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Evaluation of International Studies in Geographical and Environmental Education via the Use of Statistics and Scientometrics

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Abstract

This work uses nonparametric statistics and Shannon's entropy (diversity) formula to analyze certain scientometric and statistical aspects of papers published in the journal "International Research in Geographical and Environmental Education" from 1992 to 2009. It appears that researchers in the field of geographical and environmental education have shifted their focus since 2004. Among the most common themes that have emerged over the past 18 years, "teacher education" ranks highest, followed by "values & attitudes" and "inquiry & problem solving." d) IRGEE citations rise every year, c) "GIS" and "Sustainability" remained the most "stable" topics in terms of publishing priority throughout the course of the 18 years, e) The average topic diversity of articles published from 1992 to 2009 is 82.7% of the maximum thematic diversity, which is quite high; this indicates that the Journal has the potential to draw a large audience for the 10 areas it has covering thus far.

Key-words: Statistics; Scientometry; Geographical Education; Environmental Education; Shannon diversity; Nonparametric Statistics

Introduction

Research patterns may be uncovered by scientometric studies. An ideal scenario would be to do similar analysis on all publications that cover a clearly defined scientific subject. Nevertheless, when it comes to geographical estimates, the literature isn't great. The only notable exception are a few of studies that have tried to do national-level scientometric evaluations.
For instance, a bibliometric study of a Spanish geography magazine covering the years 1982–2007 revealed a rising focus on geographical features over that time (Guimera et al., 2007). However, a recent trend in geography has been to bibliographically investigate the connections between human and physical geography (Aspinall, 2010). A few years ago, someone in the United States brought up the topic of how to strike a balance between environmental and geographical education (Bednarz, 2006). Is the increase in "sustainability"-related articles in IRGEE indicative of a trend toward integrating geography and environmental studies? Given that sustainability has recently been a central focus in geography education, this viewpoint appears plausible (Lidstone & Stoltman, 2007). While working to improve sustainability (and education on the topic), it's important not to simplify or overemphasize the connections between geographical and environmental education or between human geography and environmental science (Demeritt, 2009).
The subjects of interest for geography researchers showed remarkable variability in another bibliometric study that covered 39 journals of geography with articles from 1997 to 2005. Not a single journal had been the most important for more than two years, suggesting that key priorities in geographical research change at a rapid pace (Barriocanal, 2007). Does geography teaching follow the same pattern as geography research? How stable are geography education research topics? Also, and this is becoming trickier: Is environmental education any different?
There are a lot of concerns about research goals, as shown by the amount of publications each year,

and about the specific topics covered in journal articles. The goal of both the journal's content and statistical studies might be to detect shifts in the priorities of research. These alterations may be examined by

various scientometric and statistical approaches; readers are directed to relevant works (e.g., Nederhof, 2006).

In addition, this work introduces a new approach to the diversity issue in scientometry, which has been previously discussed in the literature of environmental and geographical education (Stirling, 2007; Zitt & Bassecoulard, 2008). To what extent may scientometric measures of theme variety be used to the analysis of geographical and environmental education publications is an open question, as is the formulation of indices for assessing diversity in all its manifestations.

Methods and data

This paper uses statistical and scientometric analyses based on Gillian Kidman's 2011 content analysis of IRGEE to examine the evolution of geographical and environmental education as reported in the journal. The analysis covers the years 1992–2009.

Organizing the publications according to their themes is a crucial approach. An issue's rank value decreases as the number of publications per subject increases. To do statistical analysis on this ranking, one may average the rankings, use Spearman's non-parametric coefficient of rank correlations to find correlations across study topics, and estimate the "stability" of these correlations over time. Citations are a good measure of a publication's impact, and variety of topic is another essential consideration. The citation data used to make this determination comes from the online databases of the University of Leiden and SCOPUS (http://www.journalindicators.com/SearchJournal.aspx).

Results

Ranking publications per theme

The increasing quantity of articles within each area over time reflects the changing priorities of the scholars who have contributed to IRGEE. This matrix of rankings by subject and historical period identifies them. According to table 1, the order of importance decreases as the rank value increases from 1 (highest priority) to lower (lowest priority). This table shows that the first rank theme is dynamic, meaning it changes with time.

Table 1 may be found here.

Using Spearman's ranks correlation coefficient rho, we compared the rankings for each paper topic (syllabus, sustainability, etc.) by pair of years (starting with 1992/3 and finishing in 2008/9) (table 2).

Table 2 may be found here.

Predictably, up to 2004–2005, there existed a strong relationship (r=1, the stronger the connection) between the rankings of research disciplines according to IRGEE volume. After 2004, the association started to weaken, indicating that scholars in geography and environmental education seem to have shifted their focus. The increasing prominence of sustainability and GIS as topics in the most recent issues of IRGEE may explain this.

Figure 3 displays the results of a calculation of the average rank of research priority by subject of papers published in IRGEE.

* Here is Table 3:

Subjects with higher average ranks had lower average priorities during the 18-year period under consideration. "Teacher education" has appeared 18 times in this table, coming in first, followed by "values" and "inquiry."

