Methodological Articles

Reading a Scientific Paper for Psychology and the Social Sciences: A Critical Guide

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Abstract

Aim: A critical review of a journal article is a comprehensive evaluation of the article content, formal structure and methodological approach. Success in this task requires students to develop analytic and reflexive skills as pre-requisites to identify key research question(s), relevant findings and main conclusions reached. Critical skills are also an important aspect of a student's academic and future professional life, yet this has been a largely overlooked component of academic training. This paper aims to provide undergraduate students with a simple and straightforward set of guidelines for reading, analysing and interpreting research articles. Content, structure and common mistakes in research papers are addressed, along with the most relevant standards for review.
Conclusion: With this reference guide we hope students will be able to more thoroughly analyse and critically discuss the strengths and weaknesses of a research article.

Keywords: critical review, scientific journal articles, undergraduates, theoretical study

Introduction

It is easy to find good (though dense) books on how to write, read and review scientific papers. However, this literature may not be particularly useful to aid students in the task of critically reviewing research articles. In addition, there is a lack of published papers on this topic (e.g., McKenzie, 1995). This topic is essentially covered in the *Instructions for Authors* section of *Scientific Journals*, and general guidelines for the structure and content of the manuscripts differ according to the specifications of each journal. Although students are asked to critically review the scientific literature throughout their undergraduate studies, limited training and resources are available. In fact, accomplishing this task requires not only that students develop objective and mature reading and comprehension skills, but also the ability to identify the core aspects of an article, namely key research questions and hypothesis, relevant findings and main conclusions. This article conveys a systematic approach for reviewing manuscripts. In each section, content, writing style and common flaws are addressed. In complement, an exhaustive set of guiding questions is provided to support the evaluation of the quality of scientific articles (see Appendix).

One must note that this work is circumscribed to correlational research articles and not to the full range of scientific articles (e.g. experimental designs).

Conceptualisation and Characteristics

A critical review is a systematic evaluation of what one has learned from reading a scientific article. It conveys an assessment of the article's strengths, weaknesses and validity through explanation, interpretation and analysis.

A good critical review (a) frames the content of the article in the context of the current knowledge, (b) clarifies the study aims and tested hypotheses, (c) evaluates how replicable is the methodology used to test hypotheses and (d) assesses whether the conclusions are in line with the main findings. In addition, the article must provide readers with information about the work's contribution to research in a particular scientific domain.

Structure of a Scientific Article

Scientific articles present original findings based on rigorous empirical research. They vary in content or structure, depending on the type of journal to which they will be submitted. In general, the structure follows: Introduction, Methods, Results and Analysis, and Discussion structure (IMRaD; Saracho, 2013). For didactic purposes we add considerations about title, author affiliations and abstract, as they are essential to capture the attention of the reader for the paper.

The *title* provides a clear description of what the paper is about. It is the first thing that will be read and sometimes the last, being determinant for the reader to continue to be interested. A well-written title is accurate, clear, concise, revealing and provocative. In 10 to 15 words, it provides the reader in a timesaving but informative way, the general field of the paper, objectives and/or main results. Titles can be worded in different ways, including (a) general versus specific, (b) declarative versus interrogative, (c) with or without subtitles, and (d) short indicative versus long informative. The option for a particular type of title is in accordance to the style of the author and the requirements of the scientific journal. Titles that are long, grandiose or promise too much are to be avoided.

The *authors* and *affiliations* section presents the authors of the manuscript by based on the relevance and nature of their contribution to the article. In the authors' list, the institutional affiliation, academic degree and area of expertise are presented. The section ends with the identification of the e-mail and full address of the author to whom all correspondence should be addressed.

