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## Mapping the World of Coaching Science: A Citation Network Analysis

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### ABSTRACT

The purpose of the present study was to use citation network analysis to identify key publications and influential researchers in coaching science. A citation network analysis was conducted on references of English-language peer-reviewed coaching research articles published in 2007 and 2008 (n=141 articles; 3,891 references). Publications were coded for type (e.g., conceptual, empirical) and topic (e.g., efficacy, coach development). The structure of the field was revealed through the creation of a co-authorship network. Results show that coaching science is highly influenced by a small set of key publications and researchers. The results provide a unique overview of the field and influential authors, and complement recent overviews of coaching science (Gilbert & Trudel, 2004; Lyle & Cushion, 2010; McCullick et al., 2009).

Key Words: sports coach, research review, bibliometrics



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## Mapping the World of Coaching Science: A Citation Network Analysis

While sport coaching has expanded as a legitimate profession around the world, so too has the volume and scope of scholarly activity related to it (Lyle & Cushion, 2010). Some of the most prominent sports coaching research articles have been traced back to the early 1970s, and the yearly publication rate has dramatically increased since then (Gilbert & Trudel, 2004; Rangeon, Gilbert, Trudel, & Côté, 2009). There are over 1,000 research studies on sports coaching published in peer-reviewed English language journals (Gilbert, 2010) and numerous overviews of coaching science are now available (Côté & Gilbert, 2009; Gilbert & Trudel, 2004; Horn, 2008; Lyle & Cushion, 2010). In addition to global reviews of coaching science, overviews of sub-topics within coaching science are increasingly common, as witnessed by recent review papers on coach education (McCullick, et al., 2009), coach leadership (Vella, Oades, & Crowe, 2010), coaching effectiveness (Côté & Gilbert, 2009), and positive coaching (Dennison & Avner, 2011) to cite a few. These types of reviews provide important glimpses not only into what is known about specific coaching science topics, but also reveal much about the evolution of the field, in terms of research foci, conceptual frameworks, and the researchers who are shaping the field of study.

In perhaps the most comprehensive review of the research in coaching science, Gilbert and Trudel (2004) used content analysis to create an annotated bibliography of 30 years of coaching research. Using a four-phase design, a total of 610 coaching research articles were coded in regard to their focus, method, participants, context, and sport. Results revealed the prominence of studies on coaching behaviors and use of quantitative methodologies. However, the distinct popularity of quantitative methodologies such as questionnaires/scales and systematic observations seemed to be decreasing over the years to the profit of qualitative methodologies (e.g., interviews, qualitative observations/field notes, documents). Another distinctive trend was the dominance of studies conducted with coaches of team sports and in the school-based context. Although research trends were noted in the results of their study, Gilbert and Trudel's analysis did not distinguish publications based on any measure of influence or significance to the field. An additional outcome of that study was a list of the most often published scholars in coaching science. A total of 836 authors were identified as having published coaching science articles between 1970 and 2001. Only 25 of them (3%) had published more than five coaching articles in English peer-reviewed journals. This list of 25 researchers provided a starting point to identify the most influential researchers in the field. However, this measure is limited in that it only considers the number of publications, without taking into consideration the influence that these publications have on the field. Therefore, a more comprehensive measure for identifying influential coaching researchers and key publications that are shaping the field is warranted.

To identify key contributors, and by association the key publications, in academic fields, several measures have been used. One such measure is the *h*-index. The *h*-index takes into consideration the entire list of an author's publications in decreasing order of



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indegree centrality score (ICS), and counts how many ( $h$ ) papers have been cited  $h$  or more times (Henzinger, Suñol, & Weber, 2010; Saad, 2010). This index thus takes into account not only the number of publications, but also their prominence as measured by ICS. The  $h$ -index of many researchers can be calculated on the ISI Web of Knowledge ([www.isihighlycited.com](http://www.isihighlycited.com)). The  $h$ -index first requires compiling the list of an author's publications, then analyzing the number of citations received by the author's top publications, according to citation databases such as Web of Science or Google Scholar. This index is thus limited to the citation counts in the databases and is also biased toward older publications that receive more citations only because they have been cumulating citations for a longer period of time (Barabási & Albert, 1999). A solution to this problem would be to limit the measure to a specific period of time for the articles cited. Any text being cited by articles in this specific timeframe would be entered regardless of its publication year, which would eliminate the bias toward older publications. In addition, the citation counts on the Web of Science or Google scholar are limited to the journals for which reference lists are indexed. This indexing process has shown to be biased toward more established fields, which makes these measures highly unreliable for newer fields such as coaching science (Gilbert & Trudel, 2004).

An alternative, innovative approach to identifying the most influential publications and researchers in a field such as coaching science is to use citation network analysis. Citation network analysis is an analytical technique designed to reveal the links between publications in a given field. It originates in social network analysis, a field of study made popular by the six degrees of separation experiment (Milgram, 1967). The essence of social network analysis relies on revealing the interconnectedness of actors in a particular population. Actors are typically individuals, but they can also be scientific publications in the case of a citation network analysis. Citation patterns are thus the links between publications. Such analyses have been conducted in fields as varied as athlete development, public health research, medicine, polymer science, engineering, economics, human resource development, and sport psychology (e.g., Bruner, Erickson, Wilson, & Côté, 2010; Moore, Shiell, Hawe, & Haines, 2005).

