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Good Scientific Practice in Computer and Data Science

What, Why, & How on Good Scientific Practice in Reviewing a Scientific Article

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Course Objectives

To Understand:

- What?, Why? and How? about Scientific Literature Review.
- What are the Ethics and Practical Approaches behind.
- Provide the guidelines with perspective of good scientific practice.
- Overall to introduce & explain fundamentals of literature review. i.e.,

Peer review is not about rejecting or accepting $\rightarrow$ it is about improving science.

What is Scientific Literature/Article Review?

Definition

- Committee on Publication Ethics (COPE), (2017) →https://publicationethics.org/
  - "Scientific literature review is the systematic and critical evaluation of research work, methodology, findings, and their implications within the broader scientific context".

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Key Principle

- Good scientific practice requires:
  - Objectivity,
  - Thoroughness, and
  - Constructive criticism.

Types of Scientific Literature Review

Formal Reviews:

- Peer review (journals, conferences)
- Thesis examinations
- Grant proposal evaluations

Informal Reviews:

- Literature surveys
- Group discussions / lab meetings
- Self-assessment of work

Common Goal

- All reviews aim to advance knowledge through
  - Quality control, &
  - Constructive feedback.

Why We Do Scientific Reviews?

Fundamental Principles

- **Scientific Integrity:**
  - Honesty in reporting,
  - Transparency in analysis,
  - Acknowledgment of uncertainties
- **Reproducibility:**
  - Sufficient detail for replication,
  - Open data/code when possible,
  - Clear methods
- **Objectivity:**
  - Unbiased evidence evaluation,
  - consideration of alternatives,
  - separation of facts and interpretations

Why? (Contd..): Research Ethics in Review

Ethical Considerations

- Plagiarism detection and originality
- Verification against data fabrication
- Disclosure of conflicts of interest
- Proper handling of human/animal subjects

Red Flags

- Missing citations or unrealistic results
- Lack of error analysis / statistics
- Inadequate methodological details

How?: The IMRaD Structure Review

Introduction (I)
- Problem defined?
- Hypothesis clear?
- Literature gap?

Methods (M)
- Experimental design
- Sample size
- Reproducibility

Results (Ra)
- Data presented clearly?
- Figures/tables complete?
- Statistical analysis correct?

Discussion (D)
- Valid interpretations?
- Limitations addressed?
- Significance explained?

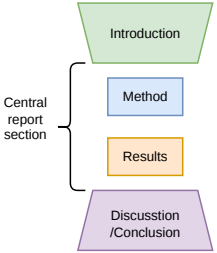

Figure: IMRaD Wineglass Diagram

IMRaD Diagram - Two Charactersitics:

- The first, the top-bottom symmetric shape,
  - Represents the symmetry of the story development.
- The second, the change of width,
  - Represents the change in generality of the viewpoint.
- https://link.springer.com/book/10.1007/978-3-319-03101-9
- https://en.wikipedia.org/wiki/IMRAD

How? (Contd..): Common Review Mistakes

Pitfalls to Avoid

- Confirmation bias
- Surface-level review
- Authority bias
- Overemphasis on recency
- Personal bias

Mitigation Strategies

- Use structured checklists
- Seek multiple perspectives
- Focus on evidence quality

Example Evaluation Framework

When reading a paper, ask:

1. What is the research question?
2. What is the main contribution?
3. Is the methodology appropriate?
4. Are experiments sufficient?
5. Are conclusions supported by data?

If you cannot answer these clearly
$\rightarrow$ The paper has clarity issues.

How to Conduct a Scientific Peer Review

1. Read for Understanding

- Identify the research question and contribution
- Understand methodology and assumptions
- Distinguish claims from evidence

2. Evaluate Scientific Quality

- Originality: Is the contribution novel?
- Technical soundness:
  - Are methods correct and justified?
- Reproducibility:
  - Is the setup sufficiently described?
- Significance:
  - Does it advance the field?

3. Structure Your Review

- Brief neutral summary (1 paragraph)
- Major comments: (Conceptual / methodological issues)
- Minor comments: (Clarity, references, presentation)

4. Provide Constructive Feedback

- Be specific and evidence-based
- Suggest improvements where possible
- Critique the work, not the authors

5. Make a Justified Recommendation

- Accept / Minor Revision / Major Revision / Reject
- Ensure recommendation aligns with comments

How Scientists Efficiently Review a Paper

1. First Pass (15–20 min): Orientation

- Read abstract, introduction, conclusion
- Scan figures and tables
- Identify main contribution and claims
- Decide: Is the contribution potentially sound?

2. Second Pass: Technical Evaluation

- Read methodology carefully
- Check equations, assumptions, baselines
- Verify whether results support conclusions

3. Practical Techniques

- Highlight unclear claims while reading
- Write margin notes (PDF annotation tools or tablet.)
- Some print for deep reading (Reduces screen fatigue.)
- Keep a separate structured review document

4. Efficiency Tips

- Separate major from minor issues early
- Do not rewrite the paper (Focus on scientific quality)
- Review in two focused sessions (Avoid one long sitting)

Key Takeaways

Essential Elements of Good Scientific Review

- **Systematic Approach**: Use structured frameworks and checklists
- **Critical Thinking**: Question assumptions and evaluate evidence
- **Objectivity**: Minimize bias and maintain scientific integrity
- **Constructive Feedback**: Aim to improve scientific quality
- **Continuous Learning**: Develop expertise through practice

Remember

- Reviewing is not only about finding flaws
  - It is about improving the reliability and impact of science.

Additional Resources

Guidelines and Standards

- COPE (Committee on Publication Ethics) guidelines
- ICMJE (International Committee of Medical Journal Editors) recommendations
- Field-specific reporting standards (CONSORT, PRISMA, etc.)

