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Changing Institutional Research Productivity of United States' Science Education Programs: 2000s v. 1990s

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Abstract

The purpose of this study was to identify the major science education programs in the United States, where the science education researchers published their research during the first decade of the twenty-first century. This research study of the scholarly productivity of science education programs at United States' institutions of higher education is compared with the last decade of 1990s (Barrow, Settlage, & Germann, 2008). Each issue of the eight research journals (*Journal of Research is Science Teaching, Science Education, International Journal of Science Education, Journal of Science Teacher Education, School Science and Mathematics, Journal of Computers in Math and Science Teaching, Journal of Science Education and Technology, and Journal of Elementary Science Education*) published in the 2000s provided the author(s) and their institutional affiliation. The resultant ranking of raw and weighted counts for the top 30 U.S science educations programs shows variation in journals where research was published. There were almost 50% of the 2000s top 30 institutions which were not listed for the 1990s. Potential explanations for variations and uses for ranking are discussed.

Keywords: Institutional faculty productivity, science education research, research journals

1. Introduction

1.1 Introduce the Problem

This study of institutional research productivity in science education is a replication of the first instructional research productivity study in science education (Barrow *et al*, 2008). That baseline study identified the top 30 U.S. science education programs for the 1990s based upon eight research journals (*Journal of Research is Science Teaching* [JRST]*, Science Education* [SE]*, International Journal of Science Education* [IJSE]*, Journal of Science Teacher Education* [JSTE]*, School Science and Mathematics* [SS&M]*, Journal of Computers in Math and Science Teaching, Journal of Elementary Science Education* [JESE]*, and Journal of Science Education and Technology* [JCM&T]) to provide a coherent view of science education research. The original study identified the top 30 ranked U.S science education programs based upon both raw count (all authors) and weighted score (credit assigned to author's position with reduced emphasis). The only change in this study was the 2000-2009 time period.

Why is it important to compare 2000s with 1990s institutional productivity? If institutions are basing decisions on the 1990s results; it is important to know whether rankings are static or dynamic. The first purpose of this study was to compare major U.S science education programs based upon their empirical research publications of the 2000s with the 1990s. The second purpose was to compare raw and weighted counts to determine the best rating for future instructional productivity research.

1.2 Related Literature

A review of perception or prestige/reputation (rankings based upon perceptions [*e.g. U.S. News and World Report's* (annual ranking of graduate schools)]) and productivity (e.g. faculty was members' publications) was detailed by Barrow *et al.* (2008). According to Keith and Babchuk (1994), use of institutional program as a unit of analysis is superior to use of individuals. In 2010, the National Research Council published an extensive review of graduate programs at many U.S higher education institutions. It should be noted that science education like most of education programs were excluded.

In addition to the study of science education's institutional productivity (Barrow *et al.*, 2008), the fields of library and information science, sociology, social work, counseling, psychology, and reading/ literacy education have had studies reported on institutional productivity over the past two plus decades. Budd and colleagues (Budd & Seavey, 1996; Budd, 2000; Adkins & Budd, 2006) have conducted replication of institutional productive research for library and information science. For their three studies, Budd and colleagues used only *Social Science Citation Index (SSCI)* to rank programs. Over the ten year period, they concluded there was an increase in research productivity and productive programs of 1996 were still productive in 2006. The *SSCI* favors faculty with longer careers resulting in more citations.

Keith and Bobchuk (1994) conducted a longitudinal assessment (1936-1989) of three dominant sociology empirical research journals. They concluded that previous prestige level was considered more important than current level of scholarly productivity and number of faculty influences prestige. In the related area of social work, Thyer, Ligon and colleagues conducted a series of replication studies every five years: 1979-1983 (Thyer & Bentley, 1986), 1984-1988 (Ligon, Thyer, & Dixon, 1995; Thyer, Boynton, Bennis, & Levine, 1994), 1994-1998 (Ligon & Thyer, 2002), 1999-2003 (Ligon, Jackson & Thyer, 2007), and 2004-2008 (Ligon, Cobb, & Thyer, 2012). Their longitudinal analysis of over 25 years showed an increase in number of articles per institution has steadily increased. This analysis used the same six journals. Ligon *et al*. (2012) cautioned that these six journals do not capture overall scholarly activity of social work researchers, including non-social work.

