Research Methodology (M.Sc. Candidate)

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RESEARCH METHODOLOGY SYLLABUS (M.Sc.)

1. Foundations of Research: Meaning, Objectives, Motivation, Utility. Concept of theory, empiricism, deductive and inductive theory. Characteristics of scientific method – Understanding the language of research – Concept, Construct, Definition, Variable. Research Process

2. Problem Identification & Formulation – Research Question – Investigation Question – Measurement Issues – Hypothesis – Qualities of a good Hypothesis –Null Hypothesis & Alternative Hypothesis. Hypothesis Testing – Logic & Importance.

3. Research Design: Concept and Importance in Research – Features of a good research design – Exploratory Research Design – concept, types and uses, Descriptive Research Designs – concept, types and uses. Experimental Design: Concept of Independent & Dependent variables.

4. Qualitative and Quantitative Research: Qualitative research – Quantitative research – Concept of measurement, causality, generalization, replication. Merging the two approaches.

5. Measurement: Concept of measurement– what is measured? Problems in measurement in research – Validity and Reliability. Levels of measurement – Nominal, Ordinal, Interval, Ratio.

6. Sampling: Concepts of Statistical Population, Sample, Sampling Frame, Sampling Error, Sample Size, Non Response. Characteristics of a good sample. Probability Sample – Simple Random Sample, Systematic Sample, Stratified Random Sample & Multi-stage sampling. Determining size of the sample – Practical considerations in sampling and sample size.

7. Data Analysis: Data Preparation – Univariate analysis (frequency tables, bar charts, pie charts, percentages).

8. Interpretation of Data and Paper Writing – Layout of a Research Paper, Journals in Computer Science, Impact factor of Journals, When and where to publish ? Ethical issues related to publishing, Plagiarism and Self-Plagiarism.

9. Use of Encyclopedias, Research Guides, Handbook etc., Academic Databases for Computer Science Discipline.

10. Use of tools / techniques for Research: methods to search required information effectively, Reference Management Software like Zotero/Mendeley, Software for paper formatting like . LaTeX/MS Office, Software for detection of Plagiarism

Books Recommended:-

1. Business Research Methods – Donald Cooper & Pamela Schindler, TMGH, 9th edition
2. Business Research Methods – Alan Bryman & Emma Bell, Oxford University Press.
3. Research Methodology – C.R.Kothari
4. Select references from the Internet

Research methodology is the specific procedures or techniques used to identify, select, process, and analyze information about a topic.

In a research paper (**Scientific Research**), the methodology section allows the reader to critically evaluate a study's overall validity and reliability.

Scientific Research

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Introduction of Scientific Research

Definition 1: Application of scientific method to the investigation of relationships among natural phenomenon, or to solve a medical or technical problem.

Definition 2: Problem solving: Step-by-step approach consisting of

(1) Identifying and defining a problem,

(2) Accumulating relevant data,

(3) Formulating a tentative hypothesis,

(4) Conducting experiments to test the hypothesis,

(5) Interpreting the results objectively, and

(6) Repeating the steps until an acceptable solution is found.

Definition of problem: A perceived gap between the existing state and a desired state, or a deviation from a norm. or it is a question without answer

How to Conduct Scientific Research?

Four Parts:

1) Planning a Research Project

2)Designing an Experiment

3)Conducting the Experiments

4) Analysing and Publishing the Data

If you want to contribute knowledge to the scientific community by conducting a scientific research project, you need to know the basic steps. There are many steps to doing research beginning with identifying a problem to solve. Thoroughly researching a topic and identifying gaps in knowledge is the best place to start with research. From there, you can design experiments, perform them, gather data, and submit your articles for publication!

PART 1: Planning a Research Project

1) **Choose a topic that interests you.** First, you must identify a field of study that you would like to research. At the student level, you will either be assigned a topic during a course or choose a lab that performs research that interests you

Note: -Choose a subject that excites you or that you find yourself drawn to.