The *abstract* is the "hall of entrance" of the article. It summarizes the most important features of the manuscript (Provenzale & Stanley, 2006), providing the reader with a global first impression on the paper (Hartley & Betts, 2009). In general, the abstract must answer two questions: "What should be learned in this article?", "Is it worth reading the paper further on?". The abstract is a synopsis of the whole paper. In 150 to 250 words it provides a succinct, clear, and comprehensive summary of the main sections of the paper. A well-structured abstract follows a standard back-bone structure of problem/purpose of the study, method, results, and conclusion (Hartley, 2012). The problem sums up the reason(s) and purpose of the study, research questions, hypotheses being tested, and their relative contribution to the field. The methods covers the methodologies used to investigate the problem, including the identification of participants, procedures, statistical analyses and any software used. Finally, the results section presents key findings of the research, including reference to indicators of statistical significance of the coefficients. Abstract ends with a summary of the findings, considerations about the novelty of the study, and

relevance of implications for theory and practice. In terms of writing style, a good abstract should be self-contained. It should be written in a concise and clear fashion to provide a summary of key aspects of research without the need to consult the full paper. Sentences are usually worded in an active style and exclude personal pronouns. Verbs are conjugated in the past tense, when they describe followed procedures, and in the present tense when reporting results. Digits can be used to present figures, except when these are placed in the beginning of the phrase. Acronyms should only be used in exceptional cases and should be clear defined. Abstracts should not cite references, report on subsequent tables and figures and provide statements that are not supported by data. They should also avoid lengthy or omitted background information.

Most scientific journals require, after the abstract, three to 10 index terms, keywords or short phrases for cross-indexing purposes. Keywords should clearly indicate the field of study and main concepts targeted in the paper. The paper proceeds with the introduction.

Crafting a convincing *introduction* can be a challenge for authors (Drotar, 2009). Indeed, in just a few pages, re-searchers need to set the conceptual framework of the paper, address the problem under investigation and state the novelty and relevance of the current research to answer specific research questions. To make this task easier, the introduction follows a common structure. In the first paragraph, authors specify the broad research topic, main issues and questions left unanswered from previous research (when applicable) and the main research question under study (Drotar, 2009).

From the second to the penultimate paragraph, the introduction reviews the relevant literature for understanding the state of the art in the subject. In general, this section starts with an historic overview of the topic covered and most relevant conceptual frameworks. It follows a description of the conceptual framework adopted in terms of key constructs and operational definitions. Specific linkages are then made between previous research and the work addressed in the scientific paper. Theory-based research is then presented. Authors generally convey a broad perspective on the findings, including both confirmatory and contradicting evidence to the hypotheses of the current study.

The purpose and specific contribution(s) of the study to the field are addressed in a subsection of the introduction usually entitled "Aims of this research". In this section authors clearly state the study objectives and hypotheses under testing. The focus is put on new research questions, or innovative ways to address them (in terms of methods, theory, and/or findings; Drotar, 2008; Sternberg & Gordeeva, 1996). The translation of research questions into hypotheses aims to help readers understanding the logic of the study and give focus to methods. Common flaws in the introduction include (a) insufficient background information, or limited to a unique conceptual framework, (b) unclear coverage of the subject matter and/or deficit of comprehensive information, (c) confusing operational-ization of constructs, research questions and hypotheses, and (d) dated or excessively detailed previous research. Most importantly, introduction should not anticipate methods, results and implications subsequent sections do not support.

The *methods* section provides a description of how the study was conducted, and should be sufficiently detailed to allow replication (Baker, 2012; Olson & Meyersburg, 2008). Traditionally, this section is divided in the *Participants and Procedures* and *Measures* subsections. Many papers also include a *statistical analyses* subsection (which, in alternative, is also commonly placed at the beginning of the results section). The first subsection details the sampling methodology (e.g. probabilistic versus non-probabilistic; independent versus paired samples) and so-ciodemographic characteristics of participants' (e.g., sex, age, ethnicity, educational level), along with a justification

for the sample choice. Information should be provided in sufficient detail for readers to reach an informed conclusion. The procedure describes the data collection method, waves of measurement defined for the study, pilot studies performed, and the time, place and duration of data collection. Information about the ethical aspects is also to be conveyed, including the procedures followed to recruit the participants, and permissions from the institution(s) and informed consent from the participants (or parents of underage participants). Procedures followed to ensure anonymity are made explicit and, when applicable.

