

SCIENTIFIC ARTICLES STRUCTURE¹

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Abstract

Scientists and researchers communicate their research results one to another through scientific articles. These articles are generally published in scientific journals or presented in conferences. To make the communication efficient and effective, the articles must be presented coherently and logically. This can be realized through the use of the format commonly used in scientific articles. This paper describes the structure of scientific articles that are commonly used to communicate the results of research, known as AIMReDCaR (Abstract, Introduction, Methodology, Result, Conclusion, and References). Discussions are focused on the scientific article features and guidelines for writing each section.

Keywords: *AIMReDCaR*, scientific article, journals

Introduction

Scientific articles are the 'storehouses' of scientific researches results plus the procedures used to make those researches. They are written to provide a means for scientists to communicate each other about the results of their researches. To make the communication effective, the media (manuscripts) must have a standardized framework so that the authors could present their findings and ideas in an orderly, logical manner. This paper introduces the generic structure of scientific articles written based on actual and relevant studies. Discussions are focused on the stereotyped sections of the articles and their features as well. By being more familiar with those things, readers are expected to have clearer idea for writing journal articles. In this paper, the term scientific article is used

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interchangeably with manuscript, scientific paper, journal article, research paper, or research article.

Before exploring the scientific article structure in detail, it is important to note that based on their contents, scientific articles are differentiated into two types: full research papers, which are written based on actual and relevant studies; and conceptual papers, which do not present new data from fresh research but rather selectively discuss and compare the findings of other scientists (through library study) in order to advance thinking in the area of interest. The focus of this paper is on full research articles, especially those in English teaching field.

Discussion

Generic Structure of Scientific Articles

All scientific articles have general parts which follow a set of conventions that have developed over the years from 1665, when the first issue of *Philosophical Transactions* appeared in England (Cargill and O'Connor, 2009, p. 9). The inclusion of general parts in scientific articles makes scientific papers have a uniform or rigid format. Katz (2009, p. 3) explains that scientific papers have a stereotyped format, i.e. (1) *Abstract*; (2) *Introduction*; (3) *Materials and Methods*; (4) *Results*; (5) *Discussion*; (6) *Conclusion*; and (7) *References* (AIMReDCaR).

The use of AIMReDCaR format makes scientific articles' structure rigid, and there are two reasons for this. First, scientific articles are intended to facilitate a communication of scientific findings in the community of scientists. To assure the communication occurs efficiently, the media (manuscripts) must be standardized. Second, this format allows the paper to be read at several different levels. For those who merely want to find out what information is available on a subject, they may just skim the Titles and Abstracts. Those who need to go deeper may look at the Tables and Figures in the Results, and so on. In short, the scientific format

helps to insure that a reader knows what to expect and where to find specific types of information.