In the present paper the authors review the empirical research related to coaching science with the intent of extending previous reviews (Gilbert & Trudel, 2004; Lyle & Cushion, 2010; McCullick, et al., 2009). Using citation network analysis, the objective was to identify key publications and influential researchers in coaching science. This type of information provides an important complement to the ongoing efforts of others in the field to summarize the ever-expanding body of knowledge in coaching science (Côté & Gilbert, 2009; Horn, 2008; Lyle & Cushion, 2010). An up-to-date list of influential publications and researchers in coaching science, based on a systematic analysis, has a number of practical implications. This type of information can assist scholars and practitioners alike by allowing them to quickly identify publications and authors of prominence to facilitate literature searches. The information can also help scholars gauge the influence of their publications in relation to others in their same field of study. Lastly, the results of this type of analysis can certainly aid prospective graduate students in



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identifying coaching science publications and scholars who are most active in their field – in a sense providing a measure of scholar effectiveness at converting research data and ideas into influential scholarly publications.

## Method

The first step in conducting this review was to select a data sample that would a) be large enough to provide sufficient depth to identify the most influential researchers in coaching science, but not so large as to become unfeasible for data management and analysis purposes, and b) provide a snapshot of publication and researcher influence that reflects the current literature in the field. After consultation with scholars who have conducted similar types of analyses, a comprehensive review of related literature, and attendance at an international network analysis training seminar, it was determined that the initial data sample would be delimited to the most recent two complete years of coaching science publications at the time the review was conducted. The second step was to create a reliable and systematic method for measuring publication and researcher influence in coaching science, and then test it with the data sample obtained in step one. Each of these steps is described in detail in the following sections of this paper.

## Procedure

The present study was conducted in late 2009 so the two most recent complete years of coaching science publications used in the analysis were 2007 and 2008. The selection of texts for the citation network analysis was conducted in two phases. Phase one involved searching for English-language peer-reviewed original research articles that contained the word ‘coach’, or any variation of the word in the title, published in 2007 or 2008. The search was conducted using EBSCOhost, which provides access to dozens of electronic databases across a wide range of academic disciplines ([www.ebscohost.com](http://www.ebscohost.com)). The particular version of EBSCOhost used in the present study included access to 34 electronic databases, including ones most commonly used in coaching science related fields (e.g., SPORTDiscus, ERIC, PsychINFO). A complete list of the 34 electronic databases is available from the first author. The same search was then performed on Web of Science, the online academic database referencing over 10,000 scientific journals ([http://thomsonreuters.com/products\\_services/science/science\\_products/scholarly\\_research\\_analysis/research\\_discovery/web\\_of\\_science](http://thomsonreuters.com/products_services/science/science_products/scholarly_research_analysis/research_discovery/web_of_science)). A total of 141 coaching science research articles were identified in phase 1. Full-text copies of these journal articles were compiled in a database using the Endnote bibliographic software program ([www.endnote.com](http://www.endnote.com)).

In phase two all entries from the reference list of articles retrieved in phase one were added. The final sample, therefore, was not limited to research articles, but also included the full range of literature dissemination options such as books, book chapters, concept papers, etc. All references identified in phase two of the data collection process were compiled in a Microsoft Excel spreadsheet to create a literature master list. This list



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represented the literature that shaped the coaching science published in 2007 and 2008, the most recent years of publication at the time of the present review.

The final number of references included in the analysis was 3,891. These 3,891 references were converted to a file compatible with the UCINET and NETDRAW programs used to conduct citation network analyses (Borgatti, Everett, & Freeman, 2002). A network of publications cited three times or more by the original sample was created, as well as a network that takes into consideration the number of publications and the number of collaborators.

## *Data Analysis*

Two types of centrality scores were calculated from these networks (publication network and publication + author network). The first type of centrality score is referred to as an Indegree Centrality Score (ICS). The ICS refers to the number of citations received by an individual publication. Using the UCINET analysis program, an ICS was calculated for each and every publication in the dataset ( $n = 3,891$ ).

A more detailed analysis was conducted on what were determined to be the most influential publications based on each publication's ICS. The research team initially set the 'influence threshold' at a ICS of 14 or greater, meaning that for a publication to be included in the 'most influential' group it had to be cited in at least 10% of the original dataset of 141 2007-2008 research articles. However, only four publications achieved this level of influence. The 'influence threshold' was extended to a ICS score of 7 or greater, meaning that for a publication to be included in the 'most influential' group it had to be cited in at least 5% of the original dataset. This broadening of the 'influence threshold' resulted in the identification of 41 key publications.

