to learn.
- Take initiative to do things.
- Ask questions.
- Pursue excellence.
- The student who is willing to learn and work hard, will be given more opportunity to expand his or her experience.
- Your mentor is a good and reliable source of a letter of recommendation for a job or graduate school. Faculty members are particular about their recommendations as they are a reflection on the quality of work being done in their program.

What to Expect of Your Faculty Mentor

A mentor–mentee relationship is one of the most mutually beneficial relationships in academia. The mentor, a faculty member, has greater skills and experiences than the mentee, the student. The student looks up to the faculty mentor for professional guidance, but also desires a relationship that can nurture his or her passions and aspirations. The opportunity to shape a mentee and prepare them for life is priceless to a mentor. A faculty member would be available to students in various ways including the following:-

- Serve as a professional role model
- Serve as an adviser
- Committed to student academic success
- Train student in research skills through practice, coaching, feedback, encouragement, etc.
- Guide the student to conduct a defined research project
- Assist in providing professional networking opportunities
- As mutually agreed upon, establish trusting relationships to assist student in personal development.

The bond established between the mentor and mentee will depend on how the student avails himself or herself of the research opportunity. Mentors and mentees can become friends.

Planning and Time Management

Whereas class-based research is part of the course, additional research experience that is available to selected students should be considered additional work for which the student must budget time. It must not distract from the regular academic work. Students are allowed to work up to 20 hours a week on campus. For some students, a research experience with a faculty member may be a paid activity, as some faculty members have such opportunities written into their grants. Often, the work load on a faculty research project is variable in intensity. There may be some weeks in which the full 20 hours would be intense; there may be other weeks in which the student would have "free time," e.g., waiting to take measurements. The free time should be used wisely by the student to conduct some class work. Some research projects may require some activities over the weekend. Students should discuss their academic schedules each semester with their faculty mentors, so the proper work schedule can be designed for student success.

Ethics and Integrity in Research

It is critical that honesty and integrity prevail throughout the research activity. "*For individuals research integrity is an aspect of moral character and experience. It involves above all a commitment to intellectual honesty and personal responsibility for ones actions and to a range of practices that characterize responsible research conduct*." (National Academy of Science). Among other factors:

a. The faculty mentor and student must be honest in proposing, performing, and reporting research. It is irresponsible to falsify data to make them say what you'd like. Conduct the research properly and let the outcomes speak for themselves.
b. Be certain to acknowledge the contributions of all participants as accurately and fairly as possible.
c. The mentor and mentee must fulfill their responsibilities in the project.
d. When conducting or participating in research that involves human subjects, it is critical that the subjects or research participants be clearly informed about the study and voluntarily grant their consent. Bowie State has an IRB (Institutional Research Board) policy to guide this kind of research.
e. Examine the data objectively and conclude without bias towards any preconceived notions. Do not fudge the data to fulfil a desired end!

Plagiarism is a misconduct in academia whereby an original work is cited or used without the permission of the author. Various tools are available for exposing such misconduct. Some information may be so commonplace such that it may be used without giving credit to any one person. On the other hand, as one conducts and uses information from literature searches, it is critical that the sources of information be acknowledged. If the idea is obtained from multiple sources, they must all be acknowledged in chronological order.

Group vs. Individual Research

Opportunities exist for students to be assigned independent or group research projects. Either way, the student can have a meaningful and productive research experience. At the undergraduate level, our

focus is to get students to become familiar with the various aspects of research. The following are possible arrangements in the various departments:

- A unique and specific research may be designed for a particular student.
- Students may be assigned to work on various aspects of a large research project simultaneously or in succession. They may work in teams or as individuals.
- Faculty members may mentor one or more students at a time.

There are advantages and disadvantages to either scenario. Working solo might provide opportunity for a more intensive mentor-mentee relationship to occur. Teamwork allows for students to learn how to work together and assist each other. Unfortunately, students who are not self-motivated may not benefit fully from the experience, if they defer to "leaders" to do all the work while they are content to watch.

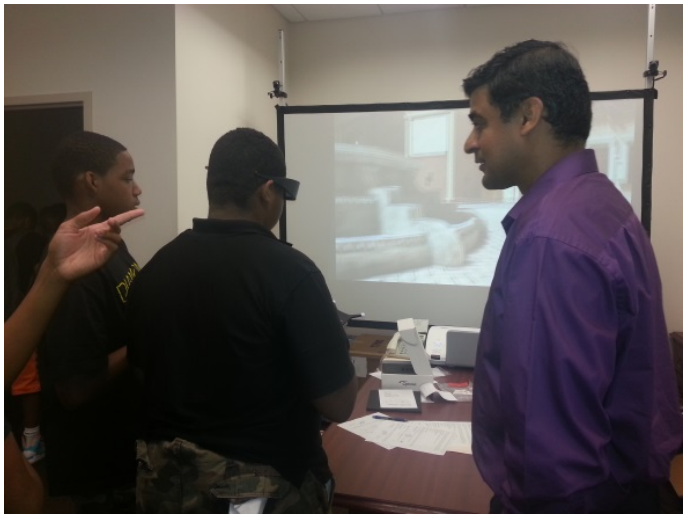
Depth of Research

As much as possible, our goal in the CAS is to make it possible for the student to experience the research process in its entirety – from planning to publication/presentation. To this end, students are usually assigned projects that can be completed within a semester or the summer.