Another career productivity index called h-index (Hirsch, 2005) was used by Tracey to study institutional productivity in counseling psychology. Earlier, the *Journal of Counseling Psychology* was used to rate counseling psychology programs (Bohn Jr., 1966; Cox & Cott, 1977). While Howard (1983), Delgado and Howard (1994), and Smith *et al*. (2003) used different time periods plus different journals to rank counseling psychology programs, Smith *et al.* reported that counseling psychology research was published in more than five journals in their ranking. Earlier, Barrow (2002) made a similar observation for science education.

Two studies of institutional productivity for counseling psychology were published by Buboltz Jr. *et al*. (2005) focused on seven journals and used institutional credit of 1.0 for each article. They considered the number of faculty had a limited impact on ranking. They reported that 7 of the top 10 individuals in Delgado and Howard's (1994) study were consistent for 1993-2002. Diegelman, Uffelman, Wagner and Diegelman (2005) used recommendations from counseling psychology training directors about major publications associated with counseling psychology. They found consistent top 20 ranking with earlier studies; however, 13 of the top 40 had not been previously ranked. Variations in rankings between these studies could be due to the use of different journals.

Recently, Smith (2010) investigated institutional and individual productivity in lesbian, gay, bisexual, and transgender (LGBT) publications in counseling psychology journal articles from 1990-2008. Smith used a weighted count as recommended by Howard, Cole, and Maxwell (1987). Smith noted institutions continue to publish LGBT manuscripts which were consistent with earlier analysis by Tinsley and Tinsley (1979).

Lau, Cisco, and Delgado-Romero (2008) analyzed five multicultural psychology journals (1994-2007) nominated by 14 journal editors and members of editing boards. They used a weighted score for individuals and correlated productivity for the top 30 for each journal. Researchers tended to publish in mainly one of the journals. They noted the variability due to some faculty could be starting their career and other are tapering off into retirement.

Morrison and Wilcox (2008) focused on institutional productivity for reading/literacy education publication in nine different journals. They considered consistency among top ranked programs that had been reported by Johns (1986), Hopkins (1979), and Hollingsworth and Reutzel (1994). Morrison and Wilcox noted regardless of time period and different journals that major reading/literacy education programs are still dominant. The stability of faculty employment contributes to this pattern. Also, Morrison and Wilcox reported on increase in multiple authors from collaboration institutions, including precollege authors.

Ku (2009) identified researchers whose work was published in *Educational Technology Research and Development (ETR&D)* for 20 years. Ku used only the first three authors of *ETR&D* manuscripts. He considered that only the first three authors make major contributions to the work. He concluded that first authors differed for productivity and total authorship in *ETR&D*. There has been greater number of multiple authors involved in research studies. For example, there were 23 authors associated with one published concept inventory (Johanes Stroble, Personal Communication, August 9, 2012).

In summary, institutional productivity research in these disciplines has found stability and variation in rankings of programs. The lack of consistent criteria (e.g. *SSCI*, raw score, weighted, or different journals in the field) causes questions about the results. This study was needed to see if science education programs institutional productivity was stable or not.

2. Method

This replication study maintained the criteria from the baseline study (Barrow *et al*., 2008): 10 year time interval as recommended by Howard (1983), all articles were utilized except letter to editor, editorials, and book reviews, same journals (*JRST, SE, IJSE, JSTE, SS&M* [only science articles], *JCM&ST* [only science articles], *JESE*, and *JES&T*), all authors for raw credit received 1.0 and weighted count where decreased position in author chain resulted in lower rated based upon the article's total value was 1.0 as recommended by Howard *et al*. (1987). According to Lykken (1968) and clarified by Kelly, Chase, and Tucker (1979), this is a literal replication since the only difference was the publication years (2000-9).

In Australia, Howard (2011) summarized attributes for top research journals as having low acceptance rate and editorial board consisting of leaders in the field. The eight journals in this study are noted for publishing empirical science education results. Table 1 contains the acceptance rates for each journal based upon Cabell (2011) or editor's personal communication. Generally, these research journals are associated with a professional organization except *SE*, *IJSE,* and *JSE&T*. Also, editors were faculty at major science education research institutions. Table 2 contains a listing of journals, volumes, years, editors, and institutional affiliation for the 2000s.

