Universidad de Granada

Facultad de Comunicación y Documentación

Departamento de Comunicación y Documentación

Aplicación de Técnicas Bibliométricas en el Análisis del Área de Trabajo Social

Tesis Doctoral

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Aplicación de Técnicas Bibliométricas en el Análisis del Área de Trabajo Social

Memoria Presentada por

Dª. Mª Ángeles Martínez Sánchez

Para Optar al Grado de

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Dirigida por

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La memoria titulada "*Aplicación de Técnicas Bibliométricas en el Análisis del Área de Trabajo Social*", que presenta Dª. Mª. Ángeles Martínez Sánchez para optar al grado de doctora, ha sido realizada dentro del Master Oficial "*Información y Comunicación Científica*" del Departamento de Comunicación y Documentación adscrito al Doctorado en Ciencias Sociales de la Universidad de Granada bajo la dirección de los doctores D. Enrique Herrera Viedma, D. Evaristo Jiménez Contreras y D. Manuel Herrera Gómez.

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Índice

Parte I. Memoria

1. Introducción

El Análisis y Evaluación de la Ciencia mediante herramientas bibliométricas es una actividad científica de actualidad en multitud de áreas científicas como Medicina, Computer Science, Psicología, Ciencias Empresariales, Sistemas de Transporte, etc., [126]. Lo más usual es usar índicadores bibliométricos basados en citación para evaluar la calidad y el impacto de la investigación desarrollada en cada área, y analizando o las publicaciones del área, o las revistas usadas en la difusión de resultados, o los autores, o los centros de investigación e incluso los países [126]. Para sentar las bases de conocimiento de un área temática es fundamental desarrollar estudios bibliométricos que nos permitan identificar la estructura científica del área en cuanto a las temáticas que trata, las principales revistas donde se concentra el conocimiento de la misma, las principales instituciones que trabajan en ella, los principales grupos de investigación, los autores más sobresalientes, así como los los países más avanzados en el área. Para que un área de investigación crezca y se consolide los miembros de su comunidad deben de conocer cuáles son las pautas y cauces tradicionales de transmisión de la producción científica, así como los principales estándares internacionales que se usan en otras áreas de investigación [59].

El Área de Trabajo Social es un área incipiente y relativamente joven en el ámbito de la investigación, tanto a nivel nacional como internacional [9]. En comparación con otras áreas de investigación (Medicina, Psicología, Computer Science, etc.,), el Área de Trabajo Social está poco estudiada y analizada desde el punto de vista bibliométrico [58]. El principal problema es encontrar bases de datos bibliográficas fiables de las cuales extraer información sobre el área de investigación.

En la mayoría de las disciplinas, las revistas constituyen uno de los medios más usados para difundir los resultados de la investigación científica. En la actualidad, en el mundo académico podemos afirmar que las publicaciones en revistas constituyen uno de los medios fundamentales para realizar la transmisión del nuevo conocimiento científico, y al mismo tiempo, son la base de los procedimientos de evaluación de la calidad de los resultados científicos generados.

La *Bibliometría* es la *Ciencia de Evaluación y Análisis de las Ciencias* [95] que usa las publicaciones en revistas como medio principal para analizar y evaluar la calidad de la actividad científica realizada por investigadores individuales, por grupos de investigación, por universidades y por países. Existen dos tipos de estudios bibliométricos que se pueden realizar para analizar la actividad científica desarrollada en un campo del saber [87, 125]:

- *Estudios bibliométricos de rendimiento basados en indicadores cuantitativos*, como el número de publicaciones, y/o en indicadores de impacto construidos a partir del análisis de citas que obtienen las publicaciones [44], entendiendo las citas entre publicaciones como el medio que caracteriza la importancia de dichas publicaciones en función del reconocimiento otorgado por otros investigadores.

- *Estudios bibliométricos de contenido basados en mapas de ciencia* construidos mediante co-ocurrencias de términos [20] que permiten descubrir la estructura conceptual subyacente de una disciplina científica e incluso analizar su evolución conceptual [29, 87]. Recientemente en nuestro grupo SECABA hemos desarrollado una herramienta de análisis bibliométrico basado en mapas de ciencia que usaremos en esta memoria, llamada *SciMAT (Science Mapping Analysis Tool)*[1] [32, 33].

Ambos procedimientos pueden englobarse en un marco longitudinal [48, 94] para, de este modo, analizar los cambios estructurales que se han dado en la información científica a lo largo del tiempo, es decir, para estudiar la evolución intelectual, conceptual y social de un área científica.

Por tanto, para realizar cualquier estudio bibliométrico de cualquier tipo se necesita disponer de bases de datos bibliográficas que almacenen la información bibliográfica de las publicaciones en revista como, autor, título, fecha, nombre de la revista, palabras claves, y las citas recibidas. Tres son las bases de datos bibliográficas más populares:

1. *Web of Science (WoS)*[2] propiedad de Thomson Reuters,
2. *Scopus*[3] propiedad de Elsevier, y
3. *Google Scholar*[4] propiedad de Google.

Todas ellas cubren un amplio espectro de publicaciones tanto de Ciencias, como Ciencias Sociales, como de Humanidades. Las dos primeras son de pago y la tercera gratuita. Tanto WoS como Scopus realizan procesos de control de calidad y de depuración de errores sobre las revistas a indexar, mientras Google Scholar no. Por todo ello, WoS y Scopus son las bases de datos bibliográficas de referencia que soportan la mayoría de estudios bibliométricos realizados. Sin embargo, a pesar de su sesgo lingüístico y geográfico (a favor de las revistas en inglés, sobre todo procedentes de los EE.UU. y del Reino Unido) WoS presenta dos aspectos a su favor que la hacen ser la preferida de la mayoría de los investigadores:

1. Indexa una gran cantidad de revistas desde sus orígenes (desde 1900) mientras Scopus recoge tan sólo información de las publicaciones realizadas desde el 1996.
2. Sobre WoS se construye el famoso *Factor de Impacto de una Revista* [44], que se ha convertido en un indicador clave para evaluar la calidad de la actividad científica de un investigador, y que se recoge en la base de datos de revistas *Journal Citation Reports (JCR)* con una edición para evaluar las revistas de Ciencias y otra edición para evaluar las revistas de Ciencias Sociales, almacenando información relevante del impacto de las revistas más prestigiosas en ambos casos. El JCR en su edición de Ciencias Sociales identifica el área de Trabajo Social como una disciplina científica en la que se desarrolla actividad investigadora y recoge datos

[1] http://sci2s.ugr.es/scimat/
[2] http://www.webofknowledge.com
[3] http://www.scopus.com
[4] http://scholar.google.com

de impacto de un buen número de revistas científicas en Trabajo Social, número que ha ido creciendo año tras año.

En la presente memoria presentamos varios estudios bibliométricos sobre el Área de Trabajo Social con objeto de ayudar a comprender mejor la estructura científica internacional del área de Trabajo Social. Estos estudios son tanto de análisis de rendimiento como de análisis de contenido mediante mapas de ciencia y se realizan usando como referencia las bases de datos de Thomson Reuters, WoS y JCR. Por ello, el resto del capítulo está organizado de la siguiente forma: en la Subsección 1.1 se describe los fundamentos de la Bibliometría y los principales indicadores usados para realizar estudios bibliométricos de áreas de investigación; en la Subsección 1.2 se analizan los fundamentos de los estudios bibliométricos basados mapas de ciencia y de la herramienta SciMAT que usamos para desarrollarlos; y en la Subsección 1.3 se describen algunos de los estudios bibliométricos existentes en el Área de Trabajo Social.

1.1. La Bibliometría y su Uso en la Evaluación de la Ciencia

La Ciencia es el conjunto de conocimientos que se genera en las diferentes áreas del saber de la sociedad, bien mediante la observación de fenómenos sociales o naturales, bien mediante la experimentación, o bien mediante el razonamiento, y por medio de un método científico preferentemente. Como es sabido, el desarrollo de la Ciencia es la base y el motor del progreso humano, y por ello La Ciencia es uno de los pilares de la sociedad actual en la que vivimos, la llamada *Sociedad de la Información y el Conocimiento*. Atendiendo al mayor o menor uso del método científico, podemos hablar que existen tres grandes bloques de áreas científicas: el *Área de Ciencias* relacionada con las disciplinas más formales y empíricas, aplicadas y tecnológicas, y de la naturaleza, como las Matemáticas, la Física, la Química, la Biología, Medicina, Arquitectura, Ingenierías, etc; el *Área de Ciencias Sociales y Jurídicas* que identifica a las disciplinas relacionadas con los aspectos del ser humano y su vida en sociedad, como la Economía, el Derecho, la Sociología, la Antropología, el Trabajo Social, etc; y el *Área de Artes y Humanidades* que identifica a aquellas disciplinas relacionadas con la historia y la cultura y el pensamiento del ser humano, como la Filosofía, Arqueología, Música, Dibujo, Historia, Filología, etc.