However, if a student secures an opportunity that would allow him or her to work with the same professor for multiple semesters, this would allow the student to have an enhanced experience that could result in a major publication. For most students, the depth of research opportunity would result in a conference publication.

Original vs. Repeated Research

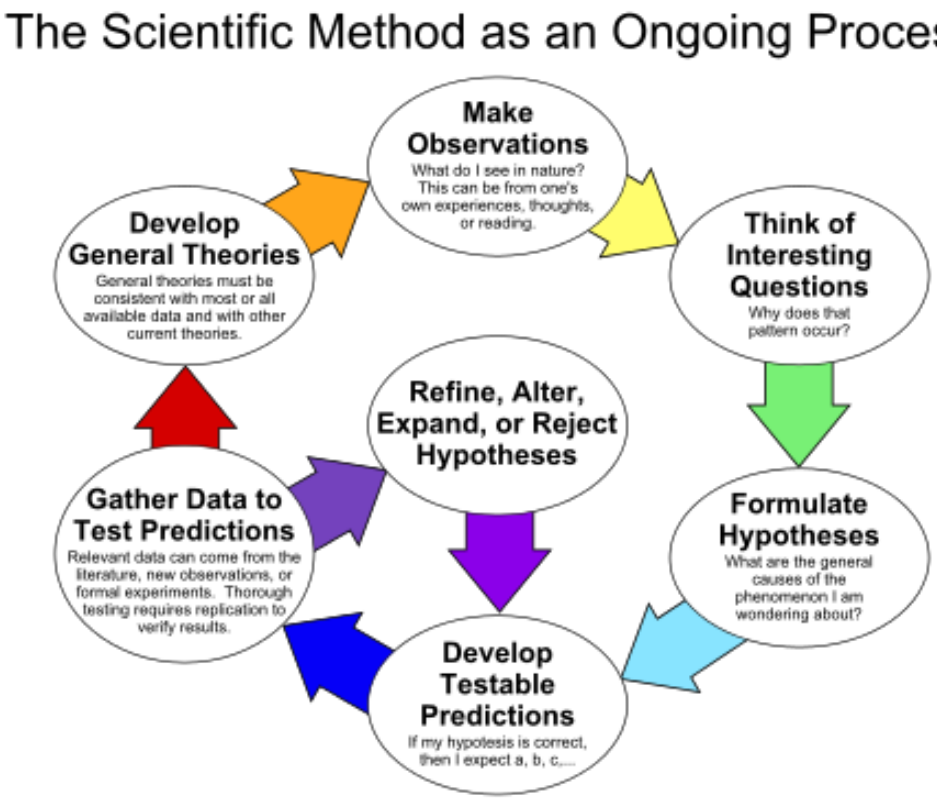
More often than not, researchers repeat their work before publishing the results to the general community. They may publish preliminary results, while taking more time to repeat and refine their work for more conclusive results. It is possible that a student may be assigned to repeat some work done by previous students in the program. When this occurs, all students who have worked on the project over the years would share in the credits when the results are published.



Repeating a previous study provides opportunities for students to learn from the challenges the previous colleagues encountered to have better chance of success.

The Scientific Method

Also called the Method of Science, the Scientific Method is an ongoing and iterative process used by scientists to investigate phenomena, acquiring new knowledge, or modifying existing ones. Basically, researchers use various techniques to make systematic observation, collect and measure evidence, analyze, interpret and make conclusions. This methodical process is used to eliminate the possibility that an event occurred by chance alone.



Source - http://idea.ucr.edu/documents/flash/scientific_method/story.htm

There are several basic steps that are followed by scientific researchers (empirical researchers) in their work:

- Make observations about the natural world or phenomenon
- Ask questions (define the problem)
- Make some conjecture or formulate ideas (hypothesis) to explain the phenomenon
- Testable predictions are further evaluated through planned experiments to collect data
- Analyze data to test hypothesis
- Depending on whether or not the tests and predictions match, the hypothesis may be accepted, rejected or modified.

Basic Steps of Scientific Research

1. **Make observations**

   Humans are naturally curious about their world. Make observations about the natural world to find out what would be a good idea to investigate. This idea must be testable to be suitable for research. E.g., Every fall season, leaves change color from green to other bright colors, and then drop. What could be causing the phenomena? Could temperature or light be factors in the change? Could nutrient availability in cold weather be the cause? What is being demonstrated here is how one defines a question.

2. **Research the existing knowledge about the question**

   Surely, many people would have made similar observations about the phenomenon of leaves changing color in fall. Possibly, some may have attempted to find out how that occurs in previous studies, successfully, or in the process found even more unanswered questions. This stage of the research process is called literature search or literature survey. It may help you refocus your research and in formulating your hypothesis.