After identifying the sub-set of key publications ( $n=41$ ) based on their ICS's, a second type of centrality score was calculated, known as a Cumulative Indegree Centrality Score (CICS). A CICS is simply the sum of all ICS for a specified attribute. In the present review CICS were calculated for publication outlet, publication topic, and type of publication using this sub-set of 41 key publications. Publication outlets were self-evident, but a classification system had to be created in order to calculate CICS's for publication topic and type of publication. Members of the authorship team independently coded the topic and type of each publication. The coding system created by Gilbert and Trudel (2004) to analyze 30 years of coaching science was used as a provisional start list for coding the publications. Several attempts were made to code the top 41 publications by topic and type, and after each coding attempt the research team met to review their coding and discuss discrepancies. After the third attempt, the researchers achieved 100% consensus on the coding topic and type assigned to each of these 41 publications. The final coding list for publication topics included 12 topics (sport coaching general, coach development, coach knowledge, qualitative research, coaching efficacy, general self-efficacy, coach-athlete relationship, general talent development, quantitative data



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analysis, coaching behaviors, coach leadership, professional development). The final coding list for publication types included five types (conceptual book, conceptual article, research book, research article, methods book). The term ‘conceptual’ refers to a publication that doesn’t report results of original research, while the term ‘research’ refers to a publication in which original research is presented. The term ‘method’ refers to a publication that provides research methodology guidelines.

A high CICS may accurately reflect the prominence of a publication, as a high number of citations is commonly accepted to be representative of the influence a publication has on a particular field (Moore, et al., 2005). Relying on the CICS as a measure of a researcher’s influence, however, may not be as valid. For example, an author’s position on a publication – as a measure of contribution to the publication – and the number of collaborators with whom an author has worked – as a measure of connectedness – may be important characteristics to consider when attempting to calculate a researcher’s influence. For example, the position of authorship on a publication is an important indicator of influence in many disciplines. Typically placement as a first author on a publication is reserved for the researcher who made the most prominent contribution to the publication (Xiaojun, Rousseau, & Jin, 2010).

To address these concerns, a 2-mode network was created as a first step to identify key contributors to the field of coaching science. In a 2-mode network, actors are linked to events that they have taken part in. In this case, researchers are linked through publications. This type of network is undirected since links do not represent a hierarchical relation (unlike citations, collaborations are bi-directional in nature). The degree centrality score is thus not divided between in- and out-degree. Centrality score in this network represents the number of publications added to the number of connections to other researchers. However, the software Netdraw could not handle the very high number of nodes existing if the whole master list was entered. It was therefore decided that the 2-mode network would be based only on publications cited twice or more by the original sample, reducing the whole network from over 15,000 nodes to 7,204 nodes. Although informative, simply adding the number of publications to the number of connections does not accurately represent the prominence of a researcher. This 2-mode network was only used as an indication of potentially prominent researchers, for which a more complete measure of prominence was used. A formula, therefore, was created that used the centrality scores obtained through the citation network analysis as a foundation while taking into consideration the placement of authorship on a publication and a researcher’s connections to other authors. The formula created to measure a researcher’s influence for the purpose of the present review is referred to as the Researcher Influence Factor (RIF) and is as follows:

$$\text{Researcher Influence Factor (RIF)} = \text{CICS primary author} + (\text{CICS secondary author})/2 + N \text{ connections}$$



## Results and Discussion

The original sample of coaching science literature published in 2007 and 2008 comprised 141 articles. The coaching science citation network includes the references cited by this original sample (n=3,891).

### *Distribution of Indegree Centrality Scores (ICS)*

The distribution of ICSs for all 3,891 publications in the network is presented in Table 1. The distribution of ICSs shows that most publications (nodes) have a low number of connections (ICS of 1) while a few central texts earned a higher number of citations. Publications with a high number of citations (ICS) are ‘hubs’ in the network and can be considered more prominent in the field than publications with low indegree centrality scores. This type of distribution is represented by a power law and characterizes what is called a scale-free network (Barabási & Bonabeau, 2003). In mathematical terms, any node has  $1/k^n$  probability of being connected to  $k$  other nodes,  $n$  being approximately equal to 2. In the case of a citation network analysis, a scale-free network shows the high influence of few studies, while many other publications receive very low attention from the rest of the scientific community. One hundred and twenty eight publications have an indegree centrality score of ‘0’. This means that these publications were not cited by any other publications. These publications comprise most of the 2007-2008 articles. This is expected because at the time of the study others in the field had not yet had time to integrate them into their work. Some 2007 articles were cited by 2008 articles because authors cited their own manuscripts while still in press.

Using an ICS ‘influence threshold’ of 7 or greater (cited by 5% of more of the original dataset of 141 research articles), 41 publications were identified as ‘key publications’ in coaching science (see Table 2). John Lyle’s (2002) book *Sports Coaching Concepts: A Framework for Coaches’ Behaviour* earned the highest ICS (17) and is therefore considered the biggest ‘hub’ in the coaching science network. Other prominent publications include Cushion, Armour, and Jones’ (2003) article on coach education (ICS = 16), and the Coaching Model, published by Côté and colleagues in 1995 (Côté, Salmela, Trudel, Baria, & Russell, 1995) with an ICS of 15. This type of model has been termed a model ‘of’ coaching, in opposition to models ‘for’ coaching, the latter being idealistic representations of the coaching process (Cushion, Armour, & Jones, 2006; Lyle, 2002). Despite views that the field is lacking a consensual model (Cushion, 2007) it seems that the Coaching Model is frequently used as a guiding conceptual framework.