En [95] Price definió la Ciencia como aquello que se edita en las publicaciones científicas y al científico como la persona que ha colaborado escribiendo alguna de esas publicaciones. En esta definición estaba implícita la idea de que la publicación de resultados forma parte del proceso de investigación científica, como el medio a través del cual se evalúan, se validan y se dan a conocer los avances científicos alcanzados. Actualmente se valoran principalmente las publicaciones en revistas científicas o académicas, pero también hay otro tipo de publicaciones que podrían considerarse como las publicaciones en congresos, libros, blogs, páginas webs, etc. Como hemos comentado, la Ciencia forma parte de nuestra sociedad, y por ello, los desarrollos científicos que se producen no están exentos de críticas, análisis y procesos de evaluación. Por tanto, si consideramos que las publicaciones son el vehículo de transmisión y validación del conocimiento científico, el llamado *"output de la actividad investigadora"*, se entiende mejor que el análisis de las publicaciones sea una de las herramienta de la evaluación de la actividad investigadora.

La *Bibliometría*, definida como *"La Ciencia de Ciencias"* [95], es la ciencia cuyo objetivo es analizar y evaluar los avances científicos que se producen en los diferentes campo científicos o de conocimiento, principalmente a través del análisis de la producción científica o publicaciones. En la comunidad científica bibliométrica, encontramos que muchos autores usan términos como *Cienciometría* o *Informetría* para hablar de Bibliometría, como si designaran una misma disciplina. Lo cierto, es que existe un alto grado de solapamiento entre ellas y es difícil separar sus respectivos

cuerpos de conocimiento [5]. Siendo las tres disciplinas constitutivas de la denominada *"Ciencia de la Información"* [82] y compartiendo algunas veces los mismo instrumentos científicos, sin embargo, tienen objetivos diferentes.

López-Piñero define la Cienciometría como [75]: *"El análisis estadístico y sociométrico de la bibliografía científica mediante el uso de modelos matemáticos, y cuyos objetivos se basan en el estudio del tamaño, crecimiento y distribución de la bibliografía científica y en el estudio de la estructura y dinámica social que la producen y la utilizan"*. Como indica Daniel Torres [121], Garfield es quien propuso una definición más amplia del concepto de Cienciometría que no se limitaba solamente a analizar la producción científica [46]: *"El estudio de la medición de progreso científico y tecnológico"*. Por tanto, la Cienciometría estudia los aspectos cuantitativos de la ciencia como disciplina o actividad económica, incluyendo aquellos aspectos relacionados con las publicaciones [5]. De este modo, los estudios cienciométricos persiguen comparar políticas de investigación de países y organizaciones desde una perspectiva económica y social. Los temas de estudio de la Cienciometría incluyen, entre otros [5]: crecimiento cuantitativo de la ciencia, la relación entre ciencia y tecnología, la productividad y creatividad de los investigadores, las relaciones entre el desarrollo científico y el crecimiento económico, etc.

La Bibliometría podría considerarse una parte de la Cienciometría que aplica métodos matemáticos y estadísticos a la producción científica o publicaciones registradas, en cuanto a sus procesos de producción, difusión y uso, con el objetivo de estudiar y analizar la actividad científica [121]. Otros autores ligan el concepto de Bibliometría al de los sistemas bibliotecarios, y consideran que el objeto de la Bibliometría es usar métodos cuantitativos para el análisis de las regularidades que ofrece el documento, los procesos y las actividades bibliotecarias, lo que contribuye a la organización y dirección de las bibliotecas [82, 96]. Sus campos de aplicación más frecuentes son entre otros [5]: selección de libros y publicaciones periódicas, identificación de las características temáticas de la literatura y su evolución, evaluación de bibliografías y de colecciones, determinación de revistas núcleos en determinada temática, identificación de los países, instituciones y autores más productivos en un período determinado, etc.

Ambas disciplinas, Cienciometría y Bibliometría, se engloban en una disciplina más amplia y global llamada *Informetría* [16, 114]. Egghe define la Informetría como la disciplina *"que representa todas los estudios métricos relacionados con la Ciencia de la Información"* [37]. La Informetría incluye *"todos aquellos estudios de los aspectos cuantitativos de la información en cualquier forma, no solamente aquella almacenada en registros bibliograficos, y en cualquier grupo social, no solamente el de los científicos"* [114]. Sus campos de aplicación más frecuentes son entre otros [5, 114]: Las características de productividad de los autores, grupos de investigación, instituciones y países; características de colaboración de los autores; características de las revistas y su clasificación en disciplinas; los análisis de citas por autores, tipo de documento, instituciones y países; estudios de obsolescencia de la literatura mediante medición de uso y frecuencia de citación; distribución idiomática según la disciplina científica; los procesos de recuperación de información; los aspectos estadísticos del lenguaje y la frecuencia del uso de las palabras y frases; etc.

Por tanto, las tres disciplinas Bibliometría, Cienciometría e Informetría presentan un denominador común, y es el uso de instrumentos estadísticos cuantitativos para realizar estudios desde documentos, pero objetivos diferentes aunque complementarios. Mientras la Bibliometría lo hace en el ámbito de las bibliotecas centrándose en el análisis de las publicaciones y las bibliografías, la Cienciometría lo hace en el ámbito de la Ciencia centrándose en los análisis de impacto de tipo social y económico, y la Informetría lo hace en el ámbito de la *Ciencia de la Información*, centrándose en el fenómeno de la información. Con *Internet* y el nacimiento de la *Web* y los documentos electrónicos, ha aparecido otra disciplina bibliométrica relacionada, llamada *Webometría*

[1]. La Webometría se define como la Informetría aplicada en la *Word Wide Web* y su objetivo es el análisis del fenómeno de la información en la Web mediante técnicas estadísticas cuantitativas. Las cuatro disciplinas presentan objetos y cuerpos diferentes de estudio, y prueba de ello son los tres journals que identifican claramente el campo de estudio de las más recientes: *Scientometrics*[5], *Journal of Informetric*[6] y *Cybermetrics*[7]. Sin embargo, comparten el instrumento, es decir, el uso de medidas de información cuantitativas aplicadas sobre un mismo objeto, el documento, y por ello, recientemente se ha propuesto englobar las cuatro disciplinas en una disciplina superior, llamada *I-Metrics (Métricas de Información)* [77].

Para analizar y evaluar la actividad científica, la Bibliometría se ayuda de *leyes bibliométricas* bien establecidas, basadas en el comportamiento estadístico regular que a lo largo del tiempo han mostrado los diferentes elementos que forman parte de la Ciencia, y de los *indicadores bibliométricos*, que son medidas que proporcionan información sobre la producción científica. Algunas leyes bibliométricas que han sentado las bases de la Bibliometría como disciplina son: i) *Ley de Lotka del año 1926 sobre la productividad de los autores* (pocos autores publican la mayor parte de la bibliografía relevante sobre un tema de investigación); ii) *Ley de Bradford del año 1934 sobre la dispersión de la bibliografía* (pocas revistas concentran la bibliografía relevante de una disciplina); iii) *Ley de Price del año 1956 sobre el crecimiento exponencial de la producción científica* (la producción científica de la Ciencia crece de forma exponiencial).

Por otro lado, para el análisis bibliométrico basado en indicadores bibliométricos se necesita manejar y disponer de una cuantiosa información bibliográfica gestionada mediante sistemas informáticos. Los análisis bibliométricos actuales son realizables gracias a la existencia de importantes bases de datos bibliográfica que almacenan toda la información bibliográfica relativa a las publicaciones científicas (autor, título de la contribución, de la revista, palabras clave, institución, fecha de la publicación, editorial,...), y también las citas (*"índice de citas"*) recibidas por dichas publicaciones. Muchas de estas bases de datos contienen también enlaces a los formatos electrónicos de las publicaciones en las revistas.

En las próximas dos subsecciones, presentaremos las principales bases de datos bibliográficas existentes y los principales indicadores bibliométricos que pueden construirse a partir de ellas.

1.1.1. Bases de Datos Bibliográficas

Las tres principales bases de datos bibliográficas que se usan para desarrollar estudios bibliométricos son, como ya hemos mencionado: Web of Science (WoS), Scopus y Google Scholar.

1. **Web of Science:** WoS es la base de datos bibliográfica de referencia internacional más importante para analizar la Ciencia que existe. Los índices de citas que la componen fueron diseñados en *El Instituto para la Información Científica (Institute for Scientific Information (ISI))* por Eugene Garfield en 1960. WoS ofrece servicios de bibliografía e índices de citas para realizar análisis de citación de las tres ramas del conocimiento (ciencias, ciencias sociales, y arte y humanidades): *Science Citation Index (SCI), Social Science Citation Index (SSCI) y Art& Humanities Citation Index (AHCI).* WoS también da acceso a dos bases de datos químicas: *Current Chemical Reactions (CCR)* y *Index Chemicus (IC)* ; y también a dos bases de datos de conferencias: *Conference Proceedings Citation Index in Science (CPCI-S)* y *Conference Proceedings Citation Index in Social Science & Humanities (CPCI-SSH).* De este

