

Requirements of a Good Analytical Chemistry Research Paper

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ABSTRACT AND SUMMARY

A good analytical chemistry research paper may be defined as one that passes the critical review of one's peers for publication in a recognized reviewed journal. Factors to consider in publishing an analytical paper include careful selection of the right journal, clear concise presentation that emphasizes the research contribution and its significance to the field, and careful revision if called for to account for the reviewers' and editors' criticisms. Rather special requirements apply to methods papers as opposed to other types of analytical papers. Data should be included to establish the accuracy and precision of the method by the use of standard reference materials, standard addition studies, interference studies, and comparisons with established methods. Day-to-day and run precision studies of the proposed method in a real setting help validate the method. Common problems with analytical papers are discussed. Specific suggestions are given for improving the likelihood of publication. Data are given on the ultimate disposition of manuscripts submitted to *Analytical Chemistry*. Reasons for rejection of papers submitted to the journal are summarized.

INTRODUCTION

A good analytical chemistry research paper may be defined as one that has passed the critical review of one's peers and the careful scrutiny of editors for publication in a recognized reviewed journal. Thus, those factors of most concern to editors and reviewers can be examined to provide insight for authors and potential authors as to the requirements for publication.

Before getting into this topic in detail, it is useful to describe the editorial operation of *Analytical Chemistry*. Herbert A. Laitinen, the editor, is also Graduate Research Professor at the University of Florida at Gainesville. Dr. Laitinen sets the editorial policies for the journal and is concerned with broad areas of scope, but the day-to-day operations are carried out by a trained editorial staff at the American Chemical Society headquarters in Washington, DC. The staff includes a managing editor, associate editor, assistant editor, and an editorial assistant. All of the editors are graduate chemists. The associate editor is a Ph.D. electroanalytical chemist who has been with the journal five years; the managing editor has been with the journal since 1962. All of the staff are trained in the careful use of peer review and the other facets of the editorial operation.

Each week the staff together reviews and discusses the manuscripts which have accumulated in the previous week. Each manuscript is assigned to an individual editor who becomes responsible for the manuscript through the entire process from choosing reviewers to acceptance or rejection. Active reviewer files are maintained both by alphabetical arrangement and categorized by specialty. The reviewer files are constantly being updated. Every year, for instance, Advisory Board members add names of people from various fields to the category files. Authors are also encouraged to suggest possible reviewers for their papers. Reviewers are very carefully chosen specifically for each paper. Contrary to what might be believed, good authors do not necessarily make good reviewers. Conscientiousness, a willingness to be critical, and respect for promptness in response are criteria

for the selection of reviewers, and good authors do not necessarily meet these criteria. The editor is informed of the reviewers chosen, receives a copy of the paper, and may at that time choose a third person to see the manuscript. When the reviews are received, they are evaluated by the assigned editor who then decides the type of revision required. If the manuscript is judged not acceptable for publication, a letter to that effect is written in the Washington office and forwarded along with the reviews to the editor for his concurrence and signature. When reviewers disagree, a referee is chosen. The term "referee" is reserved for use for that person who is called upon to evaluate a manuscript when the first two reviewers do not agree or when the editor is unable to make a revision or publication decision on the basis of the first two reviews. Referees are carefully selected, not only for their expertise in the research area, but also for their familiarity with the Journal's policies. They are frequently, though not necessarily, current or past Advisory Board members. Referees see the first two reviews so that differing opinions can be weighed and, hopefully, resolved. Reviewers and referees may choose to remain anonymous if they wish. Experience shows, however, that about half of the reviewers are willing to have their names revealed to authors. Serious problems which crop up are referred directly to the editor for his judgment. Prof. Laitinen is charged with full responsibility for all editorial decisions in accordance with the policies of the American Chemical Society.

The pervasiveness of analytical chemistry in science and technology is attested to by the contributions to analytical chemistry made by nonanalytical chemists. Dr. Laitinen suggested in his February 1976 editorial (1) that an analytical chemist is distinguished from his colleagues (who indeed contribute much to the discipline) by his goals of optimization and generalization of analytical methods, whereas with other types of workers, the analytical work is usually done as a means to an end rather than as an end in itself.

Who are the authors of papers in *Analytical Chemistry*? We asked 220 consecutive senior authors of accepted papers to designate their disciplines. The results of this survey are shown in Table I. Although 64% are analytical chemists, even some of these are in an additional discipline. Of the 36% nonanalytical chemists, 13% designate themselves as, for instance, geochemist, oceanographer, physicist, electronics engineer, etc. These data support the claim that much analytical chemistry research is performed by non-analytical chemists. The data also substantiate the international scope of *Analytical Chemistry*. The relatively small number of industrial contributors is a disappointing statistic and represents a downward movement from data collected on authors in the late 1960s.