3. **Formulate a hypothesis**

   This is a possible explanation the researcher offers for the observed phenomenon before conducting the study. Because of the benefit of literature search, this statement is more than just a casual guess. It can be used to predict the outcome of future observations. It posits a cause-and-effect relationship between the observed phenomenon and suggested causal factors. It is formulated in a manner that allows it to be tested through experimentation. E.g., Cold temperature is responsible for leaf color change in fall. The hypothesis is stated like fact: If the temperature drops, then leaves will change color. (**If-Then** statement). Another way in which a hypothesis may be stated is called the null hypothesis or the hypothesis of no difference: There will not be a change in leaf color with drop in temperature.

4. **Design an experiment to test the hypothesis**

   This is a critical stage in research. An improperly designed experiment can be a complete waste of time and resources as it would not answer the research question. One may suspect that temperature, light and nutrients could play a role in leaf color change in fall. The researcher could conduct a simple study, focusing on one factor at a time. There are other factors that can

be considered to make the study complex. Different species of plants respond differently to temperature drop. What level of cold temperature triggers the color change? Etc.

5. **Materials and Methods**
   An aspect of research design is the **Materials and Methods** used. A researcher should be able to describe in detail how the research was conducted, so that another person can independently read the account and duplicate the entire research. The research must list all materials used, their sources, and any relevant details. How were pots arranged in the greenhouse? How were the plants maintained? How were the data collected? How many plants were measured? What statistical methods were used for analysis?

6. **Analyze the data and test the hypothesis**
   Statistical analysis helps the researcher in testing the research hypothesis. It is critical that the experimental design effectively isolate the phenomenon and the proposed causal factors. Failure to do so would make it impossible to test the hypothesis conclusively.

   Just because the analysis suggests that the researcher accept the hypothesis does not mean the hypothesis was the correct one in the first place! It just simply means that the results of the experiment support the hypothesis. Often, statistical analysis is used to enable the researcher establish a degree of acceptance or rejection of the hypothesis. Note that a researcher never sets out to prove a hypothesis; a hypothesis can only be disproven.

7. **Draw conclusions**
   The conclusions drawn must be supported by the data and their analysis. In this imperfect world, there could always be some unknown factors that may exert their influence in an experiment, even if carefully planned and executed. Let the results speak for themselves and resist the temptation to exclude data that appear out of line.

8. **Publish results**
   Reporting scientific research results is a way of sharing information within the scientific community or the community in general. Avenues for reporting findings include presentation at professional meetings and publishing in professional journals.

Elements of a Research Project

After defining the research question and establishing an appropriate hypothesis, it is time to conduct the experiment. The project must be conducted in such a manner that the results and conclusions made are valid. It starts with selecting an appropriate Experimental Design, which will determine how the results are statistically analyzed. As previously stated, the researcher often desires to establish a degree of acceptance or rejection of the hypothesis. The confidence with which the researcher makes conclusions from the work, and how well they are received by others, depends on the degree of

acceptance or rejection of hypothesis. The following are key factors that must be considered in designing an experiment to help with making more confident conclusions:

Research design

Research design pertains to how data is collected from subjects in research. The **Survey Research Design** is popular in social science research and allows for the use of many subjects. Data are commonly collected via the use of questionnaires. For research conducted in a lab setting, the **Experimental Research Design** is often used. It allows cause and effect studied to be studies with the flexibility of manipulating the causes to produce different kinds of effects in controlled settings. Subjects are assigned randomly to groups. The faculty mentor would provide additional guidance to students in the use of specific designs.

Experimental unit

This is usually the lowest level at which observations are made (e.g., one person, a plant, an animal, a product). These units are placed in groups of like entities (a plot of plants, a collection of pots in the greenhouse, a set of test tubes, a group of 5th graders). The members in a group are treated alike in research.

Treatment

A treatment is what the research deliberately applies to experimental units in research to elicit a measurable response. If one is studying the effect of temperature on germination, temperature is the treatment. But in experimental research, the researcher may choose to study, in this example, different temperatures (5, 10, 15, 20 o C). The different numbers represent "levels of treatment." A study may investigate different grade levels at one time.

Control group

In comparative studies, one of the experimental units or groups receives no treatment or the standard treatment. If the researcher is investigating the effect of nitrogen fertilizer on plant height, he may study three different levels of the chemical (10, 20, 30 mg), which will be applied to three experimental groups. In addition, an experimental group, identical to the three, will receive no nitrogen, just water (i.e., 0 mg of nitrogen). This is called the **control** or **control group**, with which the others would be compared to determine the effect of nitrogen fertilizer on plant height. In effect, the researcher is investigating four treatments (including the control). In medical research, where a drug is being tested, one group of subjects would receive a placebo (no drug). It is important to note that the control and other levels of treatments are identical, except, the factor of interest (fertilizer, drug, etc.).

Randomization

Randomization is the process of assigning treatments to experimental units or groups without bias. In the nitrogen study, each of the four experimental units has an equal chance of being assigned any of the four treatments. Simply put, the treatments are assigned literally by the toss of a coin, if you will.

Research conducted in this fashion is sometimes called a **randomized control trial**. Randomization is critical to the validity of outcomes of research; without it, results might be deceptive or spurious.