-Scientific research isn't limited to just subjects like biology, chemistry, and physics. As long as you follow the scientific method to perform your study you are doing research

2) **Identify a problem or research question.** The research question will be the main focus of your study. Once you have a chosen a topic that interests you, investigate some of the unanswered questions within that field. The research question should be based in a field that you have some familiarity with. You can have more than one research question for a scientific study.

How you can doing it?

- Do a brief literature search to familiarize yourself with what information is already out there and what unanswered questions there are.
- Make sure you have the necessary resources available to you (funding and laboratory equipment) to work on the question.
- Talk to professors or other researchers and have them help you identify a question that you could work on.
- Many articles will state some of the unanswered questions and speculate on future directions or suggest experiments that will be necessary in the future. Use these as a springboard for your own ideas.

3) Perform a comprehensive literature search. You may have done a brief literature search to help you develop a research question, but now you must really do your homework. Find and read articles in the field related to the problem you've identified. Read the current literature as well as some of the seminal papers that established the field.

1.It is impossible to read every paper, but when performing research, you want to be an expert on the topic. You also don't want to repeat experiments that have already been done.
2.The literature search will help you design the experiments and determine the proper experimental conditions to use.
3.Take detailed notes as you read through the literature. You will likely be writing a paper on this information after your study is complete and this information will be the basis of your introduction.

4) Revise the research question. A good research question is clear, specific, refers directly to the problem, and identifies a target group of participants. After reading the literature more thoroughly, you will likely need to revise your research question to encompass all that you have read.

5) Outline your research plan. The research plan is the roadmap for your studies. When working on a research plan, keep in mind that the final objective is usually publication. Design your experiments with this in mind. Ask yourself the following questions:

-Who or what is the study population? Do you need ethical approvals to work with the necessary subjects?
-How will each experiment contribute to the answer to the question you're asking?
-How is the data collected? How do you define success in a study?
-If an experiment will not produce data that you would include in a paper, is it necessary to the understanding of the problem?
-What type of statistics will you use to analyze the data?

PART 2: Designing an Experiment

1) **Determine the sample size.** In order for your experiment to be meaningful, you need to have an experimental sample size large enough to perform statistical analyses on. In order to determine this, you need to know some information about your experimental population and use a power analysis calculator.

How ?

- To use a power analysis, you need to have an estimate of the effect size, an estimation of the variability within the data (standard deviation), the level of significance (standard convention is p=0.05), and power (the rate of false negatives you are willing to accept, generally set at 80%).
- Running smaller pilot studies can help you gather the necessary information for a proper power analysis to calculate sample size.
- If you don’t have the means to do a pilot study, use some rough estimations based on information you have gathered from the literature.

2) Identify all of the necessary solutions and equipment. When designing the experiment you need to know all of the solutions you will need to use and the type of equipment you will need access to. Many universities have core facilities with instruments you can use if your specific lab does not have all of the equipment necessary.

1. You may need to be trained on the equipment and develop the proper expertise before you can start your experiments. Keep this in mind when planning a timeline.
2. If you don't have access to the necessary equipment, you might consider working with collaborators who have the equipment and expertise.

3) State all experimental conditions. The key to a well-designed experiment is to have a manageable number of testable conditions. If you are doing a drug study, you probably want to test different dosages, but you don't want too many. You will likely have to do a few smaller experiments to optimize the test conditions you will use in the final experiments.

1. Literature searches can help you identify time points, dosages, and treatment conditions relevant to your studies.

4) Include the necessary controls. Experimental data is useless without the proper control conditions to compare them to. A control is a condition that is kept constant and used to measure the change of the experimental condition.

1. A proper experiment has only one variable and multiple controls to ensure that any changes seen in the results are due specifically to the variable that was changed.
2. To test different variables, you will need to perform multiple experiments.

5) Define the experimental outcomes. In research you must identify and define what the outcome is for your study.[You also want to define what you consider "success" of an experiment. If you are studying a biological process, the outcome may be the measure of the amount of a specific protein produced.

1. The outcomes must be measurable with consistency or they will not produce usable data.
2. All statistical analyses to be used for the study should be established before data collection.