Journal Selection

Workers in analytical chemistry are fortunate. They have many journals to choose from in making a publication selection. Some examples of publications which might serve the needs of the analytical community are shown in Table II.

The American Chemical Society has a space on its Abstract form for authors to indicate where they plan to seek publication of their contributed papers. An examination of these forms from the Fall 1976 San Francisco meeting shows the following extraordinary diversity of

TABLE I

Disciplines and Institutions of Authors of Papers
in *Analytical Chemistry*

Discipline	No.	%	Institution	No.	%
Analytical chemists*	141*	64.1	Academic	137	62.3
"Chemists"	10	4.5	Industrial	41	18.6
Physical chemists	10	4.5	Government	27	12.3
Organic chemists	11	5.0	Nonprofit, mixed	15	6.8
Biochemists	6	2.7			
Inorganic chemists	4	1.8			
Radionuclear chemists	5	2.3			
Pharmacologist	1		Country of Origin		
Biologist	1		U.S.	161	73.2
Chemical engineers	2		Non-U.S.	59	26.8
Other	29	13.2			
	TOTAL	220		220	100.0

* 13 included in this figure also gave other designations, such as physical/analytical chemist

TABLE II

Journal Selection

General Analytical Journals	Journals in other Disciplines
ANALYTICAL CHEMISTRY	Organic Chemistry
Analyst	Journal of the
Talanta	American Chemical Society
Analytica Chimica Acta	Physical Chemistry
	Inorganic Chemistry
Specialized Analytical Journals	Journals in Fields
Journal of Chromatography	Lipids
Journal of Electroanalytical	Agricultural and
Chemistry and Interfacial	Food Chemistry
Electrochemistry	Clinical Chemistry
Applied Spectroscopy	Environmental Science
	and Technology

publication plans by authors of Analytical Chemistry Division contributions: *J. Am. Chem. Soc.*; *Biochemistry*; *Anal. Chem.*; *Spectrochim. Acta*; *J. Electroanal. Chem.*; "Analytical Calorimetry" (symposium volume published by Plenum Press); *Anal. Lett.*; *Environ. Sci. Technol.*; *Inorg. Chem.*; *J. Chromatogr. Sci.*; *J. Chromatogr.*; *Anal. Biochem.*; *Can. J. Chem.*; *J. Phys. Chem.*; *Science*; *J. Mol. Spectrosc.*; and *Talanta*. This list does not take into account analytical papers in the programs of other ACS divisions and those papers are frequently directed to a publication in a research field in which the analytical work has application. Thus, the *Journal of the American Oil Chemists' Society* and the publication *Lipids* may well be the choice publication medium for analytical research applicable to edible fats and oils. Likewise, analytical papers in other fields may contribute more to the field of application than to the discipline itself.

Before a research paper is written, the author should carefully determine the main contribution of the work and decide in which periodical the work should be published to reach the most interested audience. Contributions misdirected are likely to be editorially rejected for scope reasons. *Analytical Chemistry* does receive a certain number of manuscripts that obviously belong more appropriately to a publication in the field where the work is being applied rather than to a discipline-oriented publication. *Analytical Chemistry's* manuscript requirements guide (2) is especially useful in determining if work is within the scope of the journal as well as in providing general guidance on manu-

script preparation. It is instructive to note how broad the scope of the journal has become since the 1930s and early 1940s when only methods papers were considered within the scope of the journal. Manuscripts dealing with theory or any type of basic information were at that time directed to other publications, even when the material provided information useful in understanding analytical operations.

After the choice of journal has been made, that journal's manuscript requirements should be carefully followed. The author should also consult the publication itself and prepare his paper accordingly. Although it is not of crucial importance that the style be that of the journal, it nevertheless creates a much better impression on editors and reviewers if the manuscript is in the correct style, especially for such things as reference citations.

Organization and Writing

As succinctly stated by Robert Day, managing editor of the *American Society for Microbiology News* (3), "scientific writing is primarily an exercise in organization." It is not necessary, however, to follow the long-standing formal manuscript style for scientific writing consisting of carefully arranged "introduction, experimental, results, discussion, and conclusions" unless the work naturally falls into this pattern. Some papers, theoretical papers, for instance, do not lend themselves to this type of presentation. Material should not be distorted to conform, but should be presented in a concisely-written, logical way that is easy to understand.