[5]http://link.springer.com/journal/11192
[6]http://www.journals.elsevier.com/journal-of-informetrics/
[7]http://cybermetrics.cindoc.csic.es/

modo, WoS indexa el contenido de casi 10.000 revistas de Ciencias Naturales, Tecnología, Ciencias Sociales, Ciencias de la Salud, Artes y Humanidades, y más de 100.000 actas de conferencias y congresos. Se actualiza semanalmente y mantiene el mayor registro histórico de información bibliográfica sobre la producción científica en revistas. A partir de WoS, Thomson Reuters ofrece acceso a varias bases de datos de información bibliométrica. Entre ellas, las más importantes son *Journal Citation Reports (JCR)*[8], *Essential Science Indicators*[9], y *Highly Cited Research*[10]:

a) **Journal Citation Report:** El JCR nos da un ranking anual de revistas científicas por categoría en base al famoso *Factor de Impacto* definido por Eugene Garfield [44], que es uno de los indicadores bibliométricos basado en citación más popular diseñado para valorar la calidad de las revistas y que estudiaremos en la próxima sección. El JCR constituye un estándar de calidad de revistas científicas en la Ciencia y un referente para todos los investigadores. El JCR tiene dos bloques de índices de revistas, uno para las llamadas Ciencias (que incluye Ciencias Naturales, Matemáticas, Tecnologías, Ingeniería, Ciencias de la Salud, Física, Química, Informática,...) llamado *JCR Science Edition*, y otro para las Ciencias Sociales (Sociología, Antropología, Trabajo Social, Políticas, Derecho, Filología,..) llamado *JCR Social Science Edition*. No existe un JCR para la rama de Arte y Humanidades.

b) **Essential Science Indicators:** Por otro lado, Essential Science Indicators nos da información sobre los protagonistas principales de la Ciencia como los científicos más citados, las instituciones más citadas, las revistas más citadas, y las publicaciones altamente citadas (los llamados *"Highly Cited Papers"*). También nos da información sobre las últimas tendencias temáticas en investigación, los conocidos frentes de investigación (*"Research Fronts"*). Toda esta información es elaborada sólamente considerando publicaciones en revistas indexadas en el JCR y citas desde revistas del JCR.

c) **Highly Cited Research:** Esta base de datos nos da información sobre los investigadores altamente citados (*Highly Cited Researchers*), es decir, aquellos investigadores más influyentes y que más contribuyen al avance de la Ciencia y la Tecnología. Lo que se hace es identificar los autores altamente citados para las 21 categorías científicas indexadas en el WoS a partir de indicadores de citación. Hasta el año 2012 se identificaban estos autores altamente citadas por las citas acumuladas a lo largo de su vida. A partir del 2013, se identifican a partir del número de publicaciones altamente citados que tienen según la base de datos del Essential Science Indicators. Esta es una base de datos de especial interés porque la lista de autores altamente citados que proporciona se usa para la construcción del famoso ranking de universidades que confecciona anualmente el Shangai Center, *The Academic Ranking of World Universities (ARWU)* o *Ranking de Shangai*[11].

2. **Scopus:** Ésta una base de datos de resúmenes y citaciones de artículos académicos procedentes tanto de revistas como de conferencias, desarrollada por la editorial Elsevier. Contiene sobre unos 18.000 títulos de más de 5.000 editoriales que se actualiza diariamente, por lo que ofrece a los investigadores un recurso rápido, fácil y exhausto para abastecer las necesidades de áreas científicas, técnicas, de Ciencias de la Salud, de Ciencias Sociales, y de Arte y Humanidades. A partir de Scopus el grupo de investigación de la Universidad de Granada y del

[8] http://admin-apps.webofknowledge.com/JCR/JCR
[9] http://esi.webofknowledge.com/home.cgi
[10] http://www.highlycited.com/
[11] http://www.shanghairanking.com/

Consejo Superior de Investigaciones Científicas, *SCImago*, ha desarrollado una herramienta que nos ofrece acceso a una base de datos con un ranking de revistas y de países que nos permite analizar dominios científicos, *SCImago Journal & Country Rank*[12]. El *SCImago Journal Rank (SJR)* es una herramienta que nos proporciona un ranking de revistas por categorías al estilo del JCR de Thomson Reuters pero donde el factor de impacto de una revista está calculado usando la idea del algoritmo de relevancia que usa el buscador *Google*[13], el famoso *PageRank* [15]. Comparando Scopus con WoS, observamos que indexa un mayor número de revistas aunque solamente recoge las citas a partir de 1996, frente a WoS que lo hace desde 1900 [70]. Además Scopus recoge un mayor número de citas provenientes de fuentes no norteamericanas que no usan el inglés como medio de expresión, o sea de Europa y Asia, mientras WoS favorece a las fuentes basadas en lengua inglesa [70]. Ambas cubren todas las ramas de la Ciencia, y aunque no lo hacen de la misma forma, se complementan y son usadas y aceptadas por la comunidad científica como base fiable para realizar estudios bibliométricos, porque imponen controles de calidad a las fuentes que indexan.

3. **Google Scholar** o **Google Académico**: Esta base de datos es realmente un motor de búsqueda desarrollado por Google a finales del 2004 para indexar el texto completo de la literatura académica accesible desde Internet. A diferencia de WoS o Scopus, su fuente de información es directamente la Web y no las editoriales de revistas. Debido a ello presenta una importante dosis de errores y su fiabilidad está puesta en duda por la comunidad científica [122]. Proporciona una forma sencilla de buscar bibliografía especializada de muchas disciplinas pero siempre de publicaciones online que estén en la red: artículos, tesis, libros, resúmenes, etc., de editoriales académicas, sociedades profesionales, depósitos en línea, universidades, grupos de investigación, etc. Pero, también indexa otros tipos de documentos electrónicos que están muy lejos de ser considerados buenas fuentes de información científica, como guías académicas, documentos administrativos, bibliografía de asignaturas, libros de divulgación...[122]. Esto es importante ya que no es lo mismo ser citado en un documento científico que en otro tipo de documento. A partir *Google Scholar* Google ha creado dos nuevos productos *Google Scholar Citations(GSC)*[14] y *Google Scholar Metrics (GSM)*[15]. El primero recopila la producción científica de un investigador y la ofrece agregada en una añadiendo información sobre el número de citas de cada referencia y algunos indicadores bibliométricos basados en citación [18]. En cambio, GSM ofrece el impacto de las revistas científicas a partir de los recuentos de citas [17].

Es necesario comentar que WoS, Scopus y Google Scholar no contienen indexadas las mismas revistas, por lo que su cobertura de los distintos campos científicos puede variar considerablemente. A consecuencia de esto, se han realizado diferentes estudios para comprobar y detectar la magnitud de este hecho [7, 40, 70, 76].

1.1.2. Indicadores Bibliométricos

Por otro lado, los indicadores bibliométricos son unas medidas para evaluar numéricamente, de un modo objetivo, las actividades que se desarrollan en el ámbito de la Ciencia y la Tecnología, y en especial, en la I+D+i, valiéndose del conocimiento científico publicado [22, 33, 121]. Estos indicadores permiten expresar de forma cuantitativa las características bibliográficas de las

[12] http://www.scimagojr.com/
[13] http://www.google.es
[14] http://scholar.google.es/citations
[15] http://scholar.google.com/citations?view_op=top_venues

publicaciones científicas, vinculadas tanto a la producción como al consumo de información. Los indicadores bibliométricos pueden representar una sola cualidad, por ejemplo las citas recibidas, o combinar varias, por ejemplo las citas y el número de publicaciones. Su uso nos permite analizar los outputs de la actividad investigadora, hacer procesos de benchmarking entre diferentes entidades (investigadores, universidades, países, etc), justificar la toma de decisiones en instancias superiores, y planificar procesos de mejora en la actividad científica.

Los indicadores bibliométricos pueden englobarse en dos grandes categorías [121]: *Indicadores de Rendimiento y Actividad* e *Indicadores Relacionales*. Los primeros son los que tradicionalmente han constituido la base de las técnicas de la Bibliometría. Estos indicadores caracterizan el principal output de la investigación científica que son las publicaciones científicas, bien para caracterizar el volumen de la producción científica, el grado de colaboración detectado en las publicaciones, o bien para calcular su impacto [121]. Por otro lado, los segundos son un conjunto de técnicas de mapeo que generan representaciones gráficas de la Ciencia a través del uso de información de carácter relacional. Estos indicadores permiten mostrar características estructurales de un campo científico y pueden ser usados junto con los indicadores de actividad para la toma de decisiones [87, 88]. Este tipo de indicadores forman el segundo procedimiento fundamental de la Bibliometría, los *mapas científicos* [33].

En los siguientes epígrafes analizamos en detalle algunos de los indicadores más relevantes que podemos encontrar en cada tipología de indicadores bibliométricos.

