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The 2010 Rankings of Chemical Education and Science Education Journals by Faculty Engaged in Chemical Education Research

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ABSTRACT: Faculty active in chemical education research from around the world ranked 22 journals publishing research in chemical education and science education. The results of this survey can be used to supplement impact factors that are often used to compare the quality of journals in a field. Knowing which journals those in the field rank as top tier is advantageous in academic environments that require researchers to publish often and for greatest impact.

KEYWORDS: Graduate Education/Research, Chemical Education Research, Professional Development

FEATURE: Chemical Education Research

INTRODUCTION

The current research environment in academia is one that demands productivity. Faculty members are expected to publish, with many universities showing an increase in the rate of publication over the past 30 years.[1] In Australia, for example, universities receive extra funding based on their academic publication rates, and promotion can be difficult with a low publication record.[2] In the United States, publication records are used to gauge scholarly output and are a metric often used in making promotion and tenure decisions.[3]

Pienta has documented publication rates for chemistry education active faculty and has compared them to all faculty within their departments.[4] The average publication rate per year of chemistry education articles for faculty active in chemistry education is 0.67 for those at doctoral degree-granting institutions and 0.55 for masters degree-granting institutions. The publication rates for all faculty members within the same departments as faculty active in chemistry education are 3.7 and 1.2 for doctoral degree-granting and masters degree-granting institutions, respectively. The low annual publication rate in chemistry education as compared to faculty colleagues publishing in chemistry and science research journals can be attributed to the time required to conduct research and prepare manuscripts in chemistry education. Timely review and publication is critical to the success of researchers and knowledge about the citation metrics and standing of a journal as determined by those in the field becomes vital. The prevailing viewpoint among scientists is that articles appearing in higher-quality journals tend to have greater impact.[5]

In most science disciplines, including chemistry, the impact factor has become a widely used metric to distinguish among journals in terms of influence and prestige. Eugene Garfield designed the impact factor in 1963 and founded the Institute for Scientific Information (ISI) to tabulate impact factors.[3,6] ISI is now part of the publishing company Thomson Reuters, which calculates impact factors annually for the journals it indexes and publishes these factors in Journal Citation Reports (JCR).[3,6]

Calculating Journal Impact Factor

The impact factor of a particular journal is the frequency an average article is cited in a specific time period. Frequently it is determined for a two-year time frame, but can be calculated for a five-year period as well. To calculate a two-year impact factor of a specific indexed journal, the number of articles published over a two-year period is counted. The number of citations of those articles in the following year is counted. The impact factor is the ratio of citations to the number of articles published in that two-year period.[6] Thus, a two-year impact factor of 5.0 would mean that the average article in a specific journal is cited five times in two years.

In computing the total number of articles published, JCR includes only articles, reviews, and notes, while the total number of citations can also include letters and meeting abstracts.[3] Although JCR publishes a two-year impact factor, in some fields a five-year impact factor may be a more appropriate metric. Fields that have lengthy submission-to-publication schedules, and take longer than two years to integrate and respond to publications may be better served by an impact factor which sums citations and the numbers of articles published over a longer time frame.

Thomson Reuters calculates impact factors for over 10,000 journals from 60 countries; a vast majority of those journals are published in English or at a minimum the bibliographic information is in English.[6] However, impact factors are not available for all journals in a particular field. For example, in the field of chemistry education, *The Chemical Educator* and the *Australian Journal of Education in Chemistry* are not indexed by the ISI.[6] In science education, the *Journal of College Science Teaching* is not indexed by the ISI.[6] Impact factors, while based on a mathematical formula, are not without bias. Heavily cited review articles can inflate the impact factor of a journal, though review articles can be removed from the calculation. Impact factors can also disfavor research fields that are small in size or fields that tend to

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Table 1. 2009 Two-Year and Five-Year Impact Factors with Immediacy Indices for Chemistry Education and Science Education Journals[a]