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**Table 1**

*Distribution of Indegree Centrality Scores (ICS)*

Indegree Centrality Score (ICS)	Number of Publications
17	1
16	1
15	1
14	1
13	1
12	2
11	0
10	3
9	11
8	5
7	15
6	19
5	37
4	45
3	122
2	425
1	3139
0	128

*Distribution of Cumulative Indegree Centrality Scores (CICS)*

Cumulative Indegree Centrality Scores (CICS) were calculated using the sub-set of 41 key publications identified in Table 2. Results are discussed specific to publication topic, type of publication, and publication outlet based on this CICS analysis.

*Publication topic.* Publications within the top 41 (CICS score of 14 or greater) were coded into a total of 12 topics. The number of publications in each topic as well as the CICS for each topic is reported in Table 3. Topics' CICS were computed by adding all Indegree Centrality Scores (ICS) of the publications belonging to a particular topic.

'Coach development' is the topic with the highest CICS (88), as well as the highest frequency count (n=10 publications within the top 41). Approximately one quarter of the key publications (i.e., top 41) directly pertain to coach development. Publications in this topic typically focus on coach education, learning, and related developmental issues for coaches (Gilbert & Trudel, 2004). The importance of publications on coach development compared to other topics illustrates one of the main questions underlying coaching research: How does one become a good coach? A previous synthesis of coaching science identified coaches' behaviors as the main research interest from 1970 to 2001 (Gilbert & Trudel, 2004). It seems that the field's main



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concern is now switching to developmental questions rather than mere behavioral observations. This switch in research interest is sign of a growing field moving from descriptive observation studies to a deeper quest for understanding dynamic processes of an individual's learning and development (Cushion & Lyle, 2010).

The 'sport coaching general' topic earned the second highest CICS (70), and the second highest frequency count (n=7). This topic is almost exclusively represented by conceptual books (n=6) that tend to focus on general conceptualizations of the coaching process from different perspectives (e.g., behavioral, cultural, holistic), while reviewing the existing literature. Gilbert and Trudel's (2004) analysis of coaching science is the only non-conceptual publication in this topic, as it provided an account of coaching science through an empirical study based on content analysis. It is likely that publications describing the coaching process from a general standpoint receive high citations because they help researchers situate their work in the broader picture of the field.

Methods books on qualitative research were grouped in one topic, which earned the third highest CICS (51). However, this topic ranked fourth in terms of frequency, which is explained by a relatively high average indegree score per text (10.2 citations per publication). Gilbert and Trudel (2004) already suggested an epistemological shift in coaching science. No research studies on coaches were using qualitative data analysis in the 1970's. This complete absence was then followed by a gradual increase in popularity of qualitative methodologies to study coaches (28.8% in 1998 to 2001; Gilbert & Trudel, 2004). The high citation count of qualitative methods books in the present study also reflects this epistemological shift from a complete dominance of quantitative studies to increasing consideration and use of alternative methods and research approaches (Jones, Bowes, & Kingston, 2010; Lyle, 2010). The CICS of qualitative methods books in the key publications was equal to 51, while only one quantitative methods book appeared in the key publications list, earning an ICS of 9. One might wonder if such a high CICS for qualitative methods books can be the result of qualitative research being sometimes considered 'less scientific', thus leading researchers to justify their methodology by referencing a set of popular qualitative research references (Culver, Gilbert, & Sparkes, in press). Quantitative researchers, on the other hand, might not feel the same need to cite so many references in their method section.



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**Table 2**

*Key Publications (n=41) Ranked by Decreasing Indegree Centrality Score (ICS)*

ICS	Publication	Publication Topic	Type of publication
17	Lyle, J. (2002). <i>Sports coaching concepts: A framework for coaches' behaviour</i> . London: Routledge.	Sport coaching general	Conceptual book
16	Cushion, C. J., Armour, K. M., & Jones, R. L. (2003). Coach education and continuing professional development: Experience and learning to coach. <i>Quest</i> , 55(3), 215-230.	Coach development	Conceptual article
15	Côté, J., Salmela, J., Trudel, P., Baria, A., & Russell, S. (1995). The Coaching Model: A grounded assessment of expert gymnastic coaches' knowledge. <i>Journal of Sport and Exercise Psychology</i> , 17(1), 1-17.	Coach knowledge	Research article
14	Miles, M. B., & Huberman, A. M. (1994). <i>Qualitative data analysis: An expanded sourcebook</i> (2nd ed.). Thousand Oaks, CA: Sage.	Qualitative research	Methods book
13	Jones, R., Armour, K., & Potrac, P. (2004). <i>Sports coaching cultures: From practice to theory</i> . London, UK: Routledge.	Sport coaching general	Conceptual book
12	Malete, L., & Feltz, D. L. (2000). The effect of a coaching education program on coaching efficacy. <i>Sport Psychologist</i> , 14(4), 410-417.	Coaching efficacy	Research article
12	Patton, M. Q. (1990). <i>Qualitative evaluation and research methods</i> (2nd ed.). Thousand Oaks, CA: Sage.	Qualitative research	Methods book
10	Bandura, A. (1997). <i>Self-efficacy: The exercise of control</i> . New York: W H Freeman/Times Books/ Henry Holt & Co.	General self-efficacy	Conceptual book
10	Gilbert, W., & Trudel, P. (2001). Learning to coach through experience: Reflection in model youth sport coaches. <i>Journal of Teaching in Physical Education</i> , 21(1), 16-34.	Coach development	Research article
10	Mageau, G. A., & Vallerand, R. J. (2003). The coach-athlete relationship: A motivational model. <i>Journal of Sports Sciences</i> , 21(11), 883-904.	Coach-athlete relationship	Research article



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Table 2 (cont).