Sample and sample size

The entire members of a defined group that the researcher is studying or collecting information on constitute a **population.** This could be BSU students, College of Arts and Sciences students, History majors, etc. Often times, resources and practicality would not permit data to be collected from each experimental unit. Consequently, the researcher settles for a **sample** or a portion of the population. The sample must be selected such that it represents the population (possesses the same characteristics). Whatever is concluded from working on the sample is applicable to the population. For this to be true, the sample must be very carefully selected and without bias. This is achieved by conducting a **random sample** and using a good **sample size**. One student may be selected to represent a class of 25, but 10-15 students would be better. Instead of selecting only one plant in the plot to measure, several plants should be selected. In research, a large sample is preferred. There are various sampling strategies in research.

Replication

To replicate (replication) simply means to repeat. An entire research must be repeated at least once before the findings can be accepted as well-established. But treatments in a research experiment must also be replicated for statistical analysis. For example, instead of assigning one pot to each of the four treatments in the nitrogen study, the researcher may have four pots each; instead of one plot in the field for each treatment, four plots may be used. The research environment is seldom if ever 100% homogeneous or uniform. If the research will be conducted over a large space, replication and randomization would be needed to handle environmental variation so it does not interfere with the research outcomes.

Variable

A variable is basically any factor that can be controlled, changed, or measured in an experiment (temperature, light, plant height, weight, etc.). In research, some variables are held constant while others are changed. For example, in the nitrogen experiment, nitrogen is studied at different levels. Nitrogen is called the **independent variable**, while plant height (what is measured or observed) is the **dependent variable**. In other words, change in plant height depends on the changes in amount of nitrogen applied.

Data collection

It is helpful to design data collection forms for the project. This can also take the form of a note book procured for the purpose. Loose sheets are prone to being lost; if used, they should be filed in a binder to secure them. Sometimes, the data must be processed before they are used in analysis. In surveys, the raw data may need to be “cleaned up” to remove incorrect responses, or be coded/transformed into standardized formats (e.g., assigned 0 = no, and 1 = yes) for computer analysis. As much as possible, one should avoid transcription of data from one sheet to another, as this provides avenues for transcription errors to occur. Under no circumstance should raw data be altered to influence the outcomes of the research! What might appear to be “off” data might be genuine research outcomes. Unexpected results are common in research, and sometimes lead to major breakthroughs.

Statistical analysis

The statistical analysis needed will depend on the study. Various statistical packages are available for simple general analyses (like means, standard deviation, and correlation), to more complex and specialized ones. Most of these are computer-based, allowing for sophisticated data manipulation. Graphical packages are available for generating charts and other visuals that enhance data presentation.

Conducting Survey Research

Survey research is a very widely used research technique, especially in social research. In this technique, measurements are obtained by asking questions to respondents via one of two general ways – questionnaires or interviews. These methods have advantages and disadvantages.

Select a survey method

The researcher should take the following into account in selecting a survey method:

- Determine the accessibility of the target population
- Is census data available?
- Any other pertinent data – current addresses, phone numbers, etc. available?
- Can the population be readily reached by phone or mail?
- Any language or literacy challenges?
- Any geographic accessibility challenges?
- Any suspected subject cooperation issues?
- How easy is it to reach respondents?
- What type of questions would be asked? Complex? Lengthy?
- Will respondents need to consult records for information?
- How likely is it that the targeted respondent would not actually be the one to provide the information?
- Costs
- Time
- Facilities and personnel to process the responses.

Construct the survey instrument

Survey questions may be structured or unstructured. Interview questions tend to be less structured than questionnaires; the latter can be dichotomous (has more than one possible response), based on level of measurement (e.g., ordinal question – rank from best to worst), or have contingency (if yes/no, then go to next question, or further explain).

Question content and wording

The questions asked should elicit the responses needed to address the purpose of the research.

- Is the question relevant?
- Is the level appropriate?
- Is it specific enough? Or are they actually multiple questions in one?

- Is the target audience equipped to provide responses?
- Any bias?
- Is the question loaded?
- Will the respondents be truthful?
- Any chance it can be misunderstood?
- Language – too direct, objectionable, etc.?
- Is the question too sensitive?

Response format

How do you propose to the respondents to communicate their responses to you?

- True false?
- Fill-in-the-bank?
- Write a sentence/phrase?
- Circle?
- Check the box?
- Write in the box (up to 100 words, etc.)

Start with easy questions first on the questionnaire; never start with open-ended question. Organize questions logically and chronologically. Make it easy for the respondents to willing participate.

General consideration

Always remember that the respondents are doing you a favor.

- Respect their time and privacy.
- Be respectful and courteous
- Keep it short
- Thank them for their time

Survey research by interviews

Interviews present unique challenges and opportunities to the researcher. They could be intimidating and could veer off course. On the other side, the researcher has the opportunity to ask follow up questions and get more out of the interview than was initially planned. Good preparation is needed to get good outcomes.

Some information for the section on survey research was obtained from:

http://www.socialresearchmethods.net/kb/survwrit.php

What is Literature Review?

A literature review is a critical and in depth review of a collection of previously published materials on the researcher's topic of interest. It is done for a variety of purposes including the following:

- To help shape the focus of a research project. Has the proposed research question been previously investigated? If so, what were the findings? What remains to be done?
- To help with materials and methods: What methods were used? What challenges were encountered? etc.
- To help in data interpretation and discussion of results: How did previous researchers conclude? Do current results confirm or deviate from previous ones?