Themes' temporal correlations

Though they may be connected, some subjects seem unrelated at first glance. For example, as syllabi are primarily used to shape students' values, attitudes, and choices, it is predicted that "Values" and "Syllabus" would have a correlation over time. The graphic (figure 1) clearly shows that the correlation is rather strong, with a Spearman's rho value of 0.79. One possible reading of this is that authors who write about geography and environmental education curricula and textbooks also discuss "values" and "attitudes" when they publish their work. Another reading is that these materials serve as the primary means by which students' values and attitudes are shaped in these fields.
PUT FIGURE 1 IN THIS SPACE

Matrix for rank changes: themes' consistency over time
When a theme's ranking changes from one year to the next, it's possible that it may fall or rise in the following two years. One sign of a theme's "instability" over time is when it loses prominence to another. Thus, for the 18 years of IRGEE that are considered here, we may create a matrix of theme transitions. With i rows, j columns, and elements aij, the total of the column values per row of the transition matrix is eventually provided by the

$\sum_{j=1}^{j=8}$ for all columns j of each row (*) and symbolized here as b (the total number of

columns is j=8, so the sum is from j=1 to j=8):

$$b = \sum_{j=1}^{j=8} a_{*j} \qquad \text{where } i\text{=rows, } j\text{=columns}$$

Thus, the higher the value of *b*, the higher the degree of "instability" of each theme through time.

The more probable that the theme's rank will be replaced by another theme in the next time period, the higher the *b*. From this matrix, we see that the themes *"GIS" and "Sustainability" were the most "stable" throughout the 18 years, meaning that they maintained their ranks as publication priorities more than other themes* (table 4).

INSERT TABLE 4 HERE

Diversity of themes

Generally, the higher the diversity of themes in a volume (or year) the better it is for a journal. Otherwise, if one (or a few) themes dominated a Journal it might have a very narrow readership.

The diversity of themes can be measured for each pair of years of IRGEE publications, by using the well known Shannon's formula of information uncertainty:

$$H = -\sum_{i=1}^{n} P_i \ln P_i$$

where

H= information uncertainty (or entropy, or diversity),

i=themes (from 1 to 10 in this case),

n=the total number of themes=10,

Pi=the relative fraction of participation of each theme *i* in the total number of articles published in the respective pair of years.

Thus, by applying Shannon's formula, we get the results shown in table 5:

INSERT TABLE 5 HERE

Since we have *n*=10 themes considered for each pair of years, the maximum possible diversity per pair of years is:

$$H_{\max} = \ln(n) = \ln(10) = 2.302$$

We therefore see that the average diversity for all the 18 years considered is:

$$H_{average} = \frac{-\sum_{1}^{t} \sum_{i=1}^{n} P_i \ln P_i}{t}$$

Discussion

This study offered new techniques for scientometric analysis of publications in geographical and environmental education: Spearman's rank coefficients, transition matrices, and Shannon's formula. It also explored changes in research goals in this field. Because "A research metric should have qualities such as simplicity, transparency, objectivity, replicability, precision and sensitivity; it should also allow both longitudinal and international comparisons" (Charlton & Andras, 2007), these methods are applicable to other scientometric analyses and satisfy the needs of scientometry for additional metrics.

According to Banyx (2008), Thomson ISI Web of Knowledge is "not advantageous" for humanities journals when it comes to citation reporting. This is due to the fact that a large number of papers published in the humanities are not included in this database. Since a large body of geographical literature falls within the umbrella of the "humanities," the discipline unfortunately could not avoid this. On the other hand, "citations measure visibility rather than quality" (Zitt & Bassecoulard, 2008), hence it could be more reasonable to presume that. By taking IRGEE's results into account, we can see that sustainability and geographic information systems (GIS) are becoming more important areas of study in the field of geography (Lidstone & Stoltman, 2007a). Although their "stability" has only just begun to be recorded, it is worth noting that the extensive utilization of ICTs in Geography has the potential to bolster the current trend of incorporating GIS (Gilbert & Masucci, 2005) and geospatial technologies into geographical education (Konecny & Stanek, 2010; Papadimitriou, 2010a; Papadimitriou, 2010b).

Teachers of geography may be concerned about the prevalence of theme correlations, which could indicate either that authors who write about curriculum and textbooks also discuss "values" and "attitudes" (as proposed here) or that they merely study the same material again but use different words (thus, themes are possibly overlapping).

In any event, it might be difficult for editors of academic journals to increase the breadth of topics covered (while still being true to the journal's clearly stated viewpoint). This difficulty may even extend to integrating diversity into geographical/environmental education research (Papadimitriou, 2001) or into the realm of innovation and creativity (Lidstone & Stoltman, 2007b). In light of the fact that GIS education is now a prominent trend, it is clear that avoiding issues that dominate the field is crucial.

Just as it is important to protect the world's rare and valuable species, so too should academic journals publish articles covering a wide range of topics (within their clearly defined fields).

Conclusions

Following a review of all publications published in the Journal "International Research in Geographical and Environmental Education" between 1992 and 2009, we have determined the following: a) Since 2004, there has been a noticeable shift in the research priorities of geographical and environmental education scholars. The number of articles pertaining to "GIS" and "Sustainability" has increased, and these themes have also remained at the top of the publication priorities list. b) According to the number of papers published, "teacher education" is the most prominent theme, followed by "values & attitudes" and "inquiry & problem solving." c) Despite fluctuations in the SNIP index over the past decade, IRGEE citations have been growing at a nonlinear rate. d) According to Shannon's formula, the average thematic diversity of articles is high, accounting for 82.7% of the maximum possible diversity. This indicates that IRGEE is both a focused and thematically diverse academic journal.

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