ICS	Publication	Publication Topic	Type of publication
9	Bloom, B. S. (1985). <i>Developing talent in young people</i> . New York: Ballantine.	General talent development	Research book
9	Cassidy, T., Jones, R., & Potrac, P. (2004). <i>Understanding sports coaching: The social, cultural and pedagogical foundations of coaching practice</i> . London, UK: Routledge.	Sport coaching general	Conceptual book
9	Feltz, D. L., Chase, M. A., Moritz, S. E., & Sullivan, P. J. (1999). A conceptual model of coaching efficacy: Preliminary investigation and instrument development. <i>Journal of Educational Psychology, 91</i> (4), 765-776.	Coaching efficacy	Research article
9	Horn, T. S. (2008). Coaching effectiveness in the sport domain. In T. S. Horn (Ed.), <i>Advances in sport psychology</i> (3rd ed., pp. 239-267). Champaign, IL: Human Kinetics.	Sport coaching general	Conceptual book
9	Jowett, S. (2003). When the "honeymoon" is over: A case study of a coach-athlete dyad in crisis. <i>The Sport Psychologist, 17</i> (4), 444-460.	<b>Coach-athlete relationship</b>	<b>Research article</b>
9	Jowett, S., & Cockerill, I. M. (2003). Olympic medallists' perspective of the athlete-coach relationship. <i>Psychology of Sport and Exercise, 4</i> (4), 313-331.	Coach-athlete relationship	Research article
9	Lincoln, Y. S., & Guba, E. G. (1985). <i>Naturalistic inquiry</i> . Newbury Park, CA: Sage.	Qualitative research	Methods book
9	Smith, R. E., Smoll, F. L., & Curtis, B. (1979). Coach effectiveness training: A cognitive - behavioral approach to enhancing relationship skills in youth sport coaches. <i>Journal of Sport Psychology, 1</i> (1), 59-75.	Coach development	Research article



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Table 2 (cont).

ICS	Publication	Publication Topic	Type of publication
9	Smoll, F. L., Smith, R. E., Barnett, N. P., & Everett, J. J. (1993). Enhancement of children's self-esteem through social support training for youth sport coaches. <i>Journal of Applied Psychology</i> , 78(4), 602-610.	Coach development	Research article
9	Tabachnick, B. G., & Fidell, L. S. (2007). <i>Using multivariate statistics (5th ed.)</i> . Boston, MA: Allyn & Bacon/Pearson Education.	Quantitative data analysis	Methods book
9	Trudel, P., & Gilbert, W. (2006). Coaching and coach education. In D. Kirk, M. O'Sullivan & D. McDonald (Eds.), <i>Handbook of physical education</i> (pp. 516-539). London, UK: Sage.	Coach development	Conceptual book
8	Black, J. S., & Weiss, M. R. (1992). The relationship among perceived coaching behaviors, perceptions of ability, and motivation in competitive age-group swimmers. <i>Journal of Sport &amp; Exercise Psychology</i> , 14(3), 309-325.	Coaching behaviors	Research article
8	Creswell, J. W. (1998). <i>Qualitative inquiry and research design: Choosing among five traditions</i> . Thousand Oaks, CA US: Sage Publications, Inc.	Qualitative research	Methods book
8	Gilbert, W., & Trudel, P. (2004). Analysis of coaching science research published from 1970-2001. <i>Research Quarterly for Exercise &amp; Sport</i> , 75(4), 388-399.	Sport coaching general	Research article
8	Patton, M. Q. (2002). <i>Qualitative research &amp; evaluation methods (3rd ed.)</i> . Thousand Oaks, CA: Sage.	Qualitative research	Methods book
8	Saury, J., & Durand, M. (1998). Practical knowledge in expert coaches: on-site study of coaching in sailing. <i>Research Quarterly for Exercise &amp; Sport</i> , 69(3), 254-266.	Coach knowledge	Research article



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Table 2 (cont).

ICS	Publication	Publication Topic	Type of publication
7	Bloom, G. A., Durand-Bush, N., Schinke, R. J., & Salmela, J. H. (1998). The importance of mentoring in the development of coaches and athletes. <i>International Journal of Sport Psychology</i> , 29, 267-281.	Coach development	Research article
7	Ericsson, K. A., Krampe, R. T., & Tesch-Römer, C. (1993). The role of deliberate practice in the acquisition of expert performance. <i>Psychological Review</i> , 100(3), 363-406.	General talent development	Conceptual article
7	Gilbert, W., Côté, J., & Mallett, C. (2006). Developmental paths and activities of successful sport coaches. <i>International Journal of Sports Science &amp; Coaching</i> , 1(1), 69-76.	Coach development	Research article
7	Gilbert, W., & Trudel, P. (1999). An evaluation strategy for coach education programs. <i>Journal of Sport Behavior</i> , 22(2), 234.	Coach development	Research article
7	Gould, D., Krane, V., Giannini, J., & Hodge, K. (1990). Educational needs of elite U.S. national team, Pan American, and Olympic coaches. <i>Journal of Teaching in Physical Education</i> , 9(4), 332-344.	Coach development	Research article
7	Jowett, S. (2007). Interdependence analysis and the 3+1Cs in the coach-athlete relationship. In S. Jowett & D. Lavallee (Eds.), <i>Social psychology in sport</i> (pp. 15-27). Champaign, IL: Human Kinetics.	Coach-athlete relationship	Conceptual book
7	Jowett, S., & Meek, G. A. (2000). The coach-athlete relationship in married couples: An exploratory content analysis. <i>The Sport Psychologist</i> , 14(2), 157-175.	Coach-athlete relationship	Research article
7	Jowett, S., & Poczwardowski, A. (2007). Understanding the coach-athlete relationship. In S. Jowett & D. Lavallee (Eds.), <i>Social psychology in sport</i> (pp. 3-14). Champaign, IL: Human Kinetics.	Coach-athlete relationship	Conceptual book



