

Research Methods

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1 Introduction

This section handles (deals with) the basic idea of research.

What is research

Research as a word is Re+Search, that means search again. Below (Following) are the definitions of research from some different viewpoints:-

- Research is a detailed study of a subject to discover new information or reach new understanding. (Due to Cambridge Dictionary).
- Research is a work that involves studying something and attempting (trying) to discover facts about it. (Due to Collins Dictionary)
- According to Oxford Dictionary, research is the systematic investigation into and study of materials and sources in order to establish facts and reach new conclusions.

For examples

- Medical research (Finding new medicine for a specific disease)
- Mathematical Research (Applying new methods for finding solutions (exact or approximation) for a system).

In mathematics, research has two main aims

- Pure (Basic Science): To understand the nature of mathematical thinking, teaching, and learning.
- Applied: To use such understandings to improve mathematics instruction.

2 Criteria of a good research

Following are some characteristics of a good research:-

- Started with a problem.
- Acted according a specific plan.
- Directed toward the solution of a problem.
- Expertise requirement.
- Characterised by patient.
- Courage requirements.
- Apply every possible test to validate the procedures.
- Reasonable assumption.

3 The aim of research in mathematics

Following are some reasons for why mathematician do research in their areas:-

- Enhance the knowledge: obtaining more details about a topic.
- Clarifies confusion and proper understanding: doubt on a specific topic
- Published work.

4 Components of Research

The components of research can be arranged as follows:-

- Title
- Abstract
- Introduction or (Introduction and background)
- Methodology
- Results
- Discussion and Conclusion
- References (References and Appendices)

4.1 Title

The title is the part that is read the most. following are some features of 'Title':-

- Select most suitable title.
- Neither too short nor too long (contains fewest possible words).
- State the methods if it is necessary.

4.2 Abstract

Abstract can be defined as the short powerfull statement that describes a large study. Following are some characteristics of "abstract"

- State clearly the purpose of the study.
- Summarise the most important results.
- Shortly, describe the methodology (If it is necessary).

4.3 Introduction or (Introduction and Background)

Introduction is the preliminary part of (book, article, . . .) leading up to the main part.

In, introduction,

- state the aim (more than what you have explained in the abstract) of the research.
- review the current literature on the topic.
- display an overview of the contents of the research.

For background,

- State all the definitions and known results that have been used during your study.

Remark 1.

It is necessary to write the abstract, introduction and background after completing (writing) the other parts of the research.

4.4 Methodology

According to Collins dictionary, Methodology is a system of methods and principles for doing something such as teaching or for carrying out research. In a research, Methodology assumed as the main part due to the following (some) reasons:-

- Describes
 - What was used?
 - What was done?
 - How was done?
- Articulates (shows) the reason of selecting the particular procedure or technique.
- Evaluate the work (Does an appropriate and accurate technique has been assumed during the study).
- All the aspects used in the study must be described thoroughly enough so that researchers working in that field would be able to replicate (reproduce, not to make the same copy) the work.

4.5 Results

The result is the outcome of the research. In “result’

- Restate the results that have been explained in the abstract and introduction parts.
- Summarise the collected data.
- Show tables and figures if they make the result much clear.

4.6 Discussion and conclusion

In discussion and conclusion, interpret the results without indicating to any data.

4.7 References (References and Appendices)

The reference section is the standardised method of formatting the information sources researchers considered in their study. References and appendices are the last parts in research. Appendix part includes information which is too detailed for the text of the research itself.

Remark 2.

For publication, researchers must apply the referencing style, required by the publication resource.

Remark 3.

Reference part, contains only the citation sources used in the text, while bibliography contains the consulted sources as well as the citation sources.

Remark 4.

The acknowledgement section can be add to thanks those individuals and organisation whose contributed to the work presented.

5 Academic writing

Academic as a word is related to schools, colleges and universities, or connected with studying and thinking, not practical skills. (Due to Cambridge dictionary).

Any writing that include a writing assignment given in an academic setting is called academic writing.

5.1 Some characteristics of academic writing

Below are some characteristics of academic writing:-

- Use small Roman numerals (i,ii,iii,···) for the following parts
 - Abstract.
 - Acknowledgements.
 - Table of contents.
 - List of tables.
 - List of figures.
 - List of abbreviations.
- Use easy language and short sentences.
- Statements must be supported by evidence, whether from scholarly sources or quotation from primary text.
- Follows a logical structure: Includes introduction, main part and conclusion.
- Avoids emotional, inflammatory or biased language.

5.2 Plagiarism

Plagiarism is the practice of taking someone else's work or ideas and passing them off as one's own. So, it is offence. (Due to Oxford's dictionary)

6 Notes and common mistakes

Following are some notes and common mistakes of academic writing in mathematics:-

6.1 Writing rules

Following are some writing rules

1. Avoid containing too many words.
2. Avoid informal language: Conversational language.
3. Avoid no citation resources.
4. Any formula has to be a part of a sentence.

5. Never start a sentence with a formula.
6. If a formula ends a sentence, add a dot (full stop) after the formula
7. definitions should be explained first.
8. Use the same style in the whole document.
9. Do not use equivalence or entailment-arrows in the text.
10. Letters that denote to variables, constants, functions, ... should be written in italic.
11. Do not write,

Let x be an integer ≥ 0 ,

write,

Let x be an integer greater than or equal to 0

12. Write

$$\frac{a}{b} \cdot \frac{c}{d},$$

instead of

$$\frac{a}{b} \frac{c}{d}.$$

13. Too long or too wide formulas that is not fit inside an ordinary text should be written on separate lines.
14. For integration, write

$$\int_a^b \frac{f(x)}{g(x)} dx,$$

instead of

$$\int_a^b f(x)/g(x) dx,$$

15. Functions like sine, \tan^{-1} , limits, ... should be written as \sin , $\tan^{-1} \lim_{x \rightarrow a} f(x)$
16. write

There are infinitely rational numbers

instead of

There are many rational numbers.

6.2 indices

1. Avoid the symbol i as a summation index if the text also contains complex number.

2. Write

x_1, \dots, x_n instead of $x_1, \dots x_n$.

$x_1 + \dots + x_n$ instead of $x_1 + \dots x_n$.

$x_1 \cdot \dots \cdot x_n$ instead of $x_1 \cdot \dots x_n$.

3. It is better to write

$$\{a_n\}_{n=1}^{\infty},$$

instead of

$$\{a_1, \dots\}.$$

And

$$\sum_{k=1}^{\infty} a_k,$$

instead of

$$a_1 + \dots.$$

4. Try to avoid expression like

$$\begin{matrix} X & Y & b \\ & a & \\ & Z & d \\ & & c \end{matrix}$$

6.3 Paranthesis

Parenthesis is very important in mathematics. Keep clear the distinguish between

1. $(a+b)/2$ and $a+b/2$
2. $\ln(x+2)$ and $\ln(x)+2$
3. $\sin(x/5)$ and $\sin(x)/5$.

6.4 Matrices

1. For matrices, use paranthesis or brackets
2. Use line for the determinant of a matrix A .
In the text, use $\det(A)$ instead of A .

6.5 Results (Theorems, Proposition, ...) and Proofs

1. Results such as theorems, propositions, lemma, ... and their proofs should be easy to find in the document. Enumerate the results and choose the bold font for them.

2. All assumptions in result (Theorems, Proposition, . . .)/proof should be written.
3. Mark the end of the proof with the square symbol \square or “Q.E.D’ (quod erat demonstrandum), It means “what was to be shown’.

7 References

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