6) Write up the experimental protocol. After completing the overall design of the experiment, write up a detailed protocol that includes every condition to be tested and all the necessary calculations. Performing the experiment is much simpler when you have done all of planning before you begin.

1. The more detailed you make the protocol, the easier it will be to follow and repeat the experiment later.

PART 3: Conducting the Experiments

1) **Plan your experiments.** In order to complete your studies in a reasonable amount of time, it's helpful to draw up a loose schedule of when you will do each experiment. Keep in mind that many experiments will not work the first time and you will have to repeat them to make sure the data is consistent.

   1. Use a weekly or monthly calendar to schedule experiments, including time for analysis and interpretation of results.
   2. As you continue through experiments, some conditions may change or perhaps you will end up going in a different direction. This is normal, just be flexible with your schedule.

2) **Collect the necessary materials.** During the design phase, you will have written up a detailed protocol that should include all of the solutions and components needed to perform the experiment. Using this write-up gather everything you will need. Make sure to sign up to use shared equipment in advance so it will be available to you when you need it.

   1. Do as much of the small stuff as possible the day before such as labeling tubes and making solutions.

3) **Perform the experiment.** The day of the experiment, use your detailed protocol and follow the instructions closely. If you deviate from the written protocol at all, make sure to note what you did that was different. Keeping a lab notebook with all of your experiments and results is essential to conducting research.

   1. The first time you do an experiment, it is extremely likely that you will make mistakes or things will go wrong. This is totally normal. Take notes and learn from your mistakes for the next experiment.
   2. Record your results in your laboratory notebook.

4) Troubleshoot the experiment. If the data you obtained from an experiment indicates that the experiment itself didn't work, you will need to troubleshoot it and figure out what went wrong. There are a number of factors that can contribute to an experiment failing:

1. If you were using a special kit from a company, contact them or seek out their troubleshooting information.
2. Make sure all of the reagents used were not past their use-by date.
3. Check to make sure all of your instruments were working properly that day.
4. Double check all of your calculations and make sure the proper amounts of everything were used.

5) Repeat the experiment. Once everything has been optimized and troubleshooter, you will simply need to repeat the experiment until you have the correct number of data samples to analyze as determined before in the design phase. After collecting all of the data, you can analyze it and start drafting a manuscript for publication.

1. Use all of the same reagents (detectors) and instruments whenever possible to limit variability between experiments.

PART 4: Analyzing and Publishing the Data

1) **Analyze the raw data.** For most experiments you will be given a raw data output of numbers. Depending on the study, you will transfer these numbers into another program to make graphs and compare the various groups. It's important to pay close attention to the data when moving it between programs.

1. Take care to avoid copying and pasting rows or columns of data incorrectly.

2) Run the proper statistics. During the experimental design phase, you should have decided on the statistical tests and analyses you would perform on the data. Once finished with data collection, run these tests to determine significance within your datasets.

1. Indicate significance where applicable on all of your figures and state the exact statistical values within the text of the manuscript.
2. Use programs such as Graphpad Prism, R, and SAS for the analysis.

3) Make publication quality figures. There are many programs used in the scientific community to generate figures that would be fit for publication, but even simple programs such as Excel can be used. Figures should be clear and concise. Make sure all font sizes used are clearly legible in both size and style

1. Organize panels so that similar data is grouped together.
2. Avoid using color within the figures as there are generally expensive fees associated with color figures.

4) Write the paper for publication. When you have all of your results gathered together and in figure form, you can start writing the manuscript. Begin with the material and methods section as this is the easiest. Describe the data in the results section and then talk about the conclusions you draw from them in the discussion. Finish with the introduction, abstract, and title.

1. Determine the journal you want to submit for publication before writing so you can follow their style guide.

5) Submit the manuscript for publication. Follow the submission guidelines and the style guide specific to the journal you submit the manuscript to. They will contact you within a few weeks with comments about the paper. It may be sent back without review or it will be sent to other scientists for reading and comments.