In the *measures* subsection the variables and instruments used to collect the data are described. Information usually specifies the type and format of the instruments (e.g., self-report questionnaires), the data collection methods (e.g., computer software and apparatus). When questionnaire adaptation or validation was performed a reference to authorship and publication, and a justification of their appropriateness is necessary. Further, when questionnaires are developed or validated for various cultures, this section also describes the procedures for the transcultural adaptation/validation of instruments, the changes made to the original scale and the psychometric properties of the instruments in the original and current samples. Sources of measurement error should be also conveyed, as well as the steps taken to minimize them. Finally, the methods section provide a detailed description of the statistical methods used for data analysis, a justification for their adequacy, and the statistical software used in the analyses, including the version number (e.g., AMOS 20.0).

The *results* section presents the main findings of the study. Presentation of results generally follows a funnel logic method, from more general to more specific. The report of the statistical results should be clear and concise, but with enough detail to allow replication of procedures and cross-validation of findings. In general, reports on the results of statistical tests appear in text, whereas descriptive statistics should be summed up in self-explanatory figures, tables and graphs (Vintzileos & Ananth, 2010). Further, non-standard statistical terms, abbreviations, and symbols used throughout the text should be defined.

Two common flaws in the results section of scientific articles include overwriting and underwriting. When overwriting, authors give unnecessary details for data analysis. Indeed, if statistics are an important component of the section, they should not dominate it. In turn, underwriting concerns the failure to account for important results. An additional issue is related to the non-technical use of technical statistical terms. At the end of this section, the reader should be able to conclude about the relevance of the findings and whether answers to the research questions and hypothesis were supported by the data. Importantly, the reporting of findings in this section should not include interpretation. Interpretation of findings should be included in the *discussion* and *conclusion* section(s).

The *discussion* section provides a theory-based interpretation of findings, states their significance for current research, and derives implications for theory and practice. Alternative interpretations for findings are also provided, particularly when it is not possible to conclude for the directionality of the effects.

In the discussion, authors also acknowledge the strengths and limitations/weaknesses of the study and offer concrete directions about for future research (e.g. research of statistical methods to improve inference). Several questions are usually answered in this section, including "What research questions remain unanswered?", "Is it necessary to test new hypotheses?" and "What kind of work can shed light on these issues?". Common flaws include the presentation of new data or detailed statistical results that merely reiterate the findings presented in the results section.

The *conclusion* summarizes the main findings of the study and their original contribution to the field, giving particular emphasis to the way the findings contribute to move the research literature significantly forward. The conclusion is the "business card" of the paper, i.e., the message that the reader will (hopefully) recall in the future. It may stand alone, as a subsection of the discussion or may be presented as a combined discussion and conclusion section.

Final Remarks and Limitations

In this article we provide a systematic approach to the structure of a scientific article. We examined the structure and key features of research papers according to the conventional IMRaD structure and enunciated some of the most relevant flaws. In addition, we organized the standards for a critical review by formulating a series of orienting questions that guide the review of each section of an article. Despite these limitations, we believe that the present paper provides a useful resource to guide the critical review of a research paper, and stimulates reflexive thinking and critical analysis skills on students. Future research should extend these reflections to other scientific publications, such as experimental or review articles.

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Appendix: Checklist for a Critical Review

Note: The following checklist is adapted from Maher (1978), McKenzie (1995), and Wilkinson (1999).

Cover

1. Is there any given biographical information about the author?

2. What are the authors' qualifications and authority?

3. Who is the intended audience?

Title

1. Is the title specific and does it reflect the content of the manuscript?

2. Does the title presents a suitable length?

Abstract

1. Does the abstract state what is the purpose of the article: what was done, found, and the significance of the results obtained?