1. **Indicadores Bibliométricos de Rendimiento y Actividad**: Dentro de los indicadores bibliométricos de rendimiento y actividad encontramos tres grandes bloques: *Indicadores de Producción*, *Indicadores de Visibilidad e Impacto*, e *Indicadores de Colaboración*.

   a) **Indicadores de Producción**: Tienen como objetivo el recuento de las publicaciones de los distintos agentes envueltos en la investigación, considerándose como publicaciones los documentos propagados a través de canales formales y públicos. Este tipo de indicadores sirven para medir la cantidad de los resultados, ignorándose diversos aspectos como la calidad y el contenido. Dado que las revistas científicas son las que mas garantías nos dan sobre la calidad de lo publicado, normalmente son las publicaciones en revistas lo que suele usarse para construir estos indicadores. Entre los indicadores de producción podemos encontrar: *Número de publicaciones, índice de especialización temática, porcentaje de trabajos indizados en algún repositorio o base de datos bibliográfica, distribución por idioma y tipos documentales idiomas de publicación y nivel básico/aplicado* [33, 121].

   b) **Indicadores de Visibilidad e Impacto**: Estos indicadores están basados fundamentalmente en contar las citas recibidas por las publicaciones. En un sentido más académico, las citas son entendidas como la base científica que sustenta el conocimiento nuevo que se presenta en una publicación [67] y se usan como un medida de la calidad de los trabajos citados. Sin embargo, no siempre las citas se usan de esta forma. A veces, se usan para criticar o refutar resultados no precisamente por su calidad, y por tanto, no siempre son un reflejo de la calidad científica [79]. Por ello, es más comprensible relacionar las citas con los conceptos de *utilidad* o *influencia* o *impacto* de una publicación [36, 100, 121]. Dependiendo del contexto, podemos encontrar indicadores de impacto bien para evaluar la influencia de los investigadores, bien de las revistas, o bien de las propias publicaciones. Los indicadores bibliométricos de visibilidad e impacto son los indicadores más populares de la Bibliometría porque son muy usados en los procesos de promoción de los investigadores como un medio de medir su productividad científica. Algunos de estos indicadores de visibilidad e impacto más importantes son:

- *Número de Citas*: Este índice consiste en contar el número de citas que recibe un trabajo publicado, la producción científica de un autor, o las publicaciones de una revista. Es el indicador de visibilidad e impacto más simple que existe, y permite darnos una idea de lo valioso, científicamente hablando, que es un trabajo o un investigador o una revista.
- *Factor de Impacto (FI)*: Este índice fue propuesto inicialmente por Eugene Garfield para evaluar la calidad de las revistas a partir de las citas recibidas por sus publicaciones [44]. Se define como la razón entre las citas recibidas y los artículos publicados en una revista dándonos una medida de la frecuencia media con la que los artículos de una determinada revista han sido citados en un periodo concreto. Como hemos comentado previamente, es quizás el indicador bibliométrico más famoso y pieza clave de la famosa base de datos de revistas, propiedad de Thomson Reuters, conocida como Journal Citation Reports (JCR). El JCR define el FI de una revista como el cociente de dividir las citas obtenidas en un año por una publicación en los artículos publicados los dos años anteriores entre el total de artículos publicados durante dicho año. Con el FI podemos ordenar las revistas de un área científica de mayor a menor FI y, de ese modo, clasificarlas en categorías de calidad, como cuartiles (Q1, Q2, Q3, Q4) o terciles (T1, T2, T3). Esto podría permitirnos valorar más en detalle las carreras científicas de los investigadores en función de las categorías donde publican. El FI caracteriza a las revistas, y no se debe de cometer el error de asignarlo a los trabajos que se publican en ellas, pues muchas veces, encontramos que muchos de los trabajos publicados en revistas de alto impacto no reciben apenas citas [101].
- *Índice de Hirsch o Índice H o H-Index*: El h-index, definido por el físico Hirsch [55], se ha convertido en uno de los índices bibliométricos más populares y relevantes en los últimos tiempos. El h-index fue inicialmente propuesto para calificar la calidad científica de un investigador y, posteriormente, ha sido usado para valorar otros elementos de interés bibliométrico como las revistas, los grupos de investigación, los países [2]. El h-index combina los méritos de producción científica y de citación de un científico en un valor numérico como sigue: Un científico tiene un h-index de valor h, si sus h publicaciones primeras por citaciones reciben al menos h citas cada una, y el resto tienen h o menos citas. Por ejemplo, si tenemos un autor A que ha publicado 10 trabajos con la siguiente distribución de citas (0,1,7,6,15,10,2,4,2,1), su h-index sería 4. En [2, 39] se muestra un análisis de sus ventajas e inconvenientes, y muchos de los diferentes indicadores bibliométricos de impacto que se han definido basados en él, como el *g-index* [38], el *hg-index* [3], o el q^2*-index* [19].
- *Trabajos Altamente Citados*: Los trabajos altamente citados o los *Highly Cited Papers* son un indicador para determinar la excelencia científica. Los trabajos altamente citados atraen un gran número de citas en un área científica y nos permiten identificar a aquellos agentes que están produciendo artículos muy significativos desde el punto de vista del impacto [121]. Como hemos mencionado, en la base de datos de Thomson Reuters, Essential Science Indicators, pueden encontrarse para cada área científica, y actualmente están siendo usados para identificar a los autores altamente citados en la base de datos Highly Cited Research, también propiedad de Thomson Reuters. Este indicador está siendo usado para la toma de decisiones en las políticas de promoción y en los procesos de concesión de proyectos científicos de la Unión Europea [121].

c) *Indicadores de Colaboración*: Miden las relaciones existentes entre los investigadores a

través de las publicaciones que han realizado conjuntamente. Sirven para cuantificar la colaboración existente en la producción científica. Uno de los indicadores más importantes de colaboración es el *índice de coautoría* [13], que muestra el número medio de autores por artículo, por ejemplo, de una revista. El análisis de la colaboración se puede también extender a las instituciones, por ejemplo tenemos, el *índice de coautoría institucional* [13].

Un análisis detallado de los diferentes tipos de indicadores puede consultarse en [121].

2. **Indicadores Bibliométricos Relacionales**: Existe otro tipo de indicadores denominados *indicadores relacionales* [87, 88], los cuales son un conjunto de técnicas de mapeo de Ciencia que generan representaciones gráficas de la Ciencia a través del uso de información de carácter relacional. Este tipo de indicadores constituyen el segundo procedimiento fundamental de la Bibliometría, *los mapas científicos*. En la siguiente subsección detallaremos los aspectos fundamentales del análisis bibliométrico basados en mapas científicos y de la herramienta SciMAT que usamos en esta memoria para realizar los estudios bibliométricos de contenido del área de Trabajo Social.

1.2. Análisis Bibliométricos Basados en Mapas Científicos: SciMAT

Los *mapas científicos*, también conocidos como *mapas bibliométricos* o *cienciogramas*, son una representación espacial de cómo las disciplinas, campos, especialidades científicas, y documentos individuales o autores se relacionan entre sí [107]. Dichos mapas se centran en monitorizar un campo científico, delimitando las subáreas de investigación, para de este modo, comprender su estructura intelectual, social, conceptual y cognitiva, así como analizar su evolución estructural [14, 83, 87, 88]. Al proceso de creación, y análisis de un mapa científico se lo conoce como *Análisis de Mapas Científicos* (*Science Mapping Analyisis*, en la literatura anglosajona) [33].

En la literatura se han diseñado diferentes técnicas para crear mapas científicos a partir de un conjunto de documentos, estableciendo diferentes tipos de relaciones entre ellos. En este sentido, se puede analizar un campo científico de forma intelectual, social o conceptual [33]. Las primeras técnicas que surgieron para realizar mapas científicos, analizaban los aspectos intelectuales de la Ciencia. Para ello, establecían las relaciones basándose en las referencias de los documentos científicos, es decir, en su base intelectual. De este modo, Kessler propuso el emparejamiento bibliográfico en 1963 [66] basándose en los documentos que citaban a las mismas referencias. De forma similar, Small propuso en 1973 el análisis de co-citación [106], en el que analizaban las referencias que solían citarse conjuntamente. Aunque Kessler fue el primero en proponer un tipo de mapa científico, fue sin embargo, el análisis de co-citación de Small el que obtuvo mayor acogida. La co-citación se ha utilizado para delimitar un área científica [108], descubrir comunidades de conocimiento [65] y nuevos frentes de investigación[123].

Diez años más tarde, Callon propuso analizar el contenido de los documentos mediante las relaciones de co-aparición de los términos contenidos en ellos. De este modo, surgió el análisis de co-palabras [20] como una técnica de análisis efectiva para crear mapas de la literatura científica y así mostrar sus aspectos conceptuales o cognitivos. Este tipo de mapa científico es el que nosotros usamos en esta memoria.

Otro tipo mapa científico es aquel que analiza los aspectos sociales de un área de investigación. En este sentido, el análisis de co-autores [43] nos permite analizar la estructura social y las colaboraciones a nivel de investigadores, instituciones o países de un campo científico.

Finalmente, los mapas científicos pueden emplearse para diferentes propósitos, como por ejemplo:

- Analizar la evolución estructural del campo científico a través de diversos periodos de tiempo.
- Medir y cuantificar los resultados utilizando medidas de actividad y calidad basadas en indicadores bibliométricos [65, 87, 108, 125].

El flujo general de trabajo de un análisis de mapas científicos está compuesta por una serie consecutiva de pasos [14, 30]: i) *recopilación de la información a analizar*, ii) *preprocesamiento*, iii) *extracción de redes bibliométricas*, iv) *normalización*, v) *generación de mapas*, vi) *análisis*, y vii) *visualización*. Al final del proceso, hay que interpretar y obtener conclusiones de los resultados obtenidos. Es en esta última etapa donde el conocimiento es generado y en base a él se pueden tomar decisiones correctamente.

Actualmente, existe una gran multitud de bases de datos o fuentes bibliográficas, que dan acceso a una gran cantidad de información científica, como las ya mencionadas: WoS, Scopus y Google Scholar. Normalmente, parte de la información contenida en ellas será el punto de comienzo del análisis bibliométrico basado en mapas científicos. Es decir, la información es usualmente recopilada a través de las bases de datos bibliográficas. Además, el análisis de mapas científicos pueden ser realizado utilizando patentes o datos de financiación (proyectos de investigación, ayudas en I+D+i, etc.). Los datos de patentes pueden ser recopilados a través de las numerosas bases de datos de patentes que existen para tal efecto. Por ejemplo, se puede utilizar la Oficina de Patentes y Marcas Española[16], la Oficina de Patentes Europea [17], o la Oficina de Patentes y Marcas Estadounidense[18]. Por otro lado, los datos de financiación pueden descargarse, por ejemplo, a través de la *Fundación Nacional para las Ciencias* estadounidense[19].