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Table 2 (cont).

ICS	Publication	Publication Topic	Type of publication
7	Lyle, J. (1999). The coaching process: An overview. In N. Cross & J. Lyle (Eds.), <i>The coaching process: Principles and practice for sport</i> (pp. 3-24). Oxford, UK: Butterworth Heinemann.	Sport coaching general	Conceptual book
7	Myers, N. M., Vargas-Tonsing, T. M., & Feltz, D. L. (2005). Coaching efficacy in intercollegiate coaches: Sources, coaching behavior, and team variables. <i>Psychology of Sport &amp; Exercise</i> , 6(1), 129-143.	Coaching efficacy	Research article
7	Potrac, P., Brewer, C., Jones, R., Armour, K., & Hoff, J. (2000). Toward an holistic understanding of the coaching process. <i>Quest</i> , 52(2), 186.	Sport coaching general	Conceptual article
7	Riemer, H. A., & Chelladurai, P. (1998). Development of the Athlete Satisfaction Questionnaire (ASQ). <i>Journal of Sport &amp; Exercise Psychology</i> , 20(2), 127.	Coach leadership	Research article
7	Schön, D. A. (1987). <i>Educating the reflective practitioner: Toward a new design for teaching and learning in the professions</i> . San Francisco, CA: Jossey-Bass.	Professional development	Conceptual book
7	Smith, R. E., Smoll, F. L., & Hunt, E. (1977). System for the behavioral assessment of athletic coaches. <i>Research Quarterly for Exercise &amp; Sport</i> , 48(2), 401-407.	Coaching behaviors	Research article
7	Wiersma, L. D., & Sherman, C. P. (2005). Volunteer youth sport coaches' perspectives of coaching education/certification and parental codes of conduct. <i>Research Quarterly for Exercise &amp; Sport</i> , 76(3), 324-338.	Coach development	Research article



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**Table 3**

*Cumulative Indegree Centrality Scores (CICS) and Publication Topic for Key Publications (n=41)*

Publication Topic	CICS	Number of publications (n)	Average indegree (CICS/n)
Coach development	88	10	8.8
Sport coaching general	70	7	10
Qualitative research	51	5	10.2
Coach-athlete relationship	49	6	8.2
Coaching efficacy	28	3	9.3
Coach knowledge	23	2	11.5
General talent development	16	2	8
Coaching behaviors	15	2	7.5
General self-efficacy	10	1	10
Quantitative data analysis	9	1	9
Coach leadership	7	1	7
Professional development	7	1	7



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*Publication types.* Five types of publications were identified for classifying the key publications: conceptual article, conceptual book, methods book, research article, and research book. In the same way the CICS was computed for the different topics, the CICS per type of publication was also compiled by adding the ICS of each reference in the specific category. ‘Research articles’ obtained by far the highest CICS (CICS=179) due to the high number of references falling into this category (n=21). The reliance on using primary research as a foundation for current research could be viewed as a sign of maturation and increased credibility of coaching science as a legitimate field of study (Cushion & Lyle, 2010). ‘Conceptual books’ obtained a CICS of 95 and methods books obtained a CICS of 60. Books in general thus had a total CICS of 164 from adding the ICS of all 17 books in the key publications. Articles in general obtained a total CICS of 209 from adding the ICS of all 24 articles (3 ‘conceptual’ and 21 ‘research’).

*Publication outlets.* In order to identify the most prominent outlets for key publications in coaching science, a CICS was computed for each journal appearing in the list of key publications (see Table 4). Only three journals have more than two articles in the key publications list: *Research Quarterly for Exercise and Sport* (CICS=30; n=4), *Journal of Sport & Exercise Psychology* (CICS=30; n=3), and *The Sport Psychologist* (CICS=28; n=3). The average ICS per publication in the key publication list was also computed for each journal, in order to identify the publication outlets with a strong impact on the field regardless of the number of coaching papers they publish. *Quest* obtained the highest average (average ICS = 11.5), which can be attributed to publishing the most often cited journal article (Cushion, et al., 2003) as well as another prominent article in the field (Potrac, Brewer, Jones, Armour, & Hoff, 2000). Another finding is the tight link between coaching science and sport psychology. Half of the journals appearing in the key publications list are sport psychology journals.