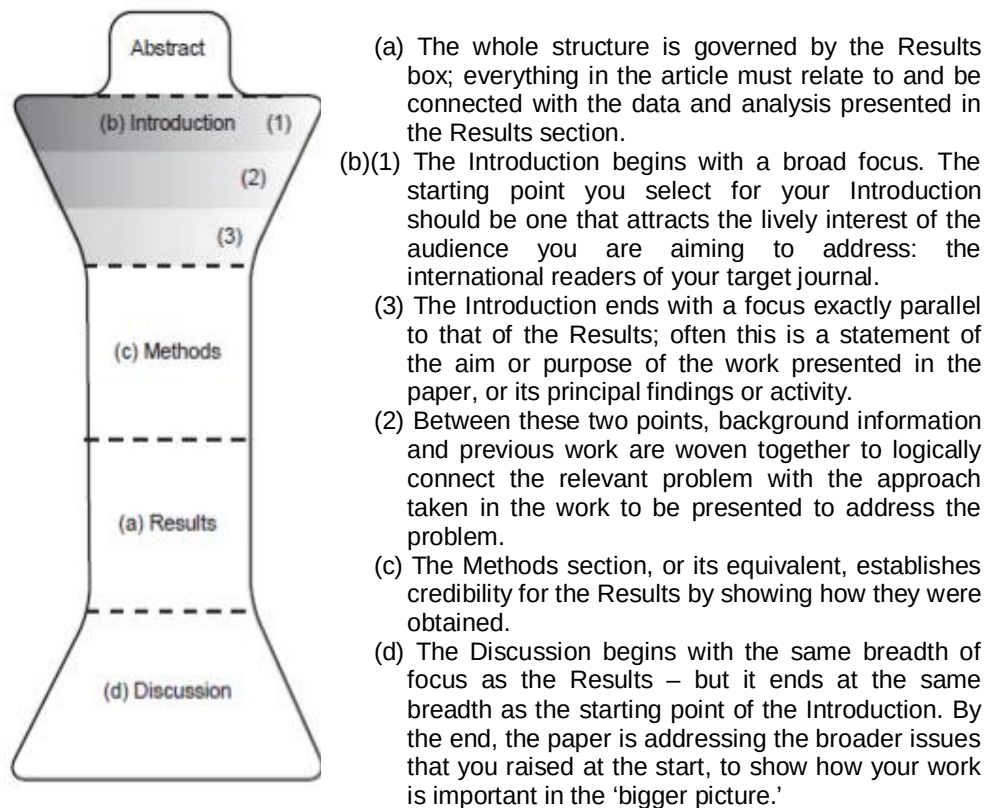


Figure 1: AIMRaD: the hourglass “shape” of a generic scientific research
[from Cargill and O’Connor (2009, p. 10)]

Since the AIMReDCaR, is basically a generic format, the exact section headings of scientific articles may vary due to two reasons. First, the research paradigms used in a field may differ from those in other fields. Second, different journals (even of the same field) have different limitations in page, figure, and article divisions that authors must adhere. To show the variety of scientific article formats, Cargill and O’Connor (2009, pp. 10-11) present three diagrams which represent the basic structure of an experimental article (Figure 1) and its two variations (Figure

2 and 3). The basic structure diagram, called the hourglass “shape” exposes important features of experimental scientific articles through the width and shape of its segments.

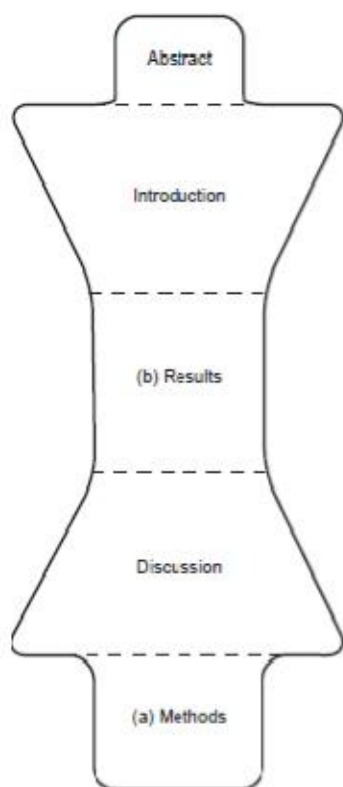


Figure 2: AIRDaM (Abstract, Introduction, Results, Discussion, Methods and materials)
[Cited from Cargill and O'Connor (2009, p. 11)]

The AIRDaM (Abstract, Introduction, Results, Discussion, Methods and materials) structure (Figure 2) is the format of the highly cited journal *Nature* (UK). It is a structure variation of articles focusing on molecular biology. It reflects the fact that the journal's aim is to present highly significant new advances in science in ways that are very accessible to scientists who are not necessarily specialists in the areas covered by the articles. Articles written in this format typically begin with a carefully structured initial section introducing the background and rationale of the work to the wide range of expected readers, followed by a concise report

of the findings and a short discussion. Methods are often only summarized in the main article, with full details appearing on a linked website. Full details on the structures required by these journals can be found on the journals' websites.