Journal Title	Two-Year Impact Factor	Five-Year Impact Factor	Immediacy Index
Chemical Education Journals			
Chemistry Education Research and Practice	0.742	None[b]	0.345
Journal of Chemical Education	0.586	0.677	0.226
Biochemistry and Molecular Biology	0.292	0.474	0.174
Science Education Journals			
Journal of Research in Science Teaching	1.910	2.805	0.434
Science Education	1.625	2.800	0.489
Research in Science Education	1.088	1.313	0.861
International Journal of Science Education	1.047	1.614	0.096

[a] See ref 6. [b] The five-year value was not listed for *CERP* within JCR.[6]

reference older studies or nonjournal sources, such as the humanities or the social sciences.[7,8]

Despite the shortcomings of impact factors, they are used by academic institutions to compare journals within a field and to evaluate a scholar's work.[6,10] Comparison of impact factors across journals and fields can be misleading, as a low impact factor would be impressive in a small, specialized field, but not in a large, general field.[6] There has also been little published regarding the validity of impact factors as indicators of a scholar's work.[3,9,11]

■ IMPACT FACTORS FOR JOURNALS PUBLISHING CHEMISTRY EDUCATION RESEARCH

The 2009 impact factors for indexed journals that publish chemistry education research in chemistry education and in science education are listed in Table 1.[6]

By way of comparison, Table 2 lists impact factors for journals that publish a broad range of science research and chemistry research, including those that focus on specific science disciplines.

The two-year and five-year impact factors for journals in chemistry including *Science* and *Nature* are substantially higher than chemistry education and science education research journals. Faculty in chemistry who evaluate the scholarship of chemistry education researchers through promotion and tenure committees, salary and merit committees, and so on, need to have a method by which they can fathom the low impact factors in the field of chemistry education.

Every two-year and five-year impact factor for chemistry education specific journals is less than 1.000. Thus, the values are nearly meaningless as a method of comparing the prestige of publishing in a given journal. The immediacy index is defined as the number of citations to articles in a given year divided by the number of articles published in that journal. Thus, it represents the average number of times an article is cited in the year that it is published. The low immediacy indices values in Table 1 indicate that integration of published work in the field of chemistry education research is longer than one year because in every case the immediacy index is less than one.

Table 2. 2009 Impact Factors for *Science*, *Nature*, and Selected Journals in Chemistry Subdisciplines

Journal Title	Two-Year Impact Factor	Five-Year Impact Factor
Nature	34.480	32.906
Science	29.747	31.052
Angewante Chemie International Edition	11.829	11.848
Journal of the American Chemical Society	8.580	8.805
Journal of Biological Chemistry	5.328	5.440
Analytical Chemistry	5.214	5.625
Journal of Physical Chemistry C	4.724	4.229
Journal of Organic Chemistry	4.219	3.994

For science education journals that publish chemistry education research articles, the two-year impact factors are all greater than 1.000. Two of the four journals have five-year impact factors approaching 3.0. However, the immediacy indices again indicate the slow pace of publication and integration of work in science education. Impact factors are not as likely to provide reliable data for making comparisons in a small field that has a slower pace of publication and integration of research. We believe that a method to supplement impact factor comparisons in determining the top-tier journals within chemistry education research needs to be explored.

The inspiration for this study and its general design originated from a mathematics education research paper *Report on Venue Study*.[12] The study focused on ranking publication venues, including peer-reviewed journals and conference proceedings, within research on undergraduate mathematics education. Questionnaires were sent out to 49 undergraduate mathematics education researchers asking them to place 22 journals in three distinct categories: Category 1 was for the most prominent venues in the field, Category 2 indicated a strong refereed venue, while Category 3 was described simply as another refereed venue. Ranking the quality of the journals in the field was an effort to provide analysis from those in the field about the quality, prestige, and influence of individual journals. This information in turn could be used to inform the promotion and tenure process.

Thus, we set out to determine how chemistry education researchers rank peer-reviewed journals in chemistry education and science education.