Measures of CICS and average ICS reflect which journals were influential in a specified timeframe – in this case 2008 and earlier. Therefore, the results presented in Table 4 must be interpreted from this historical viewpoint as the top publication outlets may be different for the most current literature (2009-2011). For example, the *International Journal of Sports Science and Coaching* has been shown to be the largest publisher of coaching science studies in the past five years (Rangeon, et al., 2009). Only one article from this journal appeared in our list of key publications, likely at least partially due to this journal having only been created in 2006. This may reflect a discrepancy between journals that have historically been influential in shaping coaching science, and journals that are currently shaping the field.



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**Table 4**

*Publication Outlets for Key Publications Ranked in Decreasing Order of Cumulative Indegree Centrality Score (CICS)*

Journal	CICS	Number of publications (n)	Average ICS
<i>Research Quarterly for Exercise and Sport</i>	30	4	7.5
<i>Journal of Sport &amp; Exercise Psychology</i>	30	3	10
<i>The Sport Psychologist</i>	28	3	9.3
<i>Quest</i>	23	2	11.5
<i>Journal of Teaching in Physical Education</i>	17	2	8.5
<i>Psychology of Sport &amp; Exercise</i>	16	2	8
<i>Journal of Sport Sciences</i>	10	1	10
<i>Journal of Sport Psychology</i>	9	1	9
<i>Journal of Applied Psychology</i>	9	1	9
<i>Journal of Educational Psychology</i>	9	1	9
<i>International Journal of Sport Psychology</i>	7	1	7
<i>International Journal of Sport Science and Coaching</i>	7	1	7
<i>Journal of Sport Behavior</i>	7	1	7
<i>Psychological Review</i>	7	1	7

## *Key Researchers*

The 2-mode network created to identify key contributors to coaching science is presented in Figure 1. Researchers (blue squares) are linked through publications (red dots) with the biggest squares representing authors with a higher centrality scores (i.e., greater influence on the coaching science publication network). This 2-mode network also shows how the field of coaching science is shaped through collaborations between researchers. The layout of the network reveals that researchers and publications isolated from the field congregate to the center of the network in a disconnected cluster. In contrast, the outer ring represents the most active researchers in coaching science. As the ring shape suggests, coaching science is a small world where key contributors in the field are linked through collaborations to intermediate connections (brokers).





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Using this 2-mode network as a guide, a Researcher Impact Factor (RIF) was calculated for the key contributors (blue squares in Figure 1). Table 5 shows researchers with the top 10 Researcher Impact Factor (RIF) scores. Demographic information about these researchers shows the field to be dominated by males working in North America. Indeed, only three of the top 10 researchers are women and only two of the top 10 are employed outside of North America. This result is not surprising, considering that sport in general, and coaching in particular, is an activity highly dominated by men (Coakley, 2008). The academic departments of current affiliation showed that almost all of the researchers are employed in kinesiology or related departments. The only two exceptions were Ronald Smith and Frank Smoll, both employed in a psychology department, who have spent their career studying psychosocial outcomes (e.g., anxiety, satisfaction, self-esteem) of youth sport participants (Munsey, 2010).

**Table 5**  
*Coaching Scientists with Top 10 Researcher Influence Factor (RIF) Scores*

Rank	Researcher	Primary Author CICS	Secondary Author CICS	Connections (n)	RIF
1	Dan Gould	67	7.5	50	124.5
2	Sophia Jowett	87	2.5	21	110.5
3	Ronald Smith	64	18	15	97
4	Jean Côté	56	9.5	25	90.5
5	Packianathan Chelladurai	49	16	23	88
6	Pierre Trudel	20	43	22	85
7	Deborah Feltz	24	26	24	74
8	Frank Smoll	27	32.5	13	72.5
9	Maureen Weiss	30	11.5	30	71.5
10	Wade Gilbert	54	7.5	9	70.5
10	Robyn Jones	33	24.5	13	70.5

Note:  $RIF = CICS \text{ primary author} + (CICS \text{ secondary author})/2 + N \text{ connections}$

Countries of current affiliation revealed a clear dominance of the USA, with more than half of the top 10 ranked researchers currently affiliated with American universities. Four researchers are currently affiliated with universities outside of the USA (Jean Côté and Pierre Trudel from Canada, and Sophia Jowett and Robyn Jones from the United Kingdom). However, two researchers currently affiliated with American universities obtained their doctoral degrees in Canada (Packianathan Chelladurai and Wade Gilbert). In terms of specific universities, Michigan State University seems to be a particularly active setting for producing coaching science publications (Dan Gould and Deborah Feltz). The University of Ottawa also seems to be one of the 'hotbeds' of coaching science with three of the top 10 ranked coaching science researchers having either worked or trained there (Pierre Trudel, Jean Côté, and Wade Gilbert). The dominance of researchers working in the USA, Canada and England could on the one hand be a sign of language barriers that restricts researchers from non-English speaking countries from



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publishing in English-language journals. On the other hand, it could be hypothesized that this Anglophone pre-eminence is at least partly due to a lower interest for coaching science in other countries. Indeed, an analysis of coaching science articles published in French revealed that 10 times fewer articles were published in French than in English (Cloes, Lenzen, & Trudel, 2009). The interest, or lack thereof, that the French speaking scientific community gives to studying coaching is influenced by a more advanced professionalization of coaching in North-America compared to some countries in other parts of the world (Cloes, et al., 2009).

