TECHNISCHE UNIVERSITÄT DRESDEN

Institut für Leichtbau und Kunststofftechnik

DCIM Dresden Center for Intelligent Materials

DRESDEN concept

Methods and Results

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Outline

- Methods
  - General recommendations
  - Case Study
  - Assessment
- Results and discussion
  - General recommendations

Methods - Creating a Mind Map

Consider the following questions as a guide:

- Does my methods section provide enough detail for it to be reproduced by someone else?
- Is it logically organised and presented?
- Have I appropriately referenced where needed?
- Is the use of all methods justified?

Methods - Creating a Mind Map

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Create a Mind Map:

A structured framework for organizing the methodology section of a paper:

- Break down each step of the methodology
- Highlight key details
- Show connections
- Ensure clarity and flow
- Easily revise
- Cover everything

It is essentially a checklist that helps to structure your ideas, keep the flow clear, and make sure all parts of the research are well documented!!!

Methods - Creating a Mind Map

In out context!!

- Describing materials or models
- Experimental or numerical procedures
- Justification of the methods
- Data collection or simulation output
- Reproducibility
- Addressing limitations

Methods - Creating a Mind Map

In out context!!

- Describing materials or models
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- Data collection or simulation output
- Reproducibility
- Addressing limitations

Ensure that the methodology is logically presented and comprehnsive, allowing others to replicate the research or understand how the findings were obtained!

Breaking down!

- Describing materials or models
- Experimental or numerical procedures
- Justification of the methods
- Data collection or simulation output
- Reproducibility
- Addressing limitations

Breaking down!

- Describing materials or models
  - Details of materials (e.g., type, source, properties)
  - Details of the numerical models (e.g., geometry, material properties, boundary conditions).
- Experimental or numerical procedures
  - Outline the steps of the procedures
  - Describe equipment and tools used.
  - Describe software, algorithms, and solvers used.
- Justification of the methods
  - Why certain methods or materials were chosen?
  - Why the methodology is a good fit for the research?
- Data collection or simulation output
  - How data was recorded?
  - What are the simulation outputs?
  - Include benchmarks or comparissons
- Reproducibility
  - Is detailed enough for reproducibility?
- Addressing limitations
  - What are the limitations in the methods used?
  - What are the assumptions and approximations made?

Case Study based on a published paper

- Choose a paper related to your topic and read the methods section
- Couple of minutes for a task

- **Objective**
  - Did the authors answered all the questions?
- **Discussion**
  - Is it logically presented?
  - Is it possible to replicate?

How authors describe this section?

Assessment 1 - Creating a Mind Map for an experimental paper

Consider an experimental work – impact on a composite plate

- **Objective**
  - Measure the impact response of composite plates.
- **Approach**
  - Experimental impact testing.

- Describe the sub-sections and sequence

Is it logically presented?

- Describe the parameters needed

Does it have enough detail?

Assessment 1 - Creating a Mind Map for an experimental paper

1. Materials and Specimen Preparation

- **Composite Material**
  - Matrix (e.g., epoxy) and reinforcement (e.g., carbon fibers).
- **Specimen Details**
  - Plate dimensions, layering, and preparation process.
- **Standards**
  - Testing standards (e.g., ASTM).

Assessment 1 - Creating a Mind Map for an experimental paper

2. Fabrication Process

- **Manufacturing Method**
  - Techniques used (e.g., hand lay-up, vacuum bagging).
- **Curing**
  - Curing time and conditions.
- **Specimen Inspection**
  - Visual inspection, quality control.

Assessment 1 - Creating a Mind Map for an experimental paper

4. Testing Procedure

- **Experimental Process**
  - Step-by-step testing (e.g., impact drop, recording measurements).
- **Environmental Conditions**
  - Control of temperature and humidity during testing.

Assessment 1 - Creating a Mind Map for an experimental paper

4. Testing Procedure

- **Experimental Process**
  - Step-by-step testing (e.g., impact drop, recording measurements).
- **Environmental Conditions**
  - Control of temperature and humidity during testing.