Table 1. Acceptance rate for each science education journal

Journal	Acceptance Rate
Journal of Research in Science Teaching	11-20% a
Science Education	21-30% a
International Journal of Science Education	32% a
Journal of Science Teacher Education	7-15% b
School Science and Mathematics	20% a
Journal of Computers in Mathematics and Science Teaching	11-19% b
Journal of Science Education and Technology	21-30%
Journal of Elementary Science Education	21-23% b

a. Cabell (2011)
b. Personal note from the editor

Table 2. Volumes, institutional affiliation, editors and years for journals

	Volume	Institution Affiliation	Editors	Years
Journal of Research in Science Teaching	37-48	Michigan State University	C. Anderson J. Gallegher	2000-2001
		Arizona State University	D. Baker M. Pilburn	2000-2005
		University of Maryland	R. McGinnis A. Collins	2006-2009
Science Education	84-93	Kings College	R. Duschl N. Brickhouse	2000-2001 2002-2005
		University of Delaware Pennsylvania State University	G. Kelly	2006-2009
International Journal of Science Education	22-31	University of Reading	J. Gilbert	2000-2009
Journal of Science Teacher Education	11-20	University of Wisconsin-Milwaukee Oregon State University	C. Berg L. Enochs	2000-2003
		University of Toledo	L. Flick	2004-2008
		Purdue University	C. Czerniak	2009
			J. Staver L. Bryan	2009
School Science & Mathematics	100-109	Oregon State University	N. Lederman M. Miess	2000
		Oregon State University	N. Lederman L. Flick	2001-2006
		Texas A&M University	G. Kulm	2007-2009
Journals of Computers in Mathematics & Science Teaching	19-28	Assn. for the Advancement of Computing in Education	G. Marks	2000-2009
Journal of Science Education & Technology	9-18	Harvard University	K. Cohen	2000-2009
Journal of Elementary Science Education	12-21	Western Illinois University Bradley University	K. Finson	2000-2006 2007-2009

Every article provided title of article, all authors, and institutional affiliation were utilized except editorials, letter to editor, and book review. All authors regardless whether faculty or graduate student in contrast to Ku (2009) who used only the first three authors and Robinson, Hartley, and Dunn (2001) who recognized only the first author. Researchers who were not specialists in science education were included. During the 2000s, only the contributors and their institution at the time of submission were considered.

The weighted ranking of institutional productivity has been previously utilized by Barrow *et al.* (2008), Corrado and Ferries (1997) and Scott and Mitias (1996). The weighted formula based upon Howard *et al*. (1987) which was utilized for the 1990s (Barrow *et al*., 2008) was also used in this study. (See Table 3 to see the weighted approach). This method provides greater weight to the senior author tradition who made the most substantive contributions to the manuscript. The total raw and weighted were compiled for each program and subsequently ranked from high too low for all eight journals.

Table 3 Weighting formula applied to authorship sequence

No. of co-authors	Author's name within sequence and associated weighting					
	First	Second	Third	Fourth	Fifth	Sixth
1	1.00	——	——	——	——	——
2	0.60	0.40	——	——	——	——
3	0.47	0.32	0.21	——	——	——
4	0.42	0.28	0.18	0.12	——	——
5	0.38	0.26	0.17	0.11	0.08	——
6	0.37	0.24	0.16	0.11	0.07	0.05

3. Results

There were a total of 1591 research authors (raw) in the eight research journals during the first decade of 2000. All institutions were totaled for the top 30 for both raw and weighted rankings. Table 4 contains the alphabetical listing for the top 30 U.S. institutions for raw count for each journal. The top five were Indiana University, University of Michigan, Purdue University, North Carolina State University, and University of Georgia. Table 5 contains the alphabetical listing for the top 30 U.S. institutions for weighted count for each journal. In contrast to the 1990s, 15 of 30 institutions were new in the 2000s. Ten percent of top 30 raw rankings were not in the 1990s top 30 weighted rankings (Table 6). All three were in the lower third of raw rankings. There was a 90% agreement among 2000s top 10 for both raw and weighted rankings; although, there was slight variation.

This 2000s ranking, regardless of raw or weighted, shows significant changes since the 1990s. Only 60% of the top 30 for 1990s are found in the 200s ranking. Also, 50% of the 1990s top 30 programs are absent in 2000s ranking. Among the top for 2000s, 50% were in the bottom 10 or absent on the 1990s rankings. Eight of the top 30 programs for 2000s ranked more than five positions higher.