1. After the paper is reviewed by other knowledgeable professionals in the field, it will come back with comments that you will need to address.
2. If the paper does not get submitted for review, you will need to submit it to a different journal. This may require revisions to adhere to the new journals style requirements.

6) Revise the manuscript. When you get the manuscript back from peer-review you will have to revise the paper according to the comments. You may need to perform many more experiments or you may simply need to provide a few more details or do some small easy experiments.

1. To address the comments, revise the manuscript and write a cover letter rebuttal stating how each comment was taken into account in the revised paper.

7) Resubmit for publication. After final revisions, resubmit the paper to the journal for another review. Usually, this is the final step and the paper will be published; however, it is possible that you may need to do another round of revisions.

1. Once your manuscript is accepted, you will be sent proofs to review and then it will be ready for publication!

WRITING A SCIENTIFIC RESEARCH ARTICLE

FORMAT FOR THE PAPER

Scientific research articles provide a method for scientists to communicate with other scientists about the results of their research. A standard format is used for these articles, in which the author presents the research in an orderly, logical manner. This doesn't necessarily reflect the order in which you did or thought about the work. This format is:

TITLE

•Make your title specific enough to describe the contents of the paper, but not so technical that only specialists will understand. The title should be appropriate for the intended audience.

•The title usually describes the subject matter of the article: Effect of Smoking on Academic Performance"

•Sometimes a title that summarizes the results is more effective: Students Who Smoke Get Lower Grades"

AUTHORS

1. The person who did the work and wrote the paper is generally listed as the first author of a research paper.

2. For published articles, other people who made substantial contributions to the work are also listed as authors. Ask your mentor's permission before including his/her name as co-author.

ABSTRACT

1. An abstract, or summary, is published together with a research article, giving the reader a "preview" of what's to come. Such abstracts may also be published separately in bibliographical sources, such as Biologic al Abstracts. They allow other scientists to quickly scan the large scientific literature, and decide which articles they want to read in depth. The abstract should be a little less technical than the article itself; you don't want to dissuade your potent ial audience from reading your paper.
2. Your abstract should be one paragraph, of 100-250 words, which summarizes the purpose, methods, results and conclusions of the paper.
3. It is not easy to include all this information in just a few words. Start by writing a summary that includes whatever you think is important, and then gradually prune it down to size by removing unnecessary words, while still retaini ng the necessary concepts.
3. Don't use abbreviations or citations in the abstract. It should be able to stand alone without any footnotes.

INTRODUCTION

What question did you ask in your experiment? Why is it interesting? The introduction summarizes the relevant literature so that the reader will understand why you were interested in the question you asked. One to fo ur paragraphs should be enough. End with a sentence explaining the specific question you asked in this experiment.

MATERIALS AND METHODS

1. How did you answer this question? There should be enough information here to allow another scientist to repeat your experiment. Look at other papers that have been published in your field to get some idea of what is included in this section.
2. If you had a complicated protocol, it may helpful to include a diagram, table or flowchart to explain the methods you used.
3. Do not put results in this section. You may, however, include preliminary results that were used to design the main experiment that you are reporting on. ("In a preliminary study, I observed the owls for one week, and found that 73 % of their locomotor activity occurred during the night, and so I conducted all subsequent experiments between 11 pm and 6 am.")
4. Mention relevant ethical considerations. If you used human subjects, did they consent to participate. If you used animals, what measures did you take to minimize pain?

RESULTS

1. This is where you present the results you've gotten. Use graphs and tables if appropriate, but also summarize your main findings in the text. Do NOT discuss the results or speculate as to why something happened; t hat goes in th e Discussion.
2. You don't necessarily have to include all the data you've gotten during the semester. This isn't a diary.
3. Use appropriate methods of showing data. Don't try to manipulate the data to make it look like you did more than you actually did.

"The drug cured 1/3 of the infected mice, another 1/3 were not affected, and the third mouse got away."

TABLES AND GRAPHS

1. If you present your data in a table or graph, include a title describing what's in the table ("Enzyme activity at various temperatures", not "My results".) For graphs, you should also label the x and y axes.
2. Don't use a table or graph just to be "fancy". If you can summarize the information in one sentence, then a table or graph is not necessary.