Conducting a review

Literature that is pertinent to the research may be found in a wide variety of formats – books, professional journal articles, government papers, academic theses, magazines, etc. They may be located in libraries, found on the internet, or in professional journal subscriptions by researchers, etc. It is important to know that just because the information is published does not necessarily mean it is accurate. This goes especially for materials posted on the internet. Researchers often refer to "peer reviewed" (vetted by colleagues and professionals with knowhow in on the subject) as reliable sources of information. Reputable journal materials can be accessed via the internet. Some sources are narrowly focused, whereas others cover a wide variety of academic areas. Each discipline has a set of sources of information that are accepted as reputable.

Start by first reading the abstract and introduction of the paper to see if it is relevant to your proposed study. Then, read the full paper more critically to understand its content. As you read, do not be afraid to question aspects of the paper. Was the research conducted properly? Are the conclusions supported by the results? Make copies of a few of the papers that are deemed to be of high quality and most informative. The references they cite can lead you to other quality papers. Some papers would support your hypothesis, others will not. Review both types of papers. Some find it helpful to extract key pieces of information and place them on index cards.

Writing a review

A literature review is presented at the beginning of the paper. Essentially, it makes a case for the importance of the research. It should be properly organized and flow in logical steps – introduction, body, conclusion. The introduction sets the tone and provides a general theme for the paper; it argues the importance of the topic. The body of the session should also follow meaningful themes whereby similar ideas are discussed and grouped together in chronological fashion. If a number of papers were consulted, summarize and synthesize the information from the various sources. End the section with conclusions that support why it is necessary for the research to be conducted. Because the review summarizes information from previously published research, proper citation of the sources of the information is most critical.

Documenting

A published article ends with a listing of the materials consulted. The preferred style (e.g., the APA – American Psychological Association style; MLA: Chicago) of writing the list, also called the **bibliography** or **literature cited**, varies among academic disciplines. A style commonly used in the STEM disciplines is:

Acquaah, G., T.G. Islieb, and A.E. Ferguson. 1994. Gene pool specificity, paucity of enzyme variation, and phaseolin polymorphism in the common bean. *HortScience* 29(11):1337-1339.

Some information for writing this section was obtained from:

http://writingcenter.unc.edu/handouts/literature-reviews/

What is an Abstract?

An abstract (summary) is a brief summary of a research article, review, or any in-depth analysis of a particular subject or discipline. It is designed to concisely describe the objective, methodology, results and conclusions of a larger project, to allow the reader quickly ascertain the purpose of the paper. Professional journals usually limit an abstract to a maximum number of words (50 – 250 words), thereby limiting what is included to the bare essentials (avoid words, expressions, phrases that only waste the limited word count allowed – "it is suggested/believed", "is described."

The first part of an abstract should state the purpose (problem or issue) of the research. This followed by how the research was conducted and the results. The final part states the conclusions and significant findings and implications of the research. The conclusion is what would entice the reader to read the full article.

Look at examples of abstracts in professional journals to compare various lengths and formats.

Writing a Research Paper

Undergraduate research usually culminates in the writing of a research paper. The goal of the paper is to communicate the research findings to a specific audience. It must be well-written and at the proper level of difficulty for the target audience. After all the hard work of conducting the research (field, lab, or library), it would be a shame to fail to communicate the outcomes effectively to the intended audience. A good paper is never ready after only attempt. It must be reviewed and revised, ensuring that the thoughts are conveyed clearly. It must be free of grammatical errors! Avoid making statements that are not substantiated with evidence.

Start the writing of the paper by first producing an outline. The more detailed it is, the easier it would be to write a good paper without omitting important information. The following are general sections of a typical research paper.

Title page

Abstract/Summary

Introduction

- Include the importance of the research, hypothesis, objectives, why you chose to do it? This section is where literature review is summarized and discussed to support the importance of the research.

Materials and Methods

- Usually can be combined into one section unless otherwise requested; do not include common supplies or standard equipment in this write up.

- Describe special chemical and equipment
- Describe clearly for another researcher to be able to duplicate the work.
- Write in third person passive voice (e.g., The seed was placed on a wet cloth vs. I placed the seed on the wet cloth).
- Use complete sentences

Results and Discussion

- Present and illustrate your findings
- Figures and tables are very helpful
- Use past tense when presenting results
- In a discussion do not just restate the results (reason why some journals combine the two)
- Be thorough
- Draw conclusions that are supported by the results
- How does it impact the literature reviewed?
- You may suggest future work needed or to be done

Conclusion

- Answer the question “so what?” What did you find from the study?
- Use very powerful language to state the facts convincingly.

References/Bibliography

Professional journals differ in the specific sections required for writing an article. Some prefer individual sections for Materials and Methods, while others combine them, as well as the Results and Discussion.