The validity of this list of researchers as an indicator of researcher influence in shaping the field of coaching science is supported by the frequency of which these researchers appear as authors in major handbooks and textbooks that include coaching science (Kirk, Macdonald, & O'Sullivan, 2006; Lyle & Cushion, 2010; Tenenbaum & Eklund, 2007). Many of these coaching scientists also have authored or edited books summarizing their work (Jones, 2006; Jowett & Lavallee, 2007; Smoll & Smith, 2002). A final indication that the list obtained in the present study is a valid indicator is that it corresponds very well to the list of most frequently published authors in the coaching science analysis completed by Gilbert (2002). For example, eight of the top researchers identified using the RIF also appeared in the top 12 on Gilbert's list. A comparison of the two lists, based on analyses completed eight years apart, provides insight both on the evolution of who is shaping the field and the value of using a measure like the RIF instead of simple publication counts as an indicator of researcher influence. Whereas the list of researchers from the Gilbert study shows simple frequency of research articles, it fails to gauge the influence of these publications. So, although a researcher like Donna Pastore who published frequently in the 1990s (ranked #1 in the Gilbert study) has historically been an extremely active scholar in the field, it appears that the role of her work in shaping the current research in coaching science is limited (not present in the key publications or key contributor tables). This shows an evolution in the focus of coaching science research. Could it be that the results of the present study illuminate a narrowing of researcher 'field awareness' and increased specialization? What might be the long-term implications of this increasingly myopic approach to scholarly research? Indeed it may also highlight the significant influence that publishing has on what is considered 'knowledge' in a field and who becomes viewed as the 'knowledge shapers'.

*Strengths and limitations of the RIF as a measure of researcher influence.* By starting from an original sample portraying the recent state of a field out of which a citation network is drawn, the RIF does not rely on a single database such as Web of Science or Google Scholar. Instead, the RIF indexes work cited by a particular sample that has clear identification criteria. In the present study these criteria were coaching science studies written in English language and published in 2007 and 2008 in peer-reviewed journals. In this regard, the RIF provides an objective snapshot of researcher influence on current theoretical and epistemological views in a given field. Moreover, whereas a measure such as the *h*-index allocates the same 'points' regardless of a researcher's authorship position, the RIF divides by two the number of ICS 'points' for a secondary author, as compared to full credit for the first author. Finally, in addition to allocating 'points' for citations earned by a researcher's publications, the RIF also includes a measure of social capital.



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Social capital of researchers has commonly been measured based on the connections a particular researcher has to other researchers through collaboration on a publication (Grenfell, 2009; Nahapiet & Ghoshal, 1998). Across fields, having a high social capital has been shown to be associated with several advantages such as faster promotions, higher salary, and more opportunities to learn and disseminate ideas (Grenfell, 2009; Johnson & Duff, 2005; Nguyen, Allen, & Godkin, 2006). Researchers with higher social capital have better chances of communicating their research to a larger population, thereby increasing the impact of the findings. An increase in direct relationships (measured by co-authorship) provides a researcher with more possibilities to share resources with other researchers (Nahapiet & Ghoshal, 1998) as well as better access to new knowledge and opportunities.

Even though the RIF may provide a fairly accurate representation of a researcher's influence, it is best viewed as a step in the evolution of our quest to make sense of an ever expanding literature base and the scholars who contribute to it. Certainly there are limitations to this approach. For example, the criteria used to identify influential scholars with the RIF do not account for the myriad of other ways scholars shape the evolution of a field. Scholars surely exert an influence on a field by serving as grant reviewers, editors of scholarly journals and texts, and in leadership positions in professional organizations. None of these types of influence are captured directly in the RIF and as a result it is possible that some key shapers of coaching science are absent from the list presented in Table 5. Furthermore, the decision to have the 'points' assigned to secondary authorships may be contested. Although typically authorship is determined by level of contribution to the publication, there may be cases where authors are listed simply by alphabetical order of surname. Also, the RIF may not fully value the contribution of mentorship in the authorship and publication process. The contributions of secondary authors may in fact outweigh first authors in cases where the first author is a graduate student who relies heavily on the guidance of a thesis supervisor in the preparation of research for publication.

Perhaps, then, the RIF is best viewed as an example of *a measure* for determining a scholar's ability to influence a field of study at a particular moment in time through his or her publications, and not as *the measure* of overall influence. The RIF clearly shows that the published work of the scholars listed in Table 5 is having a strong influence on the type, and focus, of current research in coaching science.

## Conclusion

Coaching science is highly influenced by a small set of key publications and researchers. Becoming acquainted with this list of publications and researchers could be very useful when designing future research in coaching science. Not only does it provide insight into the type, focus, and location (publication outlet) of publications influential to coaching science at a particular moment in time, it also can be used to identify gaps or neglected areas of relevance to coaching science. In the future, the same methodology could be applied to other time periods, which when viewed collectively would provide an evolutionary portrait of coaching science. Lastly, the RIF provides a unique approach to measuring a researcher's influence on coaching



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science. As with any measure, the RIF certainly is open to debate and revision. It is hoped that the review provided in this paper advances our collective understanding of the field of coaching science and causes readers to reflect on their own work and what future reviews of the field may reveal.



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