The AIM(RaD)C structure (Figure 3) is a variation that is permitted in some journals, usually for shorter articles. This format, usually written as brief notes (also called research notes or notes), and letters, is used mainly for reporting research findings. Such article may not include any section headings at all, but if you read them with an analytical eye you will be able to find the same types of information as are contained under the conventional AIMRaD headings in a full article.

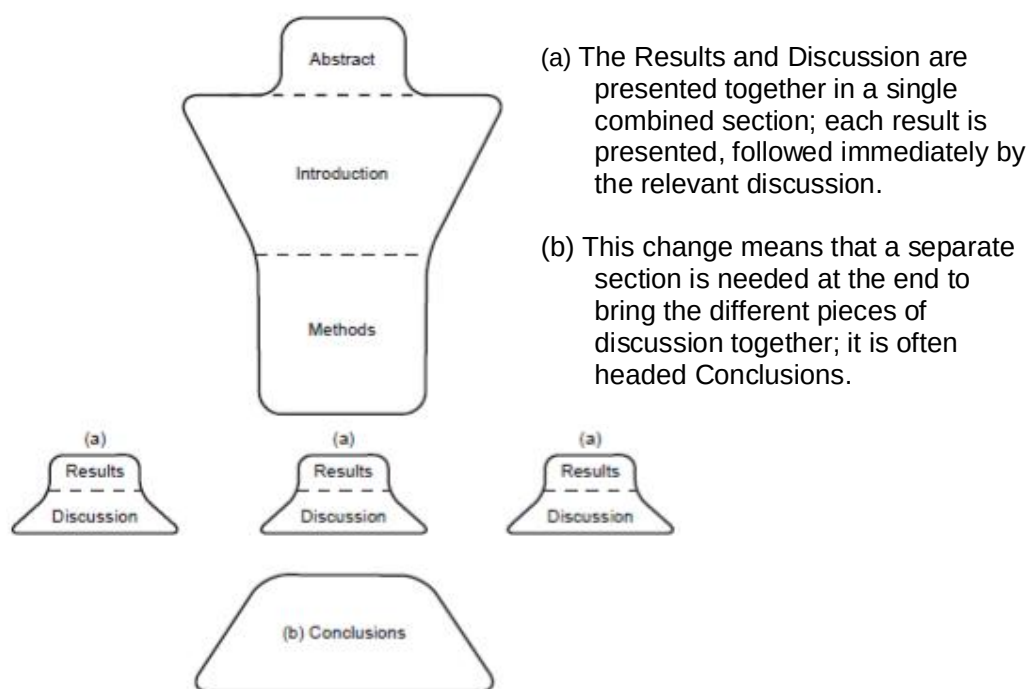


Figure 3: The AIM(RaD)C (Abstract, Introduction, Materials and methods, repeated Results and Discussion, Conclusions) [Cited from Cargill and O'Connor (2009, p. 11)]

Whether AIMReDCaR is truly the stereotyped format of journal articles could be easily checked by surveying credible journals. *Asian EFL Journal*, a highly cited journal in English teaching as a foreign language

(EFL), for instance, uses AIMReDCaR structure, although in some articles such in Brandt's (2010) "Competition and Collaboration in Initial Teacher Education in TESOL: A Case of a Classic Double Bind" the Results section is called Outcomes, while in some others, like Shang's (2010) "Reading Strategy Use, Self-Efficacy and EFL Reading Comprehension", the Discussions and Conclusions are combined into one section. *Language Learning & Technology*, a journal in English teaching as a second language (ESL) and EFL strictly applies the AIMReDCaR format for articles based on quantitative research. *Journal of English Teaching*, another journal specialized in ESL and EFL also uses AIMReDCaR format, although the Results and Discussion sections are combined into one section, as in Nazara's (2011) "Students' Perception on EFL Speaking Skill Development".

In the following segments, the seven sections of the AIMReDCaR format and their major features are discussed one by one.