DISCUSSION

1. Highlight the most significant results, but don't just repeat what you've written in the Results section. How do these results relate to the original question? Do the data support your hypothesis? Are your results consistent with what other investigators have reported? If your results were unexpected, try to explain why. Is there another way to interpret your results? What further research would be necessary to answer the questions raised by your results? How do y our results fit into the big picture?
2. End with a one-sentence summary of your conclusion, emphasizing why it is relevant.

ACKNOWLEDGMENTS

This section is optional. You can thank those who either helped with the experiments, or made other important contributions, such as discussing the protocol, commenting on the manuscript, or buying you pizza.

REFERENCES (LITERATURE CITED)

There are several possible ways to organize this section. Here is one commonly used way:

1. In the text, cite the literature in the appropriate places:

Scarlet (1990) thought that the gene was present only in yeast, but it has since been identified in the platypus (Indigo and Mauve, 1994) and wombat (Magenta, et al., 1995).

2. In the References section list citations in alphabetical order.

Indigo, A. C., and Mauve, B. E. 1994. Queer place for qwerty: gene isolation from the platypus. Science 275, 1213-1214.

Magenta, S. T., Sepia, X., and Turquoise, U. 1995. Wombat genetics. In: Widiculous Wombats, Violet, Q., ed. New York: Columbia University Press. p 123-145.

Scarlet, S.L. 1990. Isolation of qwerty gene from S. cerevisae. Journal of Unusual Results 36, 26-31.

Referencing style guides

A referencing style is a set of rules telling you how to acknowledge the thoughts, ideas and works of others in a particular way.

Referencing is a crucial part of successful academic writing and is key to your assignments and research.

Which referencing style should I use?

- There is no standard style used at all the universities
- In some cases there is a standard style used by a particular school or discipline, but even in those cases it is still possible that a particular lecturer may require a different style
- Students should check their course profile or ask their lecturer
- Researchers submitting a paper for publication in a journal should check the journal's Instructions for Authors, which will normally be available on the journal's website

NOTE: Harvard style is a standard style for Salahaddin University

Why reference?

- **Demonstrate researched appropriate literature/ undertaken reading**
- **Acknowledge used ideas of others (avoid plagiarism)**
- **Key to good academic practice**
- **Enhances the presentation of your work**
- **Shows writing based on knowledge/informed by appropriate academic reading**
- **Enables person reading your work to trace source used/give credit for effort/quality**

What should I reference?

- all sources of information used in writing your essay

What is a citation?

- acknowledging others' work in your work
- referring to them individually
- using a direct quotation

Harvard Referencing Style

Many referencing styles – Harvard easy to learn/simple to use

Referencing in the text

- Authors
  - Author's name followed by date of publication
  - E.g. Gabe (2011) argues that..

  - Quoting an author briefly:
  - E.g. Gabe (2011:75) states that `Health inequalities are...

  - Longer quotes (2+ lines) start new line

    The concept of exclusion has come into ever-greater use with the deepening social crisis. Contrary to what occurred in the industrial Revolution of the last century... (Bessis 1995:13)

Referencing in the text (continue)

- If there are two authors, cite both

  e.g. (Morris and Scott 1996)

- If there are more than two authors use *et al*

  e.g. (Williams *et al*, 2012)

- Quotations from *journals* follow the same format. E.g. Author + date of publication

  - give full details in bibliography

- Citing sources that have not been read directly

  ... (Denney 2005, cited in Moore 2008)

  - in the bibliography just reference Moore 2008

  - only list texts in the bibliography if you have **actually read them!**

Bibliography

- For essays divide bibliography into **Texts** and **Websites**
- Do **NOT** split into journals and books
- Sources cited in main text should be in the bibliography
- Publications by a single author should come before joint publications by the same order
- Don’t use *et al* in the bibliography
- If there are two books/articles by the same author in the same year, distinguish by using ‘a’, ‘b’ etc after the date
- Titles of *books* and *journals* should be in italics
- Don’t use numbers/bullet points before each source