■ METHOD

Survey Pool

The population surveyed for this study comprised two sources. A list of chemistry education researchers was identified by using the Web site constructed by Stacey Lowery Bretz containing a list of universities that have chemistry education programs (masters and doctoral level) and the faculty who direct these programs.[13] A second source noted as "journal authors" was comprised of a list of faculty members who have published in the Research: Science and Education section in the *Journal of Chemical Education* (*JCE*) between the years 2000 and 2009 or had published a research article in *Chemistry Education Research and Practice* (*CERP*) between the years 2005 and 2009. The year 2005 marks when *University Chemistry Education* published by the Royal Society of Chemistry, and *Chemistry Education Research and Practice in Europe* originally published by the

Table 3. Ranking and Statistical Analysis of Chemistry Education Journals

	Category				Response Statistics			
Journal Title[a] (Country of Publication)	1	2	3	Total *N*	Mean[a]	Median	SD	Respondents, %
Journal of Chemical Education (USA)	70	20	3	93	1.28	1	0.52	86.9
Chemistry Education Research and Practice (U.K.)	53	32	6	91	1.48	1	0.62	85.0
The Chemical Educator (USA)	7	51	32	90	2.28	2	0.6	84.1
Biochemistry and Molecular Biology Education (USA)	9	32	39	80	2.38	2	0.68	74.8
Australian Journal of Education in Chemistry (AUS)	8	31	48	87	2.46	3	0.66	81.3
Education in Chemistry (U.K.)	8	25	51	84	2.51	3	0.67	78.5
Educación Quimica (MEX)	4	26	53	83	2.59	3	0.59	77.6

[a] The journals are ordered from lowest to highest mean values.

Table 4. Ranking and Statistical Analysis of Science Education Journals

	Category				Response Statistics			
Journal Title[a] (Country of Publication)	1	2	3	Total *N*	Mean[a]	Median	SD	Respondents, %
Journal of Research in Science Teaching (USA)	73	14	2	89	1.20	1	0.46	83.2
International Journal of Science Education (U.K.)	64	17	8	89	1.37	1	0.65	83.2
Science Education (USA)	54	21	11	86	1.5	1	0.72	80.4
Research in Science Education (AUS)	34	36	13	83	1.75	2	0.71	77.6
Journal of Science Education and Technology (USA)	23	52	11	86	1.86	2	0.62	80.4
Journal of Science Teacher Education (USA)	16	44	21	81	2.06	2	0.68	75.7
Journal of College Science Teaching (USA)	12	49	24	85	2.14	2	0.64	79.4
School Science and Mathematics (USA)	9	32	41	82	2.39	2	0.68	76.6
The Science Educator (USA)	3	38	39	80	2.45	2	0.57	74.8
Science Education International (U.K.)	7	29	43	79	2.46	3	0.66	73.8
Canadian Journal of Science, Mathematics, and Technology Education (CAN)	1	23	53	77	2.68	3	0.50	72.0
Journal of Nano Education (USA)	4	14	62	80	2.73	3	0.55	74.8
Journal of Women and Minorities in Science and Engineering (USA)	4	11	64	79	2.76	3	0.54	73.8
Resonance: Journal of Science Education (India)	2	13	59	74	2.77	3	0.48	69.2
Journal of Baltic Science Education (Lithuania)	5	7	70	82	2.79	3	0.54	76.6

[a] The journals are ordered from lowest to highest mean values.

University of Ioannina merged to form *Chemistry Education Research and Practice* published by the Royal Society of Chemistry.

The two sources yielded an overall population of 267 faculty members. Chemistry faculty members from 32 countries representing six different continents were in the pool. It was rather United States-centric with 146 out of 267 faculty being employed at a U.S. college or university. In Europe, 66 faculty members were identified within the pool; 25 of those resided in the U.K.

Data Collection

The survey was conducted using a program that allows for the anonymous collection of data through a Web-based software interface. An invitation to complete the survey was sent through the Qualtrics software to the 267 faculty members.