Abstract Section

Most regular articles begin with an informative abstract which is limited by most journals to 150 to 250 words or even less. An abstract is the summary of the major aspects of a paper. It is usually one paragraph long, and should succinctly summarize why the research reported was conducted, how it was conducted and what results were obtained and what conclusions were drawn. In other words, an abstract provides maximum information with minimum words, covering (1) the Objective; (2) Materials and Methods; (3) Results; and (4) Conclusions. Unlike an indicative summary, which describes what will be covered in the paper (much like a table of contents), the abstract gives actual data. It is a minipaper that is understood on its own without reference to the paper proper (Yang, 1999, p. 53).

In addition, many journals also ask the author to put a list of three to five key words or short phrases for indexing. The key words are typed right

after the abstract. Several journals further specify that words already in the title should not be included.

Introduction Section

Every scientific report needs an introduction which presents background information a reader needs to understand the rest of the author's paper. The length of an introduction depends on the journal and the paper; however, the structure and content should be similar. In some journals the Introduction is written like a continuous essay, but in some others it is sometimes broken down into different components.

While writing the Introduction, an author should keep in mind that the reader of a scientific paper is assumed to have a basic familiarity with subject. Thus the introduction must exclude elementary facts and presents information relevant to the paper that only a specialist would be expected to know. An Introduction is usually 300 to 500 words, but may be more, depending on the journal and the topic. It usually follows this general format: (1) Problem and its background in a broad scope written in a single paragraph; (2) Specific problem to be studied, reasons why it was important to study, and how it applied to the larger field of research written in two to three paragraphs; (3) Clear statement of hypothesis (for experimental study) and objectives of the paper; (4) a brief summary of previous relevant studies by other researchers in the field to bring the reader up to date on the topic written in some paragraphs; and (5) explanation of concepts or definitions of operational terms used in a single paragraph.

Methodology (Methods & Materials) Section

Different journals may have various sections in the middle structure. Some journals entitle this section with the single "Methodology" while others, especially those that publish reports on experimental research,

entitle it Methods & Materials. This section, which describes the research procedures employed, is highly necessary for interested readers for it enables them to *repeat* the author's study and reproduce his/her results. Realizing this, the author must describe, in painful detail, exactly what he/she did: what experiments were carried out and how they were conducted, what equipment and materials were used and how they were used, how much, how often, what, where, when, and why.

According to *Journal of Young Investigators* (2005, p. 25), the information the Methodology section usually includes is: (1) Subjects used (humans, animals, plants) and their pre-experiment handling and care (anything that might affect the results must be included); (2) Sample preparation techniques; (3) Origins of samples and materials (e.g., "Thirty two 21-year-old students attending Literature II class at the English Teaching Program of the Christian University of Indonesia Jakarta"); (4) Description of the field site (if applicable) including physical and biological features, and exact location (include a map, if applicable); (5) Procedures for collecting data; (6) Statistical analysis techniques used. If used (for example, in ANOVA tests), the author must report the threshold used to determine statistical significance; (7) Information on computer programs used or written (for some computer science or physics articles, the author should include the relevant codes in the appendix); and (8) Descriptions of equipment set-up and function.

Results Section

The Results section is the meat of a paper, the most important part of a study. All other sections serve subordinate roles, either preparing the reader for the Results, or providing supplemental information to augment the findings (Yang, 1999, p. 63). Sometimes the Results and Discussion are combined into one section. This is particularly useful when preliminary data must be discussed to show why subsequent data were taken. In the following discussion, Results and Discussions are treated separately.

Results are general statements that present the key results (data) of the research without interpreting their meaning. The author should not include the raw data, but should present them as text, illustrations, and tables. All these three forms may be used, but the same data should not be repeated in more than one form. The results of statistical analyses should also be stated in this section, but every detail of the analysis should be excluded for the readers are assumed to have known what a null hypothesis is, a rejection rule, t-test, chi-square test, etc.

The text describing data may be any length. However, a brief statement such as, "The distribution of the respondents' interest in short stories are shown in Table 1," is sufficient. For clarity, long passages of text are often organized by topic into subsections, with a subheading for each topic. The subheadings assist the reader to trace paragraphs interesting to them.