Educational Resources

- "How to Write and Publish a Scientific Paper" by Day and Gastel
- "The Craft of Research" by Booth, Colomb, and Williams

Tools and Software

- Reference managers (Zotero, Mendeley, EndNote)
- Plagiarism detection tools (ithenticate, Turnitin)
- Reproducibility platforms (Open Science Framework: `https://osf.io/`)

Questions and Discussion

Review Consciously!

Exercise 1: Abstract Analysis (Bachelor's Level)

Activity: "Spot the Issues"

- **Time**: 15 minutes
- **Materials**: Take 3 abstracts with different Domains or Ranked Journal/Conference
- **Task**: Students identify strengths and weaknesses in each abstract
- **Focus Areas**:
  - Clear research question
  - Appropriate methodology mentioned
  - Results clearly stated
  - Conclusions supported by results
- **Outcome**: Discussion of what makes an abstract effective

Learning Objective

- Develop ability to quickly assess research quality from limited information

Exercise 2: Statistical Red Flags (Master's Level)

Activity: "Data Detective"

- **Time**: 25 minutes
- **Materials**: Results section with graphs, tables, and statistical tests

Student Tasks:

- Check sample sizes
- Verify statistical test selection
- Look for multiple comparisons
- Assess effect sizes
- Examine confidence intervals

Issues to Plant:

- p-hacking indicators
- Inappropriate statistical tests
- Missing error bars
- Selective reporting
- Correlation vs causation claims

- **Debrief**: Groups present findings and discuss implications

Exercise 3: Methodology Evaluation (PhD Level)

Activity: "Design Critique Workshop"

- **Time**: 45 minutes
- **Materials**: Complete methods section from recent paper
- **Individual Phase (15 min)**:
  - Read methods section thoroughly
  - Complete structured evaluation checklist
  - Note specific concerns and suggestions
- **Group Phase (20 min)**:
  - Compare individual assessments
  - Discuss disagreements and reasoning
  - Develop consensus recommendations
- **Presentation Phase (10 min)**:
  - Groups present major findings
  - Suggest alternative methodological approaches

Exercise 4: Reproducibility Challenge

Activity: "Can You Reproduce This?"

- **Time**: 30 minutes, **Level**: All levels
- **Setup**: Provide simplified data analysis example with:
  - Raw dataset (10-20 data points)
  - Brief methods description
  - Reported results and figures
- **Student Tasks**:
  - Attempt to reproduce the analysis
  - Identify missing information needed
  - Compare their results with reported results
  - Assess additional details needed for full reproduction

Key Learning

- Experience reproducibility challenges firsthand and understand the importance of detailed reporting

Exercise 5: Peer Review Simulation (Optional)

Activity: "Journal Review Process"

- **Time**: 60 minutes,
- **Level**: Master's & PhD students
- **Roles Assigned**:
  - Authors (2-3 students)
  - Reviewers (2-3 students/paper)
  - Editor (1 student)

- **Process**:
  1. Authors submit short research proposal/paper
  2. Reviewers independently evaluate using review template
  3. Editor synthesizes reviews and makes decision
  4. Authors respond to reviewer comments
  5. Group discusses the entire process

- **Templates provided**: Review forms, decision letters, response guidelines

Exercise 6: Literature Gap Analysis (Optional)

Activity: "Find the Missing Piece"

- **Time**: 40 minutes,
- **Level**: All levels
- **Materials**: 5-7 abstracts from recent papers in specific research area
- **Student Tasks**:
  1. Map out what each paper contributes
  2. Identify methodological approaches used
  3. Look for contradictory findings
  4. Spot areas that need further investigation
  5. Propose a logical next research question
- **Outcome**:
  - Students present identified gaps and proposed research directions.
  - Discuss how literature reviews should synthesize rather than summarize.

Exercise 7: Ethical Issues Identification

Activity: "Ethics Detective"

- **Time**: 20 minutes,
- **Level**: All levels
- **Scenario-Based Exercise**:
  - Present 4-5 brief research scenarios
  - Include potential ethical issues:
    - Inadequate informed consent description
    - Potential conflicts of interest not disclosed
    - Data sharing concerns
    - Authorship disputes
    - Human/animal welfare issues
- **Student Tasks**:
  - Identify ethical concerns in each scenario
  - Suggest how issues should be addressed
  - Discuss implications for review process
- **Discussion**:
  - What are their responsibilities?
  - When should reviewers raise ethical concerns?

Exercise 8: Figure and Table Critique

Activity: "Visual Evidence Evaluation"

- **Time**: 25 minutes,
- **Level**: All levels
- **Materials**: Collection of figures and tables with various quality levels
- **Evaluation Criteria**:
  - Clarity and readability
  - Appropriate chart type for data
  - Complete labeling and legends
  - Statistical information included
  - Consistency with text descriptions
- **Advanced Task** (PhD level):
  - Redesign poor figures to improve communication
  - Identify potential data manipulation or misleading presentation

Take-Home Assignment (Optional)

Extended Practice Activities

- Please Choose the activities based on course level and duration
- **Option 1: Complete Paper Review** (Advanced)
  - Select recent paper in student's field
  - Write full peer review report
  - Present findings to class
  - Receive feedback on review quality
- **Option 2: Literature Quality Survey** (Intermediate)
  - Select 10 papers on specific topic
  - Rate quality using provided checklist
  - Identify trends in research quality
  - Propose improvements for field
- **Option 3: Reproducibility Project** (All levels)
  - Attempt to reproduce published analysis
  - Document challenges encountered
  - Suggest improvements for reproducibility