Public Presentation of Research Results

Presenting research results is an exciting opportunity for the student or researcher! It may also be intimidating for first time presenters. Public speaking is dreaded by many people, not just students. The following are some suggestions that, if adhered to, would reduce anxiety and help one to be successful. An entry level way of engaging “strangers” via a presentation is the poster. The audience is usually small (1-6) at a time. You are likely to have multiple visits to your poster site during the day, thereby allowing you multiple opportunities to engage your audience. Consequently, as time goes by, one can learn from previous mistakes to make the later encounters go more smoothly. With oral presentation, the audience is usually larger. Further, you have only one shot to present!

When the research is conducted as team, the presentation of results is usually done as a team, each student in the group being assigned to present a portion of the work (introduction, materials and method, results, etc.). However, when it comes to question time, anyone in the group may be asked to respond. Whether using a poster or podium/oral format, the researcher is in the driver’s seat. The following guidelines apply to both formats:-

Preparation

Good preparation reduces anxiety and increases confidence. There is no substitute to knowing the topic very well. It helps to know some information about related topics as well. You are the expert! You did the work and should be able to speak about it with confidence.

- **Message** - Have a clear message. What do you want to communicate to the audience? What exciting discovery have you made that you want the world to know? What is the take-home message for the audience?
- **Audience** – How you approach the presentation would depend on the audience. If the presentation is to a specialized or professional audience, jargons in the discipline may be used with little explanation. If the presentation is to a general audience, one should use appropriate level of language and explain terminologies.
- **Practice** – Practice, they say, makes perfect. Rehearse the presentation as many times as you need to feel comfortable. Do it alone and with peers or others who can critique your presentation and give you feedback for improvement.
- **Anticipate questions** – Some questions are easy to anticipate. Why did you choose to study this topic? What are the practical applications? What next? What challenges did you encouter?
- **Personal appearance** – Appear professional. Dress appropriately for the event. First impression is always a lasting one.
- **Engage the audience enthusiastically** – Appear like you wanted the opportunity to present your work, and not like one who was compelled to do it. Sometimes, the audience would not ask questions because your presentation was powerful and effective. Other times, they'd not ask questions because you were so boring and unorganized that they could not wait for you get off the podium. For a poster presentation, people would simply just leave.
- **Punch lines** – Prepare a couple of punch lines to use to break the ice and liven your presentation.

Oral Presentation

Public speaking, as previously indicated, is a challenge for many people. Preparation and practice would help with success.

- **How much time is allotted**? – Whereas poster presentation is more flexible in terms of time, podium presentation is often moderated. The common time allotted is **10-15 minutes**, and even less, if the conference has a large number of participants. You will be interrupted if you go over the allotted time. The worst thing to happen is to have the moderator caution you in the middle of the presentation. This would often cause one to rush the presentation, usually with disastrous consequences.
- **Allow time for questions** – Sometimes, the moderator would request you to speak for so long, and allow some time for questions. If not, please do not use up all the time allotted. Invite questions at the end of the presentation. Answer the question without being evasive. If you do not have an answer, say so, rather than ramble an incoherent response. "I am not exactly sure about this?" "Thanks for asking. I will look into this further" Try to give an intelligent "no answer."

- **First impression** – Appearance is critical, but do not overdress so that your outfit is distracting. Dress a notch above the dress of the audience, while staying within what is deemed professional.
- **Prepare an outline of the presentation** – This should be available to you at the podium to guide you. If you have only 10 mins to present, do not use up a minute talking about the outline! Build the outline into the presentation.
- **Use visual aids** – The use of Power Point tools is all but standard at professional meetings. The slides must be well-prepared and attractive, using appropriate colors, font and font sizes, and few words. While one can use PowerPoint in a creative way to enhance a presentation, it can ruin a presentation in many ways (e.g., too busy, hard to read, poor color choice, too gimmicky, etc.). Do not waste time and irritate the audience with fancy audio and weird slide transitions. Make it simple. When you introduce a slide, allow enough time for the audience to read it! (at least 1 minute).
- **Powerful introduction** – Prepare a powerful and effective introduction to your presentation. This would serve as an ice breaker to help you relax. The introduction should excite the audience and make them want to look forward to what you have to say.
- **Powerful conclusion** – Deliver the take home message very convincingly.
- **Logical flow** – The presentation should follow a logical pattern. Planning is critical to having an effective presentation.
- **Delivery** – Everyone has a preferred style of delivery that works best for them. Be yourself! Some presenters use only the visuals, including headings and key statements in the slides. If this style is preferred, avoid showing a large amount of text and reading it word-for-word. If you use note cards, or read your essay, do not be glued to the pages. Look up every now and then, but be careful not to lose your place. Arrange the card or pages properly, so you do not get out of sequence. You conducted the research. It is reasonable for the audience to expect you to be able to memorize certain aspects of the work!

  The critical factor is being effective in your delivery. Never rush your presentation! Speak with a good volume to carry throughout the room. Speak with proper diction and clarity. If you have language problem, the use of effective visuals will reduce the need for spoken words. Note that you are presenting to people. Engage them by making frequent eye contact, even when referring to a visual (don't speak to the slide).