The followings are important guidelines to consider in writing the Results section:

1. It is not necessary to include all the collected data during the research. This isn't a diary. Select and emphasize only important and relevant data that will answer the question or solve the problem raised in the Introduction section.
2. Do not include information properly belonging to other sections of the paper such as Materials and Methods, or Discussions (if Results and Discussions are separated).
3. Prevent repeating the legends for figures or the titles of tables in the text.
4. Explain in the text only those illustrations and tables whose significance is not obvious to the reader. Important features that are readily apparent from the illustrations and tables should be pointed out in the text. Therefore, do not repeat the data presented in the illustrations and tables.

5. Be sure that the text, illustrations, and tables are consistent with one another. Make sure that all numerical values in all every table agree with the figures or data presented in it.
6. Analyze your data by statistical methods, if appropriate.
7. Be honest. Do not omit data that do not support your hypothesis and conclusion or do not answer the research question.
8. A sentence should not begin with a numeral or symbol. A numeral or symbol beginning a sentence should be spelled out, or the sentence rewritten.
9. Use the past tense of verbs in the Results section, but use the present tense when referring to figures and tables. For instances,
Seventy per cent respondents said that they got appropriate opportunity for improving speaking in speaking classes, whereas the other 30% denied in this connection.
Table 2 reveals the students' perception collected during the second cycle of the action research.

But,
The data in Table 2 were collected during the second cycle of the action research.
10. Do not begin numbers in a sentence with a decimal point. Decimal fractions less than 1 should be written with the numeral 0 before the decimal point. For instance, instead of writing, "The result of statistical analysis was (r) = .619," you should write, "The result of statistical analysis was (r) = 0.619."

Discussion Section

The Discussion section of a scientific article reiterates the main findings but in the context of furthering knowledge or impacting on teaching practice, or future research. In other words, the Discussion takes and interprets the findings reported in the Results section, evaluates their significance, and examines the implications. Among the whole sections of

an article, this is probably the most challenging to write and will demonstrate how well the author understands the results. But it does not mean that the discussion should be made long, especially if there is little to discuss. Some journals limit discussion section beyond five double-spaced typed pages or 1,500 words.

Peat (2002, p. 87) presents a template for writing an effective Discussion section (see Figure 4). Paragraph 1 briefly summarizes of what was really found and why it was important. The aim could be restated in more general terms, but the results should not be restated exactly as in the results section. Some suitable phrases to begin with are, “The results from this study showed that ...”; “The findings indicate that ...”; “This study was aimed to ... and it was found that ...” etc. This paragraph focuses on the big picture of what the results are really all about. Explain the findings precisely and show how it will add to current knowledge or teaching practice.