The Survey

The survey was composed of three questions. The first question contained a list of seven international journals that publish chemistry education research in the United States, Mexico, the U.K., and Australia. The seven journals were selected based on frequent citation across the chemistry education literature. For each journal, faculty members were asked to mark one of three choices that ranked the quality of the journal. Category 1 indicated a top-tier journal, one of the most prominent in the field. Category 2 indicated a middle-tier journal. And, Category 3 was a low-tier journal that either chemistry education researchers were unfamiliar with or considered to be the least influential in the field. The second question in the survey asked respondents to classify 15 science education journals using the same categorization scheme. The science education journal set was selected based on frequent citation across the chemistry education literature. The third question asked the survey respondents to provide the names of any peer-reviewed journals that were not listed in the previous two questions and to classify those journals using the categorization scheme.

Survey Mailing

The survey was available for 30 days and a reminder e-mail invitation was sent 15 days after the initial invitation to those faculty members who had not completed the survey, a feature available with the Qualtrics software. All response data were downloaded at the conclusion of the 30-day data collection period and stored on a password-protected computer.

■ RESULTS AND DISCUSSION

A promising response rate of 40% (107 of the 267 participant population responded). The data were analyzed

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for each question completed by the 107 survey respondents and are discussed below. Responses and analyses for chemistry education journals are displayed in Table 3. The journals are ordered by mean from smallest to largest, with the *Journal of Chemical Education* (USA) having been ranked the highest with a mean of 1.28 and *Educación Quimica* (MEX) having been ranked lowest with a mean of 2.59. The percentage of respondents is included in the last column of Table 2 to indicate that not every journal was ranked by every participant. Calculation of mean, median, and standard deviation did not include responses left blank; therefore, blank responses did not adversely impact statistical analysis.

ANOVA methods were used to test for differences in responses for each journal by geographical location. No significant effect on rankings by geographical location of the respondent emerged.

The data showed that the journals rated by active chemistry education researchers as most prominent are the *Journal of Chemical Education*, jointly published by the ACS Division of Chemical Education and ACS journals, and *Chemical Education Research and Practice*, published by the Royal Society of Chemistry. Middle-tier journals include *The Chemical Educator* and *Biochemistry and Molecular Biology Education*. Lower-tier journals include the *Australian Journal of Education in Chemistry*, *Education in Chemistry*, and *Educación Quimica*.

Table 5. Average Rankings for *JRST*, *IJSE*, and *Science Education* for Those Who Ranked *JCE* or *CERP* as a Category 1 Journal

Chemistry Education Journal	Average for *JRST*	Average for *IJSE*	Average for *Science Education*
JCE = 1	1.15	1.33	1.55
CERP = 1	1.17	1.29	1.38

Table 6. Average Rankings for *JCE* and *CERP* for Those Who Ranked *JRST*, *IJSE*, or *Science Education* as a Category 1 Journal

Science Education Journal	Average for *JCE*	Average for *CERP*
JRST = 1	1.23	1.40
IJSE = 1	1.22	1.38
Science Education = 1	1.30	1.35

Responses and analyses for science education journals are displayed in Table 4. The four highest-ranked science education journals are indexed in the ISI and have reported impact factors. Again, ANOVA methods were used to test for differences in responses for each journal by geographical location. No significant effect on rankings by geographical location of the respondent emerged.

Upon the basis of faculty responses and the analyses, the most prominent journals were the *Journal of Research in Science Teaching*, *International Journal of Science Education*, *Science Education*, and *Research in Science Education*. Middle-tier journals were the *Journal of Science Education and Technology*, *Journal of Science Teacher Education*, *Journal of College Science Teaching*, and *School Science and Mathematics*. Lower-tier science education journals were the *Science Educator*, *Science Education International*, *Canadian Journal of Science, Mathematics, and Technology Education*, *Journal of Nano Education*, *Journal of Women and Minorities in Science and Engineering*, *Resonance: Journal of Science Education*, and *Journal of Baltic Science Education*.