Clearly and objectively describe the procedure

Are the environmental conditions important?

Assessment 1 - Creating a Mind Map for an experimental paper

5. Data Collection and Analysis

- **Key Measurements**
  - Impact force, displacement, energy absorption.
- **Damage Inspection**
  - Visual damage, delamination, microscopic analysis.
- **Post-Processing**
  - Graphical representation of force vs. time, damage patterns.

What measurements have to be made in the context of the reseach?

What phenomenon is being investigated?

How the results are going to be presented?

Assessment 1 - Creating a Mind Map for an experimental paper

6. Reliability and Validation

- **Repeatability**
  - Ensure consistency in multiple tests.
- **Validation**
  - Comparison with previous experimental studies or simulations.

7. Limitations

- **Test Conditions**
  - Potential limitations due to sample size or setup.
- **Impact on Results**
  - How limitations may affect accuracy and reliability.

Those are linked to the results section!

Assessment 1 - Creating a Mind Map for an experimental paper

- **Do you agree?**
  - Have the main aspects been covered in this tought experiment?
- **Idea behind**
  - Clear organisation of steps
  - Highlight key details
  - Identifying the flow
  - Ease of revision

Don't take anything for granted!!!

Creating a Mind Map for a numerical paper

Same reasoning for a numerical paper!

- **Objective**
  - Measure the impact response of composite plates.
- **Approach**
  - Numerical Simulation
  - Finite Element Analyses (FEA)

- Describe the sub-sections and sequence

Is it logically presented?

- Describe the parameters needed

Does it have enough detail?

Creating a Mind Map for a numerical paper

1. Composite Plate Modeling

- **Material Properties**
  - Matrix (e.g., epoxy)
  - Reinforcement (e.g., carbon fibers)
- **Material Data Input**
  - Mechanical properties (e.g., Young's modulus, Poisson's ratio)
  - Failure criteria (e.g., Tsai-Wu, Hashin)
- **Plate Geometry**
  - Dimensions and layering (e.g., thickness, orientation)

Creating a Mind Map for a numerical paper

2. Simulation Setup

- **Finite Element Model**
  - Meshing
  - Element types (e.g., shell elements, solid elements)
- **Boundary Conditions**
  - Fixed supports, constraints
- **Loading Conditions**
  - Impact force definition (e.g., point load, distributed load)
  - Impact velocity and duration

Creating a Mind Map for a numerical paper

3. Numerical Techniques

- **Solver Settings**
  - Time-stepping methods (e.g., explicit, implicit)
  - Convergence criteria
- **Contact Modeling**
  - Contact algorithms (e.g., penalty method, Lagrange multipliers)
- **Failure Modeling**
  - Damage initiation and progression

Creating a Mind Map for a numerical paper

4. Data Collection and Analysis

- **Output Parameters**
  - Impact force, displacement, stress distribution
  - Damage area and depth
- **Post-Processing**
  - Visualization of damage (e.g., contour plots, animations)
  - Data extraction (e.g., stress-strain curves)

Creating a Mind Map for a numerical paper

5. Validation and Verification

- **Validation**
  - Comparison with experimental results (if available)
  - Benchmarking against known solutions
- **Verification**
  - Mesh independence study
  - Sensitivity analysis

Creating a Mind Map for a numerical paper

6. Limitations and Assumptions

- **Model Limitations**
  - Simplifications (e.g., 2D vs. 3D models)
  - Assumptions in material behavior
- **Impact on Results**
  - Possible sources of error
  - Implications for findings

Creating a Mind Map for a numerical paper

7. Documentation and Reporting

- **Detailed Reporting**
  - Description of simulation setup and parameters
  - Interpretation of results
- **Figures and Tables**
  - Simulation snapshots, graphs

Methods - Summary

Now ask yourself:

- Is the methodology written in enough detail for another researcher to replicate it?