  Avoid distracting mannerisms (pronounced hand gestures, rocking back and forth at the podium, unnecessary pacing around, slouching at the podium, rummaging in your pocket noisily, facial expressions of frustration, etc.
- **Backup presentation** – Remember Murphy's Law – Whatever can go wrong, will probably go wrong. Always have multiple backups of your presentation for eventualities. Save your presentation on multiple thumb drives and e-mail to yourself (you can retrieve it via the internet). Print out your power point slides in full-page format; if the projector or power fails, you'd be expected to continue your presentation! You are not under any obligation to provide power point handouts to the audience, but they can be helpful in certain situations.

- **Equipment check** – Always know what would be available for your use. Will there be a designated technician to operate it? Would you be required to provide your own laptop computer or bring the presentation on a thumb/flash drive? Would you have to send the presentation ahead of the day of presentation? Don't rely on the internet working on the day of your presentation.
- **Arrive early** – Arrive early to ensure that your technical needs are met. Arriving early would also allow you to catch your breath and relax before your presentation.
- **Don't let them see you sweat**! – A little nervousness is not unusually, especially, at the start of the presentation. Poor preparation can make one very nervous. If you find yourself apologizing for your presentation, it might indicate poor preparation and inadequate understanding of the research project.
- **Organized team presentation** – If there is more than one presenter, each one must know and rehearse their role so the presentation proceeds seamlessly. The time allotted will not be changed to accommodate team presentation.
- **Use humor wisely** – If appropriate, lace your presentation with well-rehearsed and effective humor. Bad humor can be disastrous to a presentation.

Poster Presentation

A poster is a visual way (visual communication tool) of presenting research information. Even though it is may be manned (that is, the researcher is available to discuss it), a poster is designed to be viewed in the absence of the researcher. That is, it must literally speak for itself (it shows not tells). It must have a very clear message and be visually attractive; it must be very well organized to keep the attention of the viewer. To be effective, the researcher must put a lot of planning into its design.

Creating a poster

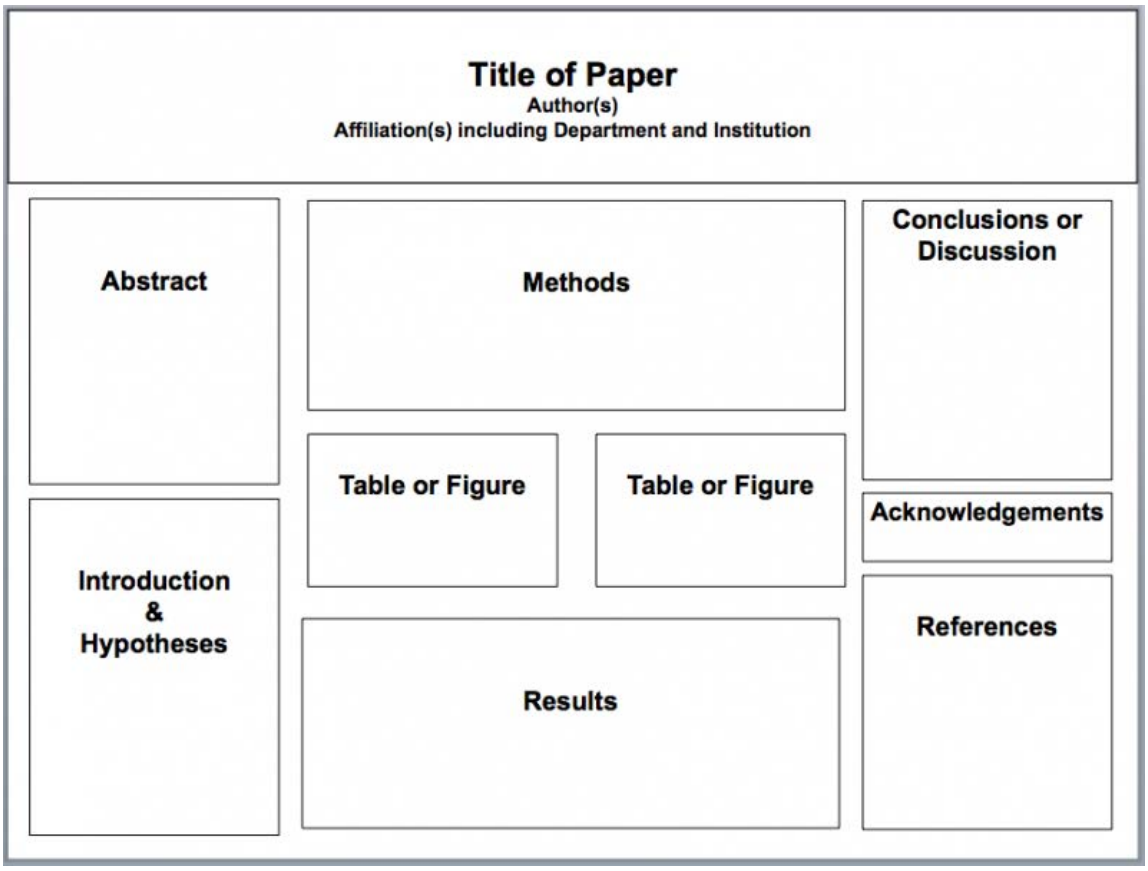
- **Planning** – First, determine the space allotted to each poster presenter (what size of poster can one use?). This would also help one to determine the amount of material that can be placed on it, and how things will be organized for a most effective presentation.
- **Message** to be communicated - The next key consideration is the message to be conveyed. What will form the focal point of the poster? Keep the message simple. Use punch lines and simple sentences. In terms of text, less is better.
- **Layout** – Organize information in columns (so that people can read down and not across if others are crowding the space). Use adequate "white space" so that the poster is not too busy and crowded. It is all about visuals! The poster should be attractive and easy to navigate. Balance the text and figures/tables around a central axis. Use appropriate effects (numbers, arrows, etc.) to show information flow to guide the reader.
- **Headings** - Use hierarchical headings (large fonts to small fonts) to guide readers to important information on the posters. Headings can be used to summarize the research.
- **Text** – Because poster presentation is a visual medium of communication, the text must be limited to the barest minimum needed! Use more images – photos, charts, graphs, etc. Phrases are better, but if full sentences are to be use, they should be short. Choose text fonts carefully;