Los datos recopilados a través de las fuentes bibliográficas, normalmente, contienen errores. Por este motivo, no se puede extraer mapas científicos directamente sobre los datos recopilados, sino que es necesario un proceso de limpieza, o dicho de otro modo, es necesario aplicar un preprocesamiento sobre los datos. De hecho, es sin duda uno de los pasos más importantes y necesarios para asegurar una buena calidad de los resultados obtenidos. Principalmente, existen cuatro tipos de preprocesamiento: detección de elementos duplicados y/o errores ortográficos, reducción de datos a nivel de elementos, reducción a nivel de redes y por último, división de la información en periodos de tiempo. Probablemente, el preprocesamiento más importante es la detección de duplicados debido a que pueden existir elementos que representen a la misma entidad, pero que léxicamente sean diferentes. Por ejemplo, el nombre de un autor puede haber sido escrito de distintas formas (p.e. Garfield, E.; Eugene Garfield) refiriéndose todas ellas a la misma persona.

El siguiente paso, una vez que los datos han sido preprocesados, es crear una red bibliométrica a partir de una de las unidades de análisis, siendo las unidades de análisis más comunes los autores, las instituciones, las universidades, los países y los términos descriptivos o palabras clave [14] de los documentos. Como términos descriptivos pueden seleccionarse las palabras clave que los autores dispusieron en el documento o aquellas provenientes de las fuentes de información bibliográfica. Además, si fuera necesario, se podría añadir términos descriptivos a los documentos mediante un proceso de minería de textos que extrajera los términos de los títulos, resúmenes, texto completo de los documentos o de alguna combinación de estos. Esto último sucede con muchos de los documentos recuperados para años muy remotos, porque es fácil encontrar muchos documentos sin

[16] http://www.oepm.es
[17] http://www.epo.org
[18] http://www.uspto.gov
[19] http://www.nsf.gov

palabras clave. Entre las unidades de análisis puede crearse diferentes tipos de relaciones, siendo la más común la relación de co-ocurrencia. Esto es, dos unidades de análisis (por ejemplo, dos autores) estarán relacionadas si aparecen conjuntamente en la información (documentos) que estamos analizando. Existen otros tipos de relaciones como el enlace directo, en el que una unidad está relacionada con otra debido a que la primera enlaza a la segunda. Por ejemplo, si el documento A cita al documento B, existirá un enlace directo desde A a B. Las relaciones entre las unidades pueden entenderse como un grafo o una red, donde las unidades son los nodos y las relaciones entre ellas son representadas mediante enlaces entre los nodos. La elección de una unidad de análisis en lugar de otra condicionará el aspecto que el mapa científico dará a conocer. Es decir, dependiendo de la unidad de análisis elegida podremos estudiar diferentes aspectos. Usando los autores, se puede realizar un análisis de co-autores o de co-autorías para analizar la estructura social de un campo científico [43, 90]. Asímismo, utilizando las afiliaciones, podemos analizar la dimensión internacional de un campo científico; por ejemplo realizando un análisis de co-instituciones, de co-universidades o de co-países. Utilizando los términos descriptivos, se puede realizar un análisis de co-palabras [20] o palabras asociadas para descubrir la estructura conceptual y los principales conceptos estudiados en el campo científico analizado.

Una vez que la red bibliométrica ha sido creada, el siguiente paso es aplicar un proceso de normalización de los valores de co-ocurrencia sobre dicha red [124] que nos permite identificar las parejas de palabras que representan de forma más adecuada al corpus de conocimiento científico analizado, y todo ello aplicando medidas de similitudes entre nodos o palabras clave. Con el proceso de normalización se le dará mayor valor a una palabra clave con una frecuencia baja pero que suela co-aparecer siempre con la misma palabra clave. Por el contrario, una palabra clave con una alta frecuencia y que co-aparezca con un gran número de palabras clave tendrá un peso menor. En este sentido, en la literatura se utilizan diferentes medidas de similaridad, siendo las más populares: *medida angular del coseno* [99], *índice de Jaccard* [91], y *índice de equivalencia* [21].

El proceso de mapeado o de creación del mapa científico, es sin duda el más importante ya que permite abstraer y simplificar la información contenida en la red bibliométrica general para de este modo crear el mapa científico. Para construir un mapa científico podemos aplicar diversos algoritmos sobre la red bibliométrica global formada mediante las relaciones entre las unidades de análisis. Sin embargo, la creación del mapa científico se suele realizar fundamentalmente mediante *técnicas de reducción de la dimensionalidad* y aplicando *algoritmos de clustering o clasificación* [14]. Las técnicas de reducción de la dimensionalidad son utilizadas para transformar las redes bibliométricas en espacios de baja dimensión, normalmente, espacios de dos dimensiones, de modo que sean más fácilmente entendibles y por tanto se más fácil su comprensión y análisis. Entre estás técnicas destacan *el análisis de la componente principal* [117] y *el escalado multidimensional* [69]. Las técnicas de clustering dividen un conjunto de elementos en diversos subconjuntos, los cuales deben cumplir la condición de tener una gran cohesión interna. Es decir, los elementos dentro de un mismo grupo deben tener una gran similitud entre sí, mientras que, por otro lado, deben ser bastante diferentes del resto de elementos que no están en el grupo. Los algoritmos de clustering aplicados a redes bibliométricas intentan descubrir las subredes que forman la red bibliométrica global, es decir, aquellos conjuntos de nodos que están fuertemente enlazados entre sí, pero pobremente enlazados con el resto de la red. Dentro de los algoritmos de clustering, existen algunos clásicos que se han aplicado más para la creación de mapas científicos, como el algoritmo de los *"Centros Simples"* [35] o el algoritmo de *"Enlace simple"* [109]. Lógicamente, la información obtenida y el tipo de mapa variará considerablemente dependiendo del tipo de técnica empleada para generar el mapa científico.

El mapa científico creado puede ser analizado utilizando diferentes técnicas, dando cada una de ellas una información diferente y complementaria que ayudará en la obtención del conocimiento.

De entre ellas destacamos las siguientes:

- *El análisis de redes [24, 34, 104].* Esta técnica nos permite realizar diferentes análisis estadísticos sobre los mapas generados, o incluso sobre la red bibliométrica global. Por ejemplo, se pueden establecer diversas medidas de red, como el número total de nodos, el numero de nodos aislados, el grado medio de la red, el número de componentes débilmente conectados, la densidad de la red, etc. Por otro lado, si se aplicó un algoritmo de clustering para construir el mapa, se puede medir la *densidad* y *centralidad* de los diversos clusters [21], o incluso establecer otras medidas a partir de las relaciones entre clusters.

- *El análisis longitudinal o temporal [48, 94].* Esta técnica trata de mostrar la evolución conceptual, social o intelectual de un campo científico, descubriendo patrones, tendencias y comportamiento estacionales o atípicos.

En cuanto a los análisis que podemos desarrollar, hemos de comentar que tanto a la red bibliométrica global, como al mapa científico generado puede aplicarse un análisis basado en medidas de rendimiento, utilizando indicadores bibliométricos de producción, actividad, calidad e impacto [33], como los mencionados anteriormente. Por ejemplo el índice h o el índice g. Como sabemos, las redes bibliométricas están formadas por unidades de análisis; estas a su vez proceden de unos documentos determinados, es decir, pueden asociarse con un conjunto de documentos. De esto modo, los nodos de una red pueden enriquecerse contabilizando el número de documentos asociados a ellos. Además, si el mapa generado está basado en clusters, a cada uno de ellos se les puede asignar un conjunto de documentos (por ejemplo, aquellos que estén asociados con al menos un nodo de la red). Asimismo, es posible utilizar medidas de calidad basadas en el número de citas recibidas por los documentos, para de este modo determinar el impacto de los diferentes elementos del mapa y así detectar aquellos con una mayor visibilidad.

La salida generada por cada tipo de análisis es diferente, por lo que necesitaremos emplear diversas técnicas de visualización para mostrar los resultados obtenidos a través de los mapas científicos. La técnica de visualización empleada es fundamental ya que, nos permitirá comprender e interpretar de forma adecuada los resultados. Las redes bibliométricas, así como las posibles subredes detectadas en el proceso de creación del mapa científico pueden representarse utilizando *mapas heliocéntricos* [84] o *redes temáticas* [6]. Si el mapa científico se construyó aplicando un algoritmo de clustering, las subredes detectadas pueden categorizarse en un diagrama estratégico, el cual es un diagrama cartesiano en donde las subredes detectadas se posicionan de acuerdo a diversas medidas de redes, como pueden ser la densidad y centralidad [21].

La evolución estructural de los mapas científicos a lo largo de periodos de tiempo (análisis temporal), puede visualizarse utilizando diversas técnicas, de entre las que destacamos las *áreas temáticas* [33]. Por otro lado, otros autores proponen posicionar la red de un periodo de tiempo teniendo en cuenta las redes de los periodos anteriores y posteriores [73], o incluso, resumiendo todos los cambios estructurales de los diversos periodos de tiempo en una única red [26, 27].