Barrow and Tang (2009) reported at National Association for Research in Science Teaching (NARST) about a 5 rather than 10 year analysis. A total of 10 institutions from 1990s study were not in the top 30 in 2004. Although, three did appear in the top 30 for 2000s. Future studies should use the 10 years interval since the review process can be long for some journals. The use of only printed manuscript than electronic acceptance seems to vary from journal to journal.

Table 4. Raw counts for Journals of Top Institutions

Institution	*JRST*	*SE*	*IJSE*	*JSTE*	SS&M	JSE&T	JCM&ST	JESE	Total
Arizona State University	28	6	17	——	5	8	1	1	66
Florida State University	8	9	6	3	—	2	——	3	31
Indiana University	24	18	13	11	8	41	2	9	128
Iowa State University	8	3	9	1	2	2	6	3	34
Mass. Instit. Tech	3	2	1	——	——	21	6	——	33
Michigan State University	13	22	4	5	1	2	4	1	52
North Carolina State University	11	11	18	5	5	18	3	1	72
Northwestern University	13	7	5	——	1	16	——	——	40
Ohio State University	6	2	5	4	1	——	4	4	26
Pennsylvania State University	7	5	2	9	4	5	6	——	38
Purdue University	22	13	9	15	3	8	8	1	79
Stanford University	20	6	4	——	1	9	——	——	40
Teachers College, Columbia University	22	9	7	5	2	3	2	1	51
Texas A&M University	7	4	——	12	11	11	2	——	47
University of Arizona	11	2	6	7	3	——	1	——	30
University of California – Berkeley	4	14	10	1	1	——	15	——	45
University of California – Santa Barbara	16	11	——	3	——	——	——	——	30
University of Delaware	15	12	——	1	——	4	1	——	33
University of Florida	5	5	9	6	1	3	——	2	31
University of Georgia	22	7	6	20	5	5	2	3	70
University of Illinois	13	3	8	1	3	1	——	1	30
University of Maryland	16	10	2	2	——	6	——	2	41
University of Miami (FL)	22	6	3	11	3	——	——	1	47
University of Michigan	52	17	9	6	2	6	——	——	92
University of Minnesota	18	5	6	1	8	10	1	2	51
University of Missouri	13	9	8	15	6	8	——	10	69
U. of Nebraska	10	4	——	4	——	38	2	——	60
University of North Carolina	17	10	1	5	2	1	——	——	36
University of Pennsylvania	14	3	2	——	8	——	——	——	28
University of South Florida	8	12	6	4	2	——	——	9	40
University of Texas – San Antonio	15	8	6	——	3	2	——	2	36
University of Toledo	5	2	2	10	4	——	1	3	27
University of Washington	9	6	7	——	2	1	——	——	26
University of Wisconsin	12	6	4	——	1	5	——	——	28
Totals	499	270	195	169	96	236	67	59	1591