2. Does the abstract provide information about the general field that the article relates to?

3. Can the abstract be understood without reading the manuscript?

4. Does the abstract clearly state what methodology was used?

5. Does the abstract provide a balanced description of the most important findings?

6. Does the abstract mention what are the practical implications of the research?

7. Are there discrepancies between the abstract and the remainder of the manuscript?

8. Are there portions that could be deleted and replaced to increase the information value of the abstract?

9. Is the abstract followed by up to five keywords?

Introduction

1. Is the purpose of the study clearly defined?

2. Is the research problem clearly stated?

3. Are the research questions clearly identified?

4. Is/are the question(s) being asked relevant?

5. Are the research questions important for current research?

6. Are all the citations correct and necessary?

7. Does the introduction cover the most significant research conducted on the topic?

8. Is the background information enough and relevant?

9. Are the most relevant theories or models clearly identified?

10. Are the definitions, assumptions and predictions clearly stated?

11. Are there any key papers that have not been referenced?

12. Has the author been careful to cite prior reports contrary to the current hypothesis?

13. How does the current study differ from previous research?

14. Is it provided a rationale for the relations between previous and current research?

15. Are the hypotheses of the study clearly defined?

16. Are the hypotheses correctly derived from the theory that has been cited?

17. Are other, alternative hypotheses compatible with the same theory?

Method

1. Is the method clearly described?

2. Is it possible to replicate the study without any further information?

3. Are the methods appropriate and relevant for the research problem?

4. Is anything important omitted in the research?

5. Is it clear what variables are measuring and why?

6. Are the reasons to choose each procedure clearly explained?

7. Are the methods used valid?

8. Can the results be trusted?

Participants

1. Is the sample adequate for answering the questions posed?

2. Are participants adequately described?

3. Are the participants sampled randomly?

4. When convenience sampling is used, is the procedure made explicit?

5. Is it provided a description of the age, sex and ethnicity of participants?

6. Have the study period and geographical area been clearly identified?

7. Are the generalisations proposed by the authors reasonable?

8. Are there probable biases in sampling (e.g., volunteers, high refusal rates, etc.)?

Measurement

1. How were the variables measured?

2. Is there an adequate description of tasks, materials, apparatus, and so forth?

3. Are the measures appropriate for the participants in this sample?

4. Have appropriate psychometric characteristics (e.g., scoring, dimensionality, reliability, and validity) been clearly established and reported for all measures and subscales used (particularly important for tailor-made measures, short versions or cultural adaptations of original instruments)?

5. Are the psychometric properties of measures reported for the previous and current studies?

6. When more than one measure was used, was the order counterbalanced?

7. If so, were order effects actually analyzed statistically?

8. Was (Were) there (a) control task(s) to confirm specificity of results?

9. If measures are scored by observers using categories or codes, is the interrater reliability reported?

10. Was administration and scoring of the measures done using blind procedures?

Procedures

1. Do the author(s) report any pilot studies?

2. Were the ethical aspects being safeguarded?

3. Do the subjects benefit from the study? If not, were the risks negligible to them?

4. Were the authorizations and informed consent obtained?

5. How have the purposes of the study been described to participants?

Figures and Tables

1. Did the authors fail to include figures, tables or graphs that best depict their findings?

2. Did they adequately complement the text?

3. Are the figures and tables necessary, sufficient and self-explanatory?

4. Can they be simplified or condensed?

5. Could several tables be combined into a smaller number?

6. Are tables and figures sequentially numbered and titled?

7. Are the tables correctly referred in the text?

8. Do the figures include lettering that is proportionate to their size?

9. Are the legends of the figures clear?

10. Are the axes of figures identified clearly?

11. Do graphs correspond logically to the textual argument of the article?

12. Are the tables adequate to summarize the data?

13. Are the trade names, abbreviations and symbols misused?

Results

1. Are the results presented in a logical way?

2. Are the results presented coherently to the study goals?

3. Does enough information exist to understand the validity and accuracy of the results?

4. Do the results answer all the previous research questions?

5. Do the authors provide a balanced analysis to each one of the aspects of the results?

6. How was the data analyzed in order to answer the research questions?

7. Does the results section clarify the statistical methods employed?

8. Is there an adequate rationale for the selection of statistics and programs?

9. Were tests of significance properly used and reported?

10. Have statistical significance levels been accompanied by an analysis of practical significance levels?

Discussion

1. Do the authors provide alternative explanations for the findings?

2. Were the authors capable of integrating the findings in relevant theory and research?

3. Is there congruence between the results, their interpretation and the study objectives?

4. What are the implications of the findings to the existent theory and field practice?

5. Are the study limitations clearly identified?

6. Are the implications of the study limitations equated?

7. Do the authors make objective suggestions about future research?

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