Una vez que el análisis de mapas científicos ha terminado, el analista tiene que interpretar los mapas y resultados obtenidos usando su propia experiencia y conocimiento, y a veces apoyándose en otros expertos, para así poder obtener conclusiones adecuadas sobre el campo científico analizado. En la interpretación, el analista trata de descubrir, así como de extraer conocimiento útil y previamente desconocido que le ayude a tomar decisiones sobre, por ejemplo, que políticas científicas implementar, dónde invertir mayores recursos, cuáles son los frentes de investigación, cuáles son los temas calientes, etc.

Existe una gran cantidad de herramientas informáticas con las que se puede realizar análisis de

mapas científicos. Algunas de ellas son genéricas, es decir, no fueron diseñadas específicamente para esa tarea. Entre ellas, podemos encontrar herramientas del ámbito de la Bibliometría, como *Publish or Perish* [54] o del campo de las Redes Sociales, como *Pajek* [8]. Además, podemos encontrar herramientas que han sido específicamente diseñadas para realizar análisis de mapas científicos. En [30] se presentó un estudio comparativo de las más importantes: *Bibexcel, CiteSpace II, CoPalRed, IN-SPIRE, Loet Leydesdorff's Software, Network Workbench Tool, Science of Science (Sci^2) Tool, VantagePoint, y VOSViewer*. Como se mostró en dicho estudio, cada herramienta tiene diferentes características e implementan diferentes técnicas que son llevadas a cabo mediante diversos algoritmos. Muchas de las herramientas contienen potentes herramientas de preprocesamiento, otras permiten la generación de una gran cantidad de redes bibliométricas, y otras en cambio sólo permiten extraer un tipo de red. Además no todos los pasos del análisis de mapas científicos pueden llevarse a cabo en cada una de las herramientas. Consecuentemente, cada herramienta ofrece su vista particular del campo científico analizado. El uso combinado de las diferentes herramientas podría permitirnos desarrollar un completo análisis de mapas científicos. Por ello, en [32] se desarrolló una nueva y más completa herramienta de análisis de mapas científicos, llamada SciMAT, que aglutina las principales ventajas de las herramientas comentadas. Más concretamente, SciMAT presenta las siguientes ventajas que la diferencian de las demás[32]:

- SciMAT incorpora todos los módulos necesarios para realizar todos los pasos del flujo de trabajo del análisis de mapas científicos, desde la carga de los datos, hasta la visualización e interpretación de estos. Además, la mayor parte de los pasos son configurables, de modo que permiten seleccionar diversos algoritmos y medidas.

- SciMAT incorpora métodos para extraer un gran número de redes bibliométricas, múltiples medidas para normalizar las redes, diferentes algoritmos de clustering, y diversas técnicas de visualización de gran utilidad para la interpretación de los resultados.

- SciMAT implementa diversas técnicas de preprocesamiento que nos permitirá detectar elementos similares que deben ser unificados, dividir los datos en diferentes periodos de tiempo, filtrar los datos para realizar el análisis con los datos más significativos, y filtrar las redes para quedarnos con las relaciones entre las unidades de análisis más importantes.

- SciMAT permite al analista realizar el análisis de mapas científicos bajo un marco longitudinal, para de este modo poder estudiar y detectar la evolución social, conceptual o intelectual de un campo científico a lo largo de periodos de tiempo consecutivos.

- Por último, SciMAT está basado en la metodología de análisis de mapas científicos presentada en [29], y por ello SciMAT enriquece los mapas con medidas bibliométricas basadas en citas, como: índice h [55], índice g [38], índice hg [3], índice q^2 [19], etc. Por tanto, es una herramienta que permite combinar las dos diferentes técnicas de realizar estudios bibliométricos, las técnicas bibliométricas de análisis de rendimiento y actividad científica y las técnicas bibliométricas de mapas científicos.

- SciMAT es una herramienta gratuita y de código libre (*open source*) para la realización de análisis de mapas científicos. De hecho, puede modificarse y distribuirse de acuerdo a los términos de la licencia GPLv3[20] y se encuentra disponible en Internet, a través de su portal web[21], el cual nos permitirá descargarnos el archivo ejecutable, o ejecutar la aplicación directamente desde Internet, así como acceder a su manual de usuario.

[20] http://www.gnu.org/licenses/gpl-3.0.html
[21] http://sci2s.ugr.es/scimat

En resumen, SciMAT integra todo lo necesario para realizar un análisis de mapas científicos completo, en un marco longitudinal y utilizando medidas bibliométricas de impacto. Además, la herramienta permite analizar la evolución social, intelectual y conceptual de un campo científico. Ya ha sido usada satisfactoriamente para realizar análisis de mapas científicos en diversas áreas de investigación como Sistemas de Transporte Inteligente [31, 28], Lógica Difusa [32], Medicina Complementaria [81].

En esta memoria SciMAT es usada para realizar los análisis de mapas científicos del Área de Trabajo Social usando como fuente de información las publicaciones en revistas del Área de Trabajo Social indexadas en la base de datos WoS de acuerdo al JCR. Construimos los mapas científicos a partir del análisis de co-ocurrencias de las palabras clave que caracterizan cada publicación y desde una perspectiva longitudinal y temporal. Dichos mapas nos permiten monitorizar el campo científico de Trabajo Social, delimitando sus áreas de investigación, para de este modo, mostrar su estructura intelectual, social, conceptual y cognitiva, así como analizar su evolución estructural. En particular, a partir del análisis de co-ocurrencias de palabras mostremos tres importantes resultados:

1. *Redes temáticas de palabras* que representan los temas de investigación del área en cada periodo de tiempo analizado.

2. *Diagramas estratégicos* para cada periodo de tiempo analizado que nos permitirá identificar los principales temas de investigación en cada momento.

3. *Un mapa de evolución temática* que nos permite mostrar como ha evolucionado la estructura científica del área a lo largo del tiempo e identificar las *áreas temáticas* que han centrado el interés de la comunidad científica a lo largo del tiempo.

Para entender mejor todo el proceso de generación de los mapas científicos vamos a explicar algunos aspectos concretos:

1. Las redes temáticas son obtenidas a partir del análisis de co-ocurrencias de palabras clave. El análisis de co-ocurrencias de palabras se basa en la idea de que la co-ocurrencia de términos puede describir el contenido de los documentos de un corpus [21]. De acuerdo con [68], esta técnica muestra las asociaciones entre términos, a través de la construcción de múltiples redes que resaltan las asociaciones entre dichos términos y entre las redes. Estas redes representan los temas científicos asociadas al campo científico analizado. Cada publicación o documento, en el campo científico bajo estudio, puede caracterizarse por un conjunto de términos clave. Dichos términos pueden interpretarse como la huella dactilar, o el ADN de una publicación [14]. De este modo, la similitud de un par de documentos puede medirse a través de la comparación de las *huellas dactilares* formadas por sus palabras clave. Cuantas más palabras clave tengan dos documentos en común, más similares serán, y por lo tanto, será más probable que pertenezcan a la misma especialidad dentro de un campo de investigación particular. Siguiendo la metáfora del ADN, si las huellas de dos publicaciones son suficientemente similares, provendrán de la misma especie. Por tanto, con la lista de las términos importantes, o palabras clave del campo científico, se puede construir un grafo o una *red bibliométrica de palabras* [33]. En esta red, los nodos representan las palabras clave, y los enlaces entre ellos representan sus relaciones. Dos nodos estarán conectados si ambos aparecen en los mismos documentos. Además, podemos añadir un peso a los enlaces, de modo que represente cómo es de importante la relación en el corpus. Además, esta relación puede cuantificarse, de modo que la relación represente el número de documentos en los que las palabras aparecen conjuntamente. De este modo se construye lo que se denomina matriz de co-ocurrencias de modo que

en cada posición (i,j) le asociamos la similitud entre las palabras clave mediante una función llamada *índice de equivalencia* [21]: $e_{ij} = (c_{ij}^2)/(c_i c_j)$, donde c_{ij} es el número de documentos donde aparecen juntas ambas palabras i y j, y c_i y c_j representan el número de documentos donde cada palabra aparece. Si dos palabras aparecen siempre juntas su índice de equivalencia es 1, mientras es 0 en caso contrario. Luego usando un algoritmo de clustering o clasificación, como el algoritmo de los centros simples [35], podemos agrupar las palabras en temáticas y establecer asociaciones entre palabras clave formando *redes temáticas* [33] (ver Figura 1). Cada red temática o tema se etiqueta usando el nombre de la palabra clave más significativa de la red (normalmente, es la palabra clave más central del tema o cluster). Entonces, como resultado del análisis de co-ocurrencias de palabras, para cada uno de los periodos de tiempo estudiados se obtiene un conjunto de temas.

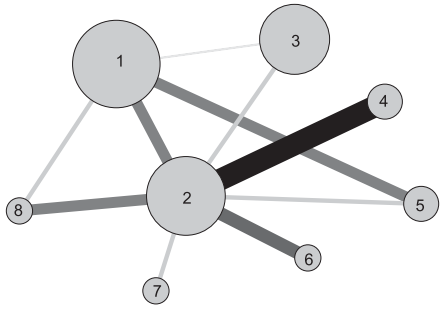

Figura 1: Ejemplo de red temática.