Table 5. Weighted Counts for Journals of Top Institutions

Institution	*JRST*	*SE*	*IJSE*	*JSTE*	SS&M	JSE&T	JCM&ST	JESE	Total
Arizona State U	9.85	2.67	5.49	—	1.6	2.21	.6	1.0	23.45
Florida State U	2.77	3.52	2.53	1.32	—	1.0	—	1.28	12.42
Indiana U	10.53	5.51	5.02	3.88	4.38	10.12	.19	6.20	45.83
Iowa State U	2.01	1.13	3.23	.47	.33	.53	1.98	1.6	11.28
Mass. Instit. Tech	1.8	.98	.4	—	—	15.1	2.01	—	20.29
Michigan State U	6.33	7.36	2.06	2.03	1.0	1.3	1.0	1.0	22.10
North Carolina State U	4.12	4.03	5.50	1.47	2.58	4.56	1.4	1.0	24.76
Northwestern U	5.61	2.20	2.42	—	.42	5.24	——	—	15.89
Ohio State U	2.62	.79	2.0	—	.6	—	3.0	1.94	11.83
Pennsylvania State U	2.54	2.61	.61	1.95	2.12	2.27	1.4	—	13.50
Purdue U	16.6	3.81	3.08	3.42	1.0	2.17	2.93	1.0	34.01
Stanford U	7.88	3.08	2.0	—	1.0	2.2	—	—	16.16
Teachers College, Columbia U	9.55	4.19	2.19	3.8	1.0	1.6	1.0	1.0	24.33
Texas A&M U	2.21	1.66	—	2.79	2.88	2.09	1.0	—	12.60
U of Arizona	4.61	1.6	4.11	4.34	1.0	—	.38	—	16.04
U of California – Berkeley	3.0	4.68	5.6	.42	.6	5.99	—	—	20.29
U of California – Santa Barbara	6.52	3.21	—	1.0	—	—	—	—	10.73
U of Delaware	1.51	5.87	—	1.0	—	2.7	.4	—	16.88
U of Florida	2.1	3.28	3.05	3.7	1.0	1.28	—	2.0	16.81
U of Georgia	8.43	4.32	2.46	5.5	2.68	1.54	.70	1.4	26.68
U of Illinois	4.7	1.6	3.66	1.0	1.4	2.47	—	.4	13.23
U of Maryland	5.73	4.78	1.21	1.0	—	1.0	—	.68	14.39
U of Miami (FL)	8.0	1.9	.88	3.79	2.07	—	—	1.0	17.64
U of Michigan	13.9	7.29	4.03	3.0	.53	4.0	—	—	32.72
U of Minnesota	6.31	2.47	2.45	.12	3.54	2.5	.21	1.0	15.06
University of Missouri	4.44	3.21	3.87	4.87	2.40	5.29	—	5.53	29.61
U of Nebraska	1.78	.63	—	1.53	—	12.15	.80	—	
U of North Carolina	4.07	3.30	1.6	2.42	1.02	1.0	—	—	12.81
U of Pennsylvania	5.64	1.68	2.0	.05	—	3.67	—	—	13.04
U of South Florida	2.92	7.0	2.32	1.68	—	1.0	—	4.0	18.92
U of Texas – San Antonio	2.0	1.0	1.0	—	1.21	2.92	—	1.07	7.20
U of Toledo	1.57	1.47	2.0	4.64	2.32	—	.4	1.12	13.52
U of Washington	4.6	3.0	3.41	—	.64	3.12	—	—	11.77
U of Wisconsin	6.4	3.4	1.32	—	.32	2.4	—	—	13.84

Table 6. Top 30 Science Education Programs of 2000s – Raw Rankings compared to 1990s Rankings

Institution	Total Number	2000s Rank	1990s Rank
Indiana University	128	1	3
University of Michigan	92	2	21
Purdue University	79	3	1
North Carolina State University	72	4	27
University of Georgia	70	5	2
University of Missouri	69	6	26
Arizona State University	66	7	8
University of Nebraska	60	8	——
Michigan State University	52	9	10
Teachers College, Columbia University	51	10	24
University of Minnesota	51	10	18
Texas A&M University	47	12	——
University of Miami (FL)	47	12	——
University of California – Berkeley	45	14	11
University of Maryland	41	15	——
Northwestern University	40	16	——
Stanford University	40	16	——
University of South Florida	40	16	7
Pennsylvania State University	38	19	7
University of North Carolina	36	20	24
University of Texas – San Antonio	36	20	——
Iowa State University	34	22	——
Massachusetts Institution of Tech.	33	23	——
University of Delaware	33	23	16
Florida State University	31	25	——
University of Florida	31	25	——
University of Arizona	30	27	22
University of California – Santa Barbara	30	27	——
University of Illinois	30	27	——
University of Pennsylvania	28	30	——
University of Wisconsin	28	30	4

4. Discussion

Why is this replication study important? This study kept all conditions stable from the research about science education institutional productivity except the time period-first decade of 21st century. This study is important because of the drastic changes in ranking of institutions. Current rankings are important because prospective faculty and graduate students should be aware of most recent ranking rather than for 1990s.

In this study, like the baseline research (Barrow *et al.*, 2008), used eight science education journals which publish empirical research. The multiple journals allow for the entire field of science education (Yager, 1984), to be considered. This pattern follows the patterns of other disciplines such as counseling education (Howard, 1983; Tracey, Claiborn, Goodyear, Lichtenberg, & Wampold, 2008; Smith *et al*., 2003), library science and information (Budd & Seavey, 1996; Budd, 2000; Adkins & Budd, 2006), and literary education (Morrison & Wilcox, 2008; Johns, 1986; Hollingsworth & Reutzel, 1994) rather than a single journal that was used by Ku (2009).