The introduction is important. The author should consider the likely readers of his work and present his material with this group in mind. The introduction should clearly state the purpose of the work and place it in perspective with current work in the particular field. In *Analytical Chemistry*, the author should write for the expert in his field, not for the novice. Although the importance of the introduction may seem obvious, the fact is that this part of a paper is often poorly done. Either it is overdone with unnecessary review material included or is so sketchily put together that neither the reviewers nor the editors can understand why the work was undertaken. Also, care should be taken by the author to make sure that claims made for the work are substantiated by the data presented. The author should not overstate the importance or significance of his work and must be prepared to defend his claims.

The writing should be done in the right order. Thus, the paper should be written first, the abstract second, and the title last. The latter two parts of the paper assume great importance because secondary abstract and title periodicals will pick up and reproduce these parts. Titles should be specific, concise, and contain keywords. Avoid ambiguous ill-defined terms in titles, such as "rapid" or "small."

Chemical Abstracts uses abstracts from many manuscripts just as they have been printed except for the introduction of abbreviations. Consult the journal for details on what information to include in the abstract. However, if the author will remember that the abstract will stand alone and represent the entire paper for many readers (of *CA*, for instance), he can more easily determine the important material to put in the abstract than if he thinks of the abstract as standing at the beginning of the paper. Because of its usual placement, authors have a tendency to include inappropriate introductory material in the abstract.

After the paper has been written, the author should rewrite, condensing where possible. He should also take a second look at the figures and tables. The use of figures rather than text is justified only when the presentation of information can be given in a shorter, more easily understood form by the use of figures. If this is not true of the planned figures, they should not be used. *Analytical*

Chemistry, for instance, does not want to publish straight-line calibration curves when the information can be summarized in a short sentence or two in the text. Representative data in figures and tables should be used where possible. Figures and tables take up a great deal of journal space and their inclusion must be justified.

Analytical Chemistry's goal as regards the length of a manuscript was effectively summed up by the editor when he stated that the length should be consistent with the amount of new information. The journal does not have any formal limitation on length and in reality would prefer one complete paper reporting a full study to a series of very short papers that present the analytical work in bits and pieces. In fragmented publication, the repetition of the material in introductory and discussion sections will in the long run require more journal space.

It is only realistic to recognize that journals have economic problems these days. Rising costs and inflation place severe constraints on page budgets. Competition for journal space is keen. Currently, in *Analytical Chemistry*, where the decision to publish could go either way, the editors are really forced to reject the borderline cases. The honest, no doubt biased, response of editors to long papers is apt to be, "oh, no!" Long papers are more thoroughly reviewed by scientific journals, which tells something about the seriousness with which editors view long papers. Juhasz, editor of *Applied Mechanics Reviews*, has undertaken a study of the peer review system. One of the statistics he presented in the 1975 IEEE Conference on Scientific Journals (4) shows that among accepted papers, short papers are seen by an average of 1.56 reviewers, whereas long papers are reviewed by 1.78 reviewers.

Finally, on length, it is instructive to note that James Watson states in his book, "The Double Helix" (5), that the Nobel Prize winning paper by Watson and Crick in *Nature* was only about 900 words long.

Revision Stage

The responsibility of the author at the revision stage is to address himself fully to the criticisms of the reviewers and the suggestions of the editor and to indicate in detail in a covering letter which revisions have been made, which have not, and why. Then it is relatively easy for the editor to decide whether the main objections or criticisms of the reviewers have been satisfactorily accounted for. If there is any doubt, the paper must go back to the reviewers. This takes extra time which might well have been avoided by more careful preparation of the revision and covering letter. There is a tendency for some authors to just ignore the reviewers' suggestions. Because of this, *Analytical Chemistry's* major revision letter states that publication is contingent upon satisfactorily addressing the reviewers' criticisms. Of course, the author does not have to follow all the suggestions. The important point is that he must have good reasons for not doing so and he should state those reasons. Some authors are very sensitive to criticism and respond angrily. Probably just as many or more are really grateful for the help that reviewers can give. Periodically, *Analytical Chemistry* receives a letter from an author who thanks the reviewers and editors for pointing out something to him and saving him embarrassment. Most reviewers attempt to be objective and helpful. To adequately review a scientific paper takes much time and effort, and both authors and editors have every reason to appreciate the efforts of reviewers.