2. Una vez que las redes temáticas (cada una representando un tema de investigación) entre las palabras clave son establecidas, SciMAT nos permite identificar la importancia de cada temática mediante la construcción de los diagramas estratégicos a través de dos medidas de análisis de redes temáticas[21]:

   a) La *centralidad de Callon*, mide el grado de interacción de una red con respecto a otras redes [21]. Puede definirse como: $c = 10 * \sum e_{kh}$, siendo k una palabra clave perteneciente al tema y h una palabra clave perteneciente a otro tema. La centralidad mide el grado de fuerza de los enlaces externos del tema con otros temas. Esta medida se puede interpretar como la importancia de un tema en el desarrollo global de campo científico analizado, o como el grado de cohesión externa del tema.

   b) La *densidad de Callon*, mide la fuerza interna de una red. Puede definirse como: $d = 100\frac{\sum e_{ij}}{w}$, donde i y j son palabras clave pertenecientes al tema y w el número de palabras clave (nodos) que forman el tema. La densidad mide la fuerza interna de todos los enlaces entre las palabras clave que describen al tema, o dicho de otro modo, el grado de cohesión interna del tema. La densidad de un tema de investigación nos proporciona una idea del nivel de desarrollo de dicho tema.

   Entonces, caracterizando cada red temática con ambas medidas un campo científico puede representarse como un conjunto de temas clasificados en cuatro categorías (cuatro cuadrantes) y posicionados sobre un espacio bidimensional llamado diagrama estratégico. De este modo, un diagrama estratégico es un espacio bidimensional construido mediante la colocación de los temas en él de acuerdo a sus valores de centralidad y densidad, a lo largo de dos ejes, la centralidad en el eje X, y la densidad en el eje Y, y donde [21, 29] cada cuadrante representa un tipo de tema distinto (ver Figura 2):

- *Temas motor:* En el cuadrante superior-derecho se encuentran los temas motor del campo científico analizado que representan aquellos temas que están bien desarrollados y que son importantes para la construcción del campo científico, dado que presentan una fuerte centralidad y una alta densidad.
- *Temas periféricos:* En el cuadrante superior-izquierdo se emplazan los temas periféricos del campo científico analizado que se corresponden con aquellos temas bien desarrollados internamente pero que están aislados del resto de los temas y tienen una importancia marginal en el desarrollo del campo científico. Estos temas se caracterizan por ser temas muy especializados y periféricos.
- *Temas emergentes o decadentes:* En el cuadrante inferior-izquierdo se sitúan los temas emergentes o decadentes que se corresponden con temas muy poco desarrollados y marginales. Los temas en este cuadrante tienen una densidad y centralidad baja. Principalmente representan temas emergentes o en desaparición.
- *Temas básicos y transversales:* En el cuadrante inferior-derecho se encuentran los temas básicos que son temas importantes para el campo científico pero no están bien desarrollados. En este cuadrante se encuentran los temas transversales y genéricos, es decir, los temas básicos del campo científico.

Además, el diagrama estratégico de un campo científico puede enriquecerse añadiendo una tercera dimensión a los temas representados en él, de modo que se ofrezca una mayor cantidad de información [29]. De este modo, los temas pueden representarse como una esfera, en donde su volumen sea proporcional a diferentes indicadores bibliométricos como: i) el número de documentos asociados a un tema; o ii) el número de citas recibidas por los documentos asociados a cada tema; o iii) el índice h del tema.

Figura 2: Diagrama estratégico.

3. Para identificar las área temáticas científicas que han vertebrado la investigación de una comunidad académica a lo largo del tiempo, SciMAT nos permite crear el mapa de evolución científica. Si el corpus de documentos se divide en diversos grupo de años consecutivos (por ejemplo, en periodos de tiempo), se puede analizar la evolución del campo científico bajo estudio. Sea T^t el conjunto de los temas detectados en el periodo de tiempo t, donde $U \in T^t$ representa cada uno de los tema detectados en el periodo t. Sea $V \in T^{t+1}$ el conjunto de los temas detectados en el siguiente periodo de tiempo $t+1$. Diremos que hay una evolución temática desde el tema U al tema V si y sólo si las redes temáticas de ambos temas comparten al menos una palabra clave. De este modo, V puede considerarse como un tema que ha evolucionado de U. Las palabras clave $k \in U \cap V$ se considerarán como el "nexo temático"

o el "nexo conceptual" de la evolución. Así, los mapas bibliométricos de evolución pueden construirse enlazando temas del periodo T^t con temas del periodo T^{t+1} a través de los nexos conceptuales. Para enlazar los temas se usa el *índice de inclusión* [124]. Además, el índice de inclusión es igual a 1 en el caso de que las palabras clave del tema V estén completamente contenidas en el tema U. Por lo tanto, un área temática es definida como un grupo de temas que han evolucionado a lo largo de diversos periodos de tiempo consecutivos. Cabe resaltar, que dependiendo de las interconexiones entre los temas, un mismo tema podría pertenecer a dos áreas temáticas diferentes, e incluso, no pertenecer a ningún área. En la Figura 3, se muestra un ejemplo de mapa de evolución con dos áreas temáticas diferentes, delimitadas por sombreados distintos. Como ocurre en el caso de los temas de investigación, las áreas temáticas también pueden enriquecerse con indicadores bibliométricos, como el índice h [33].

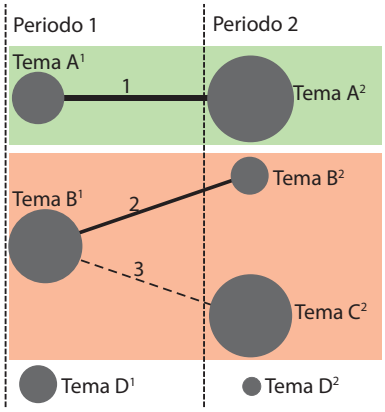

Figura 3: Ejemplo de un mapa de evolución científica con las áreas temáticas detectadas.

1.3. El Área de Trabajo Social y la Investigación: Algunos Estudios Bibliométricos

El Trabajo Social, al igual que ha pasado en otras áreas del conocimiento, como la Documentación o la Comunicación, nace primero como una profesión que trata de cubrir nuevas necesidades que surgen en la sociedad, y posteriormente, con el paso del tiempo, se ha ido consolidando también como una disciplina académica que ha ido conformando un conjunto de saberes y conocimientos, es decir, un cuerpo teórico propio que sustenta la práctica profesional. Por tanto, el Trabajo Social, además de una profesión, representa una disciplina dentro de las Ciencias Sociales [98].

El Trabajo Social tiene sus orígenes en las actividades de asistencia social caritativa, voluntaria, y muchas veces ligadas al Cristianismo, que tienen lugar en la Edad Media (S. XVI) orientadas a ayudar y a asistir a los más débiles y necesitados [80]. A finales del S. XIX, primero en Europa y luego en Estados Unidos, tiene lugar el proceso de profesionalización de la asistencia social, cuyo interés se orientaba básicamente al desarrollo de procesos de aprendizaje para tratar a la gente, comprender las condiciones en que vivía, los medios que podían emplearse para mejorarlas y conocer los diversos organismos dedicados a la asistencia. Es durante el siglo XX cuando el Trabajo Social empieza a configurarse como una disciplina con sus propios conocimientos. A principios del S. XX echa mano de saberes de otras disciplinas, como la Psicología, Psiquiatría, la Antropología y la Sociología, que le son útiles para resolver problemas sociales del individuo, de grupos de individuos y de comunidades, es decir, que le son útiles para desarrollar los procesos de intervención social [63]. A partir de mediados del S. XX con el incremento de la presencia del Estado en las actividades

de asistencia social, el Trabajo Social comienza a consolidarse no solo como una profesión sino también como una disciplina [4, 78]. El Estado comenzó a demandar trabajadores especializados en asistencia social, y de este modo se empieza a configurar las bases de conocimiento de la disciplina de Trabajo Social, que convierte a los trabajadores sociales en un tipo de *"ingenieros sociales"*, que diseñen y ejecuten la planificación de las políticas sociales requeridas por el Estado [86].

Las dos organizaciones más importantes desde el punto de vista profesional y académico del Trabajo Social, es decir, la *Federación Internacional de Trabajadores Sociales-IFSW*[22] y la *Asociación Internacional de Escuelas de Trabajo Social-IASSW*[23], definen el Trabajo Social como la profesión *"que promueve el cambio social, la resolución de problemas en las relaciones humanas, y el fortalecimiento y la liberación del pueblo, para incrementar el bienestar. Mediante la utilización de teorías sobre comportamiento humano y los sistemas sociales, el trabajo social interviene en los puntos en los que las personas interactúan con su entorno. Los principios de los Derechos Humanos y la Justicia Social son fundamentales para el Trabajo Social"*. El ámbito profesional del Trabajo Social comprende todos aquellos ámbitos donde los seres humanos precisan de una atención especial como: Tercera edad, personas con discapacidad, personas maltratadas (en especial, mujeres, menores y ancianos), reclusos, víctimas del terrorismo, inmigrantes, menores exclusión social, minorías étnicas, drogodependencias y adicciones, emergencia social, prostitución, etc.