Across the science education research journals found that Indiana University, Iowa State University, Michigan State University, North Carolina State University, Purdue University, Teachers College Columbia University, University of Georgia, and University of Minnesota had publication in each journal for 2000s. The use of only a few science education research journals could result in a drastic different ranking. All of the top 30 ranked U.S. institutions had publications in *JRST* and *SE*. Only 3 of the institutions lacked a publication in *IJSE*. There were 15 and 13 institutions without publication in *JCM&ST* and *JESE*, respectively.

Recently, Barrow and Tang (2013) compared institutional productivity in the top four science education research journals (*JRST, SE, IJSE, and JSTE*) as identified by van Aalst (2010). There was a 90% agreement among the top 10 ranked institutions in this study for 2000s. There was also a 90% agreement in the bottom 10 rankings for 2000s, but variation in rank was observed.

5. Implications

The next decade of research will use only seven empirical science education journals since *JESE* has been integrated into *JSTE* when providing a possible three decade analysis of institutional productivity in science education. This three decade research would allow analysis about stability of an institution or not. With the retirement, death, and/or faculty mobility, what is the impact upon the involved institutions? Historically when a full professor position becomes open, it is filled by an assistant professor. Typically, it takes six years to achieve tenure and how does this impact an institution's productivity? The changing institutional productivity could be more drastic for small programs with three or fewer faculty. If the search process takes longer than a year, it could result in a lower institutional productivity level.

Table 7 allows quick comparison about raw and weighted ranking for the top 30 science education programs. Administrators and faculty can compare their programs productivity for both rankings. Due to increases in number of authors/publications as noted by Ku (2009), we recommend the use of weighted ranking when all members of the author chain are to be recognized. If the number of members in an author chain keeps increasing than maybe future analysis should only use the first three authors like was done by Ku. We question whether the seventh individual in an author team makes a significant contribution. However, in raw count they would receive the same credit as senior author.

Table 7. Alphabetical Listing of Top 30 Science Education Programs of 2000s for Raw and Weighted

Institution	Raw	Weighted
Arizona State University	7	6
Florida State University	25	28
Indiana University	1	1
Iowa State University	22	—
Massachusetts Institute of Technology	23	10
Michigan State University	9	9
North Carolina State University	4	7
Northwestern University	16	19
Ohio State University	—	29
Pennsylvania State University	19	22
Purdue University	3	2
Stanford University	16	17
Teachers College, Columbia University	10	8
Texas A&M University	12	27
University of Arizona	27	18
University of California – Berkley	14	10
University of California – Santa Barbara	27	—
University of Delaware	23	16
University of Florida	25	15
University of Georgia	5	5
University of Illinois	27	24
University of Maryland	15	21
University of Miami (FL)	12	14
University of Michigan	2	3
University of Minnesota	10	20
University of Missouri	6	4
University of North Carolina-Chapel Hill	20	26
University of Nebraska	8	13
University of Pennsylvania	30	25
University of South Florida	16	12
University of Texas-San Antonio	20	—
University of Toledo	—	23
University of Washington	—	30
University of Wisconsin	30	22

Maybe a perception study should be conducted for top U.S. science education research institutions. A Delphi study could involve 5-10 year leadership of science education organizations, editorial boards, etc. could identify attributes considered most important for identifying outstanding institutional research programs.

It appears that science education researchers seem to have a preference for one or two research journals where most of their research is published. A study similar to Lau *et al*. (2008) focused upon individual researchers and where research was published. A correlation study using weighted values for each science education research Journal could be conducted.

Valle and Schultz (2011) noted that in business schools that faculty of more prestige seems to have a cumulative advantage in rankings. In addition, graduate students of editorial board members tend to produce consistent research publications. Keith and Bubchuk (1994) noted that for social work journals, the editorship had greater number of publications from their institution. Buboltz Jr. *et al*. (2005) noted that institutions active publishers provide to graduate students more opportunities to learn about publication skills. Also, Rush and Whuler (2011) noted that collaboration in very facilitative to junior faculty especially if from another institution. Does either pattern exist in science education research journals?

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