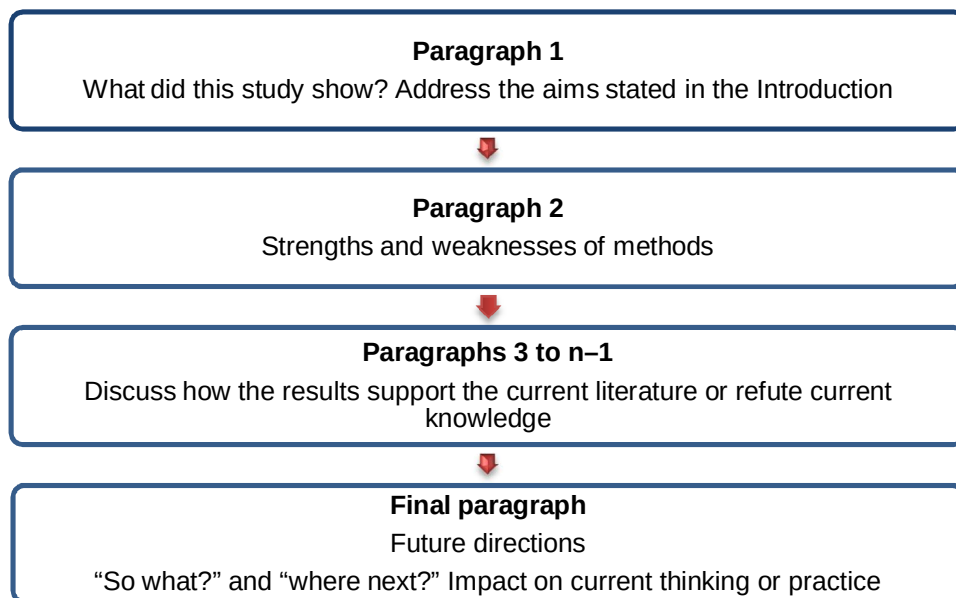


Figure 4: Template for the Discussion

The second paragraph should deal with the strengths and limitations of the study design and methods. Honesty is a must here. Just

remember that no research is ever perfect and every author should not be unnecessarily negative about what he/she done. Although putting the strengths and limitations of the study in the second paragraph is common, it can also be placed in later paragraph.

The middle paragraphs should compare the results and interpretations with related published work and theories. There is no need to discuss all the journal articles in every remotely related field. Readers will only want to know how the findings relate to results from other scientifically valid studies. Therefore, it is tactful to confine the discussion on the work in the field that is highly relevant and reputable. Give due credit to others whose work has been confirmed, but be fair with those whose results differs from the present findings and try to explain why the disagreement happened.

The last paragraph should be used to present a stimulating summary of the implications of the findings. This paragraph is also the place to end the Discussion with a conclusion (if possible) and suggestions for further research.

Conclusion Section

Some journals use a format that includes a section labeled "Conclusion" or "Summary." For other journals, the Conclusion, as what Peat suggests above, is the untitled last paragraph of the Discussion. If the Conclusion section is separated from the Discussion section, it should present (1) a succinct summary of implications of the findings, (2) general implications of the study, and (3) suggestions for further research. Lebrun (2007, p. 201) emphasizes that a Conclusion section is the place where the author restates the contribution of the research, with a particular emphasis on what it allows others to do; and proposes new research directions to prevent duplication of effort or to encourage collaboration.

References Section

Every research project usually relies in part upon the work of other scientific works. Any time an author cites from external materials, he/she is required to identify his/her sources in the form of systematic references. The importance of References section of a paper is not only for giving credit to the ideas and work of other scientists but also to provide the readers with access to these sources.

The two basic components of a referencing system are the “text citation” and the “reference list.” The former is a brief identification of the information source, and appears in the text somewhere within the paragraph where the information is used. A full bibliographic version of the citation appears with similar listings in a separate reference list, usually placed at the end of the text. The precise format for each reference section varies considerably. Some journals use the American Psychological Association (APA) style; others, (Modern Language Association (MLA) style; and some others created their own style. In addition, some journals ask that citations be listed by the order of appearance in the text, whereas others oblige that they be listed alphabetically. Therefore, it is a must for an author to check the journal’s referencing style and use it before submitting his/her paper.

This section should never be named “Bibliography”, because a bibliography contains references that an author may have read but were not specifically cited in the text. Bibliography sections are found in books and other literary writing, but not in scientific journal-style manuscripts.

Conclusion

Scientists communicate the results of their research one to another by means of scientific articles published in journals. To assure that the communication is effective and efficient, the contents of the media (manuscripts) must be presented in an orderly, logical manner. To attain this, scientific articles are written in the stereotyped format well-known as AIMReDCaR. This generic format divides a scientific manuscript into

Abstract, Introduction, Methodology, Result, Conclusion, and References sections, each with a specific purpose.

Although each section of a scientific article has its specific purpose, all of the sections are interrelated. The Abstract section succinctly summarizes the major aspects of the whole article in a single paragraph. The Introduction section shows the current need for studying a specific problem. The Methodology section describes the procedures and the materials used to conduct the study. The Result section organizes the findings, the Discussion section attaches the findings to other existing scientific papers to form new ideas, and finally the Conclusion summarizes the ideas in one succinct paragraph. The manuscript is ended with a reference list in which the author files the sources of external information he/she uses in the article.

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