Examples

- Single author:
  Denney, D. (2005) *Risk and Society*. London: Sage Publications.
- Joint authors:
  Crawford, A. and Newburn, T. (2003) *Youth Offending and Restorative Justice.* Cullompton: Willan.
- Edited book:
  Lee, R. and Stanko, E. (eds) *Researching Violence*. London: Routledge.
- Chapter in an edited book:
  Bury, M. and Gabe, J. (2006) 'Television and medicine: Medical dominance or trial by media?' In D. Kelleher, J. Gabe and G. Williams (eds) *Challenging Medicine.* London: Routledge.
- Journal articles:
  Beck, U. (2000) 'The cosmopolitan position: Sociology of the second age of modernity'. *British Journal of Sociology* 51 (1), 79-107.
- Emslie, C., Hunt, K. and Watt, G. (2001) 'Invisible women? The importance of gender in lay beliefs about heart problems'. *Sociology of Health and Illness* 23 (2), 203-33.
- There is **no need** to write Volume 51, Number 1, pages 79-107.

Citing Websites

- In the essay, identify the website in brackets:

  e.g. (Justice, 2012)
- If you cite different pages from the same website, distinguish them by adding [a], [b] etc after the reference to the website in the essay

  - match this lettering in the bibliography
- In the bibliography, give full details –

  - URL of website, date accessed in alphabetical order

Examples in the Text

Young offenders may receive a range of court orders if they are convicted, from referral orders as a first court disposal, through custody under a detention and training order (Justice, 2012[a]). As of October 2012, 1,595 youth offenders (under 18 years old) are being held in custody in the secure estate (Justice, 2012[b]).

Examples in Bibliography

- Justice. (2012[a]) *Disposals.* [online] Available from: http://www.justice.gov.uk/youth-justice/courts-and-orders/disposals [Accessed 19 December 2012]
- Justice. (2012[b]) *Youth custody data.* Available from: http://www.justice.gov.uk/statistics/youth-justice/custody-data [Accessed 19 December 2012]

Online/Electronic books/journals

- Book on line/electronic

  Elliott, G.C. (2009) *Family Matters*. [Online] Oxford: Wiley-Blackwell. Available from: http://www.mylibrary.com?ID=93941 [Accessed 18th June 2011]

- Journal article on line

  Gabe, J., Exworthy, M., Jones, I.R and Smith, G. (2012) Towards a sociology of disclosure: the case of surgical performance. *Sociological Compass*. [Online] 6, (11). Available from: doi: 10.1111/j.1751-9020.2012.00490.x [Accessed 4th February 2013]

On line journals

- **What is a DOI?**

  - digital object identifier

  - permanent identifier used by publishers so article can always be found on line

  - usually found at start of article

  - if you use a full-text data base service like EBSCO - is no DOI – use data base URL (URL = http://..... [Accessed 18th June 2012])

Referencing software

Why use referencing software?

Bibliographic software allows you to create your own database or library to store references and create automatic bibliographies in your essay or paper

- Referencing software will help you save time as it allows you to:
- enter or import online references
- manage and edit your references
- easily create a bibliography in any citation style

Referencing software options

- EndNote - on all Library computers and available to download
- EndNote online
- Mendeley (free version)
- Zotero (free software)

What is citation software?

- Citation software helps you to:
- import citations from your favorite databases and websites.
- build and organize bibliographies.
- format citations for papers.
- take notes on articles and save them in your collection of citations.
- save and organize PDFs, screenshots, graphs, images, and other files for your research.

Which program is right for you?

- The MIT Libraries support EndNote, Zotero, and Mendeley. How do you know which program is right for you? Some things to think about when you choose:
- What programs are your colleagues using? For example, if fellow researchers are all using Zotero to share citations, you might consider Zotero so that you can share your research, too.
- Use what you like! There is no one perfect program, so use what you're comfortable with.
- You can use more than one software. Records can be transferred from one program to another, so don't feel limited to choosing only one.

Overview of Peer Review Process