Methods Papers

Analytical Chemistry has problems with so-called methods papers which can create a paradoxical situation. In a paper, say, in clinical chemistry, criticisms come from analytical people who say that it is not good analytical

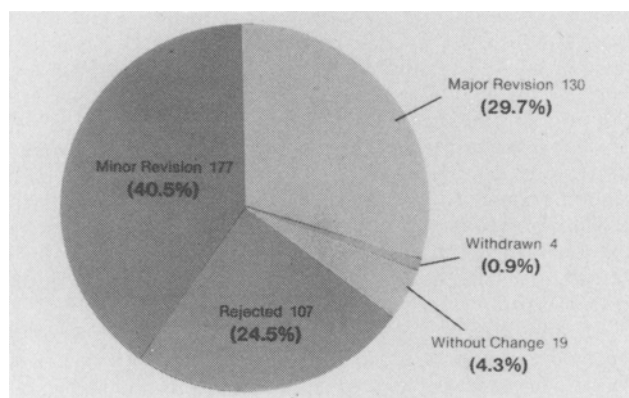


FIG. 1. Editorial decision on 437 manuscripts submitted to *Analytical Chemistry*.

TABLE III
Manuscript Rejection in *Analytical Chemistry*

Reasons for rejection	No. of Papers	%
Insufficient new information, already published, routine, not relevant, lack of originality	56	52.3
Methods paper without sufficient supporting data	14	13.1
Scientific merit questioned, validity of data questioned	13	12.1
"Present form," usually needs drastic reduction and reemphasis	8	7.5
Scope	7	6.5
Premature, more work needed	2	1.9
Combinations and other	7	6.5
TOTALS	107	99.9

chemistry, that many factors that a trained analytical chemist would take into account in development of a method have not been considered. At the same time, methods papers from analytical chemists for the clinical area elicit criticisms from clinical chemists who say that these authors are not living in the real world and that the proposed method has no validity in a clinical setting. If indeed the authors are purporting to present a method for use, many types of data are needed to substantiate the method: accuracy and reproducibility data, interference studies, comparisons with standards and other methods, standard addition studies, etc. Further, the method not only should be compared to other methods now in use, but should offer some distinct advantage, real or potential. Otherwise the work may seem pointless. Some of these problems can be minimized by careful attention by authors to their claims. As pointed out by Dr. Laitinen recently (1), most really new methods are introduced in a relatively primitive form and need much modification, refinement, and further work to be really useful.

Peer Review

The goal of peer review is not, as many seem to think, to decide whether to publish or not, but to decide what type of revision is required to present the work in the strongest possible light. The peer review system in operation at *Analytical Chemistry* was studied over a six-month period

and the results briefly reported in a recent article in the journal (6). The editorial decisions made on the basis of the reviews of 437 manuscripts submitted to the journal from Feb. 21 through Aug. 20, 1975, are shown in Figure 1. At the end of the study period—Feb. 22, 1976—299 (68.4%) of the manuscripts had been accepted; 12 (2.7%) were in the hands of the authors for revision or reviewers for second review; 15 (3.4%) had been inactivated. Manuscripts are inactivated after they have been in the hands of authors for revision six months or more. These manuscripts, of course, may well be resubmitted in revised form at any time in the future.

If a manuscript is rejected, there is much the author can learn. He should read the reject letter and the reviews carefully. The criticisms may provide clues as to avenues to take in the work. At the very least, the author may be able to revise in light of the comments of the reviewers for submission to another journal. Authors may, of course, appeal a rejection, depending on the reasons for the rejection. In *Analytical Chemistry's* peer review study, in those cases where the authors objected to rejection, four manuscripts out of a total of 11 were ultimately published. Once in a while an author responds with an irate two-, three- (or more) page letter saying in effect that the reviewers did not understand the paper, were not knowledgeable in the research area, etc. The author then explains what the reviewers did not understand and asks for new reviewers. Since the reviewers chosen are usually knowledgeable, the editor now asks himself, "If the reviewers did not understand the manuscript, how can the readers understand?" The author is advised to revise before further review if he has a creditable case.

The reasons for rejection of the 107 manuscripts in our peer review study group are summarized in Table III. While

this is a somewhat subjective process, the large number rejected for lack of originality is probably not atypical of the experience of scholarly journals. Juhasz (4) found that "originality" is given first rank consideration in reviewing papers for scholarly journals.

Communication

Laboratory research workers who have not considered publication should do so. There is valuable experience to be gained in preparing a paper either for oral presentation or for publication. Questions asked and communications that follow such activities have benefits for the worker. Although industrial concerns do not stress publication in the "publish or perish" way of the academic world, nevertheless, industry recognizes the rewards of communications, oral and written, that accrue both to its professionals and to itself.

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