some are easier to read than others (Times, Helvetica are good fonts). The pitch should not be less than 24 point for text and 36 for the heading. The poster should be readable from 1m away.

- **Graphics** – Photos and other graphics should be of high quality and attractive. Keep graphs simple. Labels should be embedded on the graph, rather than using an index. Avoid distractions like background color and effects that are too pronounced.
- **Color** – Certain colors work together better than others. Coordinate colors properly for best effects. Think about contrast when choosing colors. Limit colors to 2-3, and used in consistent fashion (e.g., headings = blue; subheadings = yellow, etc.).

Selecting a poster material

Poster materials vary in thickness, flexibility, size, color, etc. At BSU, most students print their posters on large-scale printers that use rolled paper. The finished poster can be rolled up for easy transportation. However, it is prone to damage by tearing. It requires a rigid back board for support when being displayed. If a rigid product is preferred, thick Styrofoam products are available at places like Kinko's. They are more expensive and sturdier than rolled paper, but less convenient to transport.

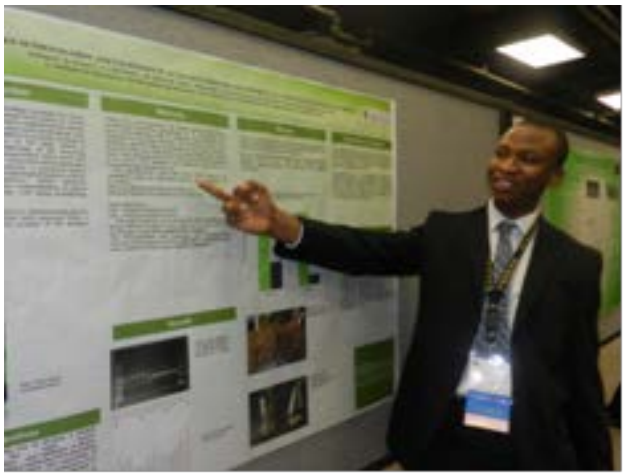


An example of a poster layout.

Mounting a poster

Usually, provisions are made for presenters to mount their posters at conferences and other professional meetings. This may include poster display easels, cork boards on walls, etc. The presenter should have appropriate mounting materials to display the poster properly and attractively. Poster hanging kits are available for purchase. They include push pins, Velcro tape, masking tape, etc. One should use materials that will stay in place for the duration of the event. It is tacky to visit a poster station only to find it peeling off the board.

Presenting a poster



Posters are a common format for presentation at most professional meetings, especially, the large ones. Opportunities for oral presentation are limited when the meeting has a large attendance. Usually, times are set aside for poster presentations, at which time the presenter is expected to be by his or her poster to present the work and be asked questions. New people may stop by during anytime of the presentation. Be on time to the presentation and dress appropriately. Some large meetings would require presenters to remove their posters after the prescribed period so new presenters may mount their work. For smaller meetings, the posters may be available for viewing throughout the duration of the meeting. If so, the presenter may have multiple opportunities to engage viewers. It is a good idea to leave business cards at the poster station, so interested viewers may contact you later.

How to make a poster using PowerPoint http://www.hs.washington.edu/locke/vislab/tech/powerpoint-poster.html)

Research Internships

Research internships are often available to undergraduate students in summer. Opportunities exist both on campus and off campus, but more often the latter. Some of these experiences are paid, while others are offered on volunteer basis. Either way, students are strongly encouraged to seek such unique experiences. Major national research agencies such as the NSF, NIH, Naval Research Office, to name a few, often have research internship opportunities for undergraduate students during the summer. These are competitive, often requiring students to maintain a GPA or 3.5 to qualify. Some of them have minority student emphasis. In addition to federal agencies, many research intensive institutions host grant-funded research opportunities for undergraduate students in summer.

Information about these opportunities is available through the Office of Undergraduate Research. Students are also encouraged to seek information online. Some faculty members arrange summer internships for students with their industry partners.

Resources for Undergraduate Research at Bowie State

For information additional information about undergraduate research at Bowie State:

Coordinator
Office of Undergraduate Research
Robinson Hall

Research Experience Coordinator
(Each Department)

Prototype Modeling Lab