Excelent!

- Is the methodology written in such a way that it can be pieced together, but with some effort?

Good!

- Is the methodology written but important details have been omitted? Is it described in an unclear way?

Needs substantial improvement!

Results and Discussions - Creating a Mind Map

Take the following as a guide!

- Have I presented my data logically and concisely, with important trends extracted and described?
- Have I clearly presented my main findings?
- Are my conclusions well substantiated by evidence?
- Does my discussion make clear points? Does it draw firm conclusions?

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Create a Mind Map:

A structured framework for organizing the Results and Discussion section of a paper:

- Presenting results
- Interpreting findings
- Using visual aids
- Connection to research goals
- Addressing limitations and counterarguments

Results and Discussions - Creating a Mind Map

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Is my research question answered?

Results and Discussions – Breaking down

- **Objective**
  - Discuss the important points to be covered in the results and discussion section
- **Approach**
  - It is common that the results and discussion sections are combined into one.

Results

Is it logically presented?

Discussion

Conclusions? Results sopported by evidence?

Results and Discussions – Breaking down

1. Results

- **Logical order**
- **Main Findings**
- **Unexpected Findings**
- **Relevance of Results**

Results and Discussions – Breaking down

1. Results

- **Logical order** → Results per experiment or study
  Results per Hypothesis
- **Main Findings** → Key data points
  Statistical analyses
  Figures and Tables
- **Unexpected Findings** → Describe anomalies found
  Describe outliers
- **Relevance of Results** → How the findings support the hypothesis?

Connection to the research question!!

Results and Discussions – Breaking down

2. Discussion

- **Interpretation of Results**
- **Implications**
- **Limitations**
- **Future Research**
- **Conclusions**

Results and Discussions – Breaking down

2. Discussion

- **Interpretation of Results** → Key findings Comparisson with previous studies (benchmark)
- **Implications** → Practical implications Theoretical implications
- **Limitations** → Limitations of the methodology, Data limitations, Alternative explanations
- **Future Research** → Questions raised What are the next steps?
- **Conclusions** → Summary of findings Final Takeaways

Results and Discussions – Breaking down

3. Visual Aids

4. Linkage to Hypothesis and Objectives

5. Addressing Counterarguments

Results and Discussions – Breaking down

3. Visual Aids

Incorporate Figure and tables
Integrate visual aids in discussion

4. Linkage to Hypothesis and Objectives

How the findings relate to the research objective?
Is the a need to revisite the hypothesis?

5. Addressing Counterarguments

Discussion of potential flaws
Counterpoints to potential criticism

Results - Summary

Now ask yourself:

- Text tells story of your major findings in logical and engaging way
- Figures and Tables are formatted for maximum clarity and ease of interpretation
- All figures and tables have numbers, titles and legends that are easy for the reader to follow

Excelent!

- Text presents data but could benefit from reorganization or editing to make story easier for reader
- Text includes interpretation of results that is better suited for discussion section
- Figures and tables are formatted to be clear and interpretable
- All figures and tables have numbers, titles and legends

Good!

- Text omits key findings, inaccurately describes data, or includes irrelevant information
- Text difficult to read due to style or mechanics of writing
- Text difficult to read due to logic or organization
- Figures and tables missing information, improperly formatted or poorly designed
- Figures and tables have inadequate or missing titles or legends

Needs substantial improvement!

Discussions - Summary

Now ask yourself:

- Appropriate conclusions drawn from findings
- Connections made between findings
- Connections made between findings and background information
- Future directions considered
- Writing is compelling

Excelent!

- Appropriate conclusions drawn from findings
- Experimental limitations considered
- Writing is clear

Good!

- Conclusions omitted, incorrectly drawn or not related to hypothesis.
- Relationship between experimental findings and background information is missing or incorrectly drawn
- Writing style and mechanics make argument difficult to follow

Needs substantial improvement!

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Thanks!