It is illustrative to compare ratings of the most highly ranked journals in chemistry education—th *Journal of Chemical Education* and *Chemistry Education Research and Practice*—with those in science education: the *Journal of Research in Science Teaching* (*JRST*), the *International Journal of Science Education* (*IJSE*), and *Science Education*. All these journals have editorial boards that include members from the broad international community of researchers except for *JCE*, which has an editorial advisory board composed of faculty and chemists from the United States.

Additional evidence about consistency of respondent opinions may be explored by looking at Table 5, which displays averages for *JRST*, *IJSE*, and *Science Education* for those who ranked *JCE* or *CERP* as a Category 1 journal. Table 6 displays averages for *JCE* and *CERP* for those who ranked *JRST*, *IJSE*, or *Science Education* as a Category 1 journal.

An ANOVA was used to test for differences in mean values for the science education journals reported in Table 5. For *JCE*, significant differences were found: $F(2, 196) = 7.32$; $p = 0.001$. Tukey posthoc comparisons indicated a significant difference between the means for *JRST* and *Science Education*, $p = 0.001$. For CERP, no significant differences were found: $F(2, 150) = 1.717$; $p = 0.183$. An analysis of the means in Table 6 demonstrated significant differences between the means of *JCE* and *CERP* for *JRST* only: $t(71) = 2.045$; $p = 0.045$. The analysis of the means does not display a pattern of bias for one journal over another.

Table 7. Additional Journal Titles Supplied by Respondents with Rankings Ordered by the Number of Times Mentioned

Additional Journals (Country of Publication)	Times Listed, *N*	Category 1	Category 2	Category 3	Mean	Times Unranked, *N*
Eurasia Journal of Mathematics, Science & Technology Education (INT)	5	0	3	1	2.25	1
Science and Education (Netherlands)	3	0	3	0	3	0
School Science Review (U.K.)	3	0	2	1	2.33	0
International Journal of Science and Environmental Education (INT)	3	0	1	1	2.5	1
International Journal of Mathematics and Science (INT)	3	0	3	0	2	0
Journal of Computers in Mathematics and Science Teaching (USA)	2	0	2	0	2	0
Journal of Science & Technology Education Research (INT)	2	1	1	0	1.5	0
Research in Science and Technological Education (U.K.)	2	0	2	0	2	0
Revista Ensenanza de las Ciencias (Spain)	1	0	2	0	2	0
Studies in Science Education (INT)	1	1	0	0	1	0
Acta Didactica Napocensia (Romania)	1	0	0	1	3	0
Primary Science (U.K.)	1	0	0	1	3	0
International Journal of Science, Mathematics, and Technology Education (INT)	1	0	1	0	2	0

Although statistically significant differences exist, overall the data demonstrate agreement among researchers on the top-tier publication venues that publish chemistry education research.

Table 7 lists the 13 additional journals supplied by survey participants. Journals are ranked by the number of times each was listed by participants. Data include the categorical rankings and means; however, it should be noted that no meaningful analysis of how these journals should be categorized can be gleaned from the low response rates for each journal. It can be concluded from the low response rates for each journal that the major journals in the fields of chemistry and science education research were included in question one and two of the survey.

■ CONCLUSION

This survey provides a method of indicating how faculty who direct and publish chemistry education research rank journals in the field. The rankings can be used by those seeking promotion and tenure as a method of identifying the most prestigious journals in the field beyond impact factor values. In the field of chemistry education research publication, venues exist that are not indexed by the ISI; thus, the results of this survey are useful for describing the standing of nonindexed journals within the field.

The results of the survey provide a snapshot of how chemistry education researchers categorize 22 chemistry and science education journals. The top-tier chemistry and science education journals based upon this survey are the *Journal of Chemical Education*, *Chemistry Education Research and Practice*, the *Journal of Research in Science Teaching*, the *International Journal of Science Education*, and *Science Education*. All of these journals are indexed by the ISI.

We believe that the results of this survey are not static and that the survey should be repeated every two to five years as opinions of the quality of these journals can change over time as new faculty become engaged in the field. New journals that publish either chemistry or science education research could also emerge, necessitating their inclusion in a subsequent survey.

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