Durante mucho tiempo, se ha visto al profesional en Trabajo Social, como una persona con formación intelectual, pero que ha adolecido de producción de conocimiento científico propio [63], y que ha centrado su actividad en a la intervención social que se apoya en el conocimiento construido por otras áreas científicas para fundamentar sus actividades [63]. En muchos casos, la disciplina de Trabajo Social se ha esforzado en definir las cuestiones relacionadas con el proceso de intervención social, pero no ha prestado la debida atención al conocimiento teórico que fundamenta la acción ni a la necesidad de relacionar ambos (teoría y técnicas prácticas) con el objeto de estudio [128]. Todavía hoy en día se observa una cierta tensión entre la Profesión del Trabajo Social y la Academia del Trabajo Social, es decir, entre el mundo de la praxis y el mundo de la teoría. Sin embargo, es claro que ambos son necesarios y complementarios, pues el primero permite retroalimentar al segundo, tanto en el desarrollo de sus investigaciones como en la configuración de las materias curriculares, y el segundo tiene como objetivo la formación científica, técnica y tecnológica de los profesionales en Trabajo Social que les permite desarrollar sus actividades de intervención social. El ejercicio concreto del Trabajo Social puede y debe ser un marco para el desarrollo de la investigación del Trabajo Social. La investigación no es sólo una herramienta de la intervención, sino que en ella radica la posibilidad de construir conocimiento y de constituir el Trabajo Social como práctica profesional [51]. Es por ello, como indica el Consejo General de Trabajadores Sociales de España[24], que en la disciplina del Trabajo Social algunos de los retos actuales más importantes están relacionados con el desarrollo de la investigación como vía de innovación en lo social, la profundización en los conocimientos específicos, la elaboración teórica a partir de la práctica, la internacionalización, y la mejora y el aumento de las publicaciones científicas.

En cuanto a las investigaciones académicas en Trabajo Social, hemos de decir que la aplicación de la Bibliometría ha permitido establecer algunas hitos importantes que la han caracterizado y ha aportado información de valor a la comunidad científica para poder continuar desarrollando la investigación y el desarrollo de la estructura científica en el área de Trabajo Social [59]. La mayoría de estudios bibliométricos que se han desarrollado han estado basados en indicadores bibliométricos de rendimiento y actividad aplicados bien a las revistas del área de Trabajo Social

[22] http://ifsw.org/
[23] http://www.iassw-aiets.org/
[24] http://www.cgtrabajosocial.es/portada

[10, 53, 57, 61, 103, 110, 113, 119, 120], bien a las facultades de Trabajo Social [11, 52, 71], bien a los autores de Trabajo Social [105, 118, 127], o bien a las publicaciones en el área de Trabajo Social [12, 60, 56, 58, 102]. Algunos de los estudios bibliométricos más significativos para nuestra investigación que han sido desarrollados en este sentido son los siguientes:

- *Estudios bibliométricos sobre la identificación de las revistas propias del área de Trabajo Social [10, 57, 113, 119].* Como hitos más significativo podemos decir que la categoría de Trabajo Social está claramente identificada en dos de las más importantes bases de datos bibliográficas, WoS y Scopus. En WoS se encuentran indexadas 41 revistas de acuerdo al JCR Edición de Ciencias Sociales del 2012 mientras en Scopus tenemos indexadas 61 de acuerdo al SJR de Scimago Edición 2012. Encontramos una gran representación de revistas del mundo anglosajón (USA y UK) y factores de impacto no muy altos. Scopus presenta un mayor cubrimiento en número de revistas que WoS, pero como sabemos el control de citas es tan solo para publicaciones posteriores al 1996. Algunos autores critican que muchas de las revistas indexadas en estas bases de datos realmente no representan a investigaciones realizadas en el área de Trabajo Social, sino en áreas afines como la Psicología o la Sociología. Se refieren a revistas como *American Journal of Community Psychology* o *Journal of Community Psychology* o *Family Relations* [57, 119]. Igualmente se indica que muchas de las revistas del área de Trabajo Social no están indexadas en dichas bases de datos, WoS y Scopus. Por ello, Hodge et. al. propusieron usar las revistas de Trabajo Social indexadas en Google Scholar para hacer estudios bibliométricos, identificando 80 revistas significativas [57].

- *Estudios bibliométricos sobre los clásicos de la literatura o artículos altamente citados en Trabajo Social [56, 58].* En ambos trabajos se intenta identificar los mejores trabajos de todos los tiempos publicados en revistas de calidad en el área de Trabajo Social según las citas recibidas. En [56] se usa el concepto de trabajo altamente citado de Garfield para identificar los clásicos [45] y la base de datos bibliográfica WoS. Más concretamente, se identifican y analizan todos los trabajos publicados en revistas de Trabajo Social del JCR y aquellos trabajos relacionados con Trabajo Social pero publicados en otras revistas del JCR que presentan más de 50 citas. Por contra, en [58] se usan también el concepto de trabajo altamente citado de Garfield [45], pero tomando como variable de umbral no el número de citas recibidas sino el número de publicaciones con más citas, en este caso las 100 publicaciones más citadas del área realizadas entre los años 2000 y 2009. Además se usa como referencia las revistas de Trabajo Social indexadas en la base de datos Google Scholar.

- *Estudios bibliométricos del área de Trabajo Social basados en el popular índice H de Hirsch [57, 71].* El popular índice H ha sido usado en los estudios bibliométricos que se han desarrollado en el área de Trabajo Social, bien para hacer un ranking internacional de revistas del área de Trabajo Social [57] o bien para evaluar la calidad de la investigación de las Facultades de Trabajo Social [71].

Sin embargo, no conocemos que se haya desarrollado ningún estudio bibliométrico usando indicadores bibliometricos relacionales basados en mapas de ciencia, que nos darían otro tipo de información más ligado a los conceptos subyacentes en las investigaciones del área así como a su evolución.

2. Justificación

La investigación académica en el área de Trabajo Social está en proceso de consolidación y desarrollo, y ha estado desarrollándose muy especialmente desde investigadores de áreas afines al Trabajo Social como Medicina, Antropología, Sociología, y Psicología. Si exceptuamos USA, Canadá e Inglaterra, la investigación científica en el área de Trabajo Social está en vías de desarrollo en el resto de países. Muchos autores reclaman que hay que sentar las bases científicas de la misma para orientar a los potenciales investigadores sobre la estructura científica y los conocimientos científicos que la sustenta [51, 56, 57, 59, 61, 63, 98, 128].

Por ello, creemos que una investigación bibliométrica sobre el área de Trabajo Social que descubra nueva información y conocimiento contribuirá firmemente a sentar las bases científicas de la misma, a comprender su estructura científica, y con ello ayudar a su consolidar los procesos de investigación en el área. En particular, en esta memoria nos planteamos desarrollar una serie de estudios bibliométricos novedosos en el área de Trabajo Social que nos sitúan en el planteamiento y la justificación de la presente memoria de tesis.

- Aunque se han presentado diversos estudios bibliométricos en el área de Trabajo Social a nivel internacional, como hemos visto, ninguno se ha realizado usando indicadores bibliométricos relacionales basados en Análisis de Mapas Científicos, de modo que queden bien identificadas las áreas temáticas que han centrado los avances científicos en el Área de Trabajo Social y cómo ha sido la evolución conceptual de la estructura científica del área. Además, realizando nuestro análisis mediante la herramienta bibliométrica SciMAT seremos capaces de identificar las temáticas de más impacto e importancia que demandan más atención en la comunidad científica de Trabajo Social y que podrían soportar los futuros avances en el área.

- Para completar esta memoria, creemos conveniente realizar otro estudio bibliométrico basado en indicadores bibliométricos de rendimiento y actividad que nos permita la identificación de los trabajos altamente citados o de los *"Clásicos de la Literatura"* del área de Trabajo Social y con ello, identificar también los actores más importantes en las investigaciones desarrolladas en el área. Como hemos comentado, recientemente se han presentado dos estudios sobre literatura altamente citada en el área de Trabajo Social, uno publicado en una importante revista del Área de Trabajo Social, *British Journal of Social Work* [58], y otro en una importante revista del Área de Bibliometría, *Scientometrics* [56]. Sin embargo, el procedimiento de identificación de literatura altamente citada en ambos casos se ha basado en una estrategia estática para identificar los trabajos altamente citados que consiste en establecer umbrales fijos bien en cuanto al número de publicaciones buscadas o bien en cuanto a las citas recibidas, respectivamente. Estrategia que consideramos obsoleta y que no se ajusta a la realidad de la producción científica en el área, que al igual que sucede en otras áreas científicas, gracias al desarrollo de las nuevas tecnologías está teniendo un notable crecimiento en los últimos años, tanto en cantidad de trabajos publicados como en la citación. Como consecuencia, hemos desarrollado una nueva estrategia más dinámica de identificación de Clásicos de la Literatura y de trabajos altamente citados que permite identificar la literatura altamente citada mediante un método adaptativo basado en el índice H. La idea es usar las buenas cualidades del índice H para caracterizar la calidad de los investigadores en la identificación de las publicaciones más significativas de un área de investigación. El procedimiento es más dinámico y flexible que aquellos basados en umbrales y se ajusta mejor al crecimiento tanto en publicaciones como en citas que experimentan las áreas de investigación.

3. Objetivos

La presente memoria de tesis tiene como objetivo principal estudiar y analizar el estado de la investigación desarrollada en el área de Trabajo Social mediante los dos tipos de técnicas bibliométricas existentes: Técnicas bibliométricas de rendimiento y actividad y técnicas bibliométricas relacionales basadas en mapas de ciencia. Este objetivo general se alcanza en esta memoria a través de la consecución de los siguientes dos subobjetivos:

- Realización de un estudio bibliométrico del área de Trabajo Social de acuerdo al WoS y al JCR usando indicadores bibliométricos relacionales basados en mapas de ciencia mediante la herramienta de mapas de ciencia SciMAT. Éste es el primer estudio que se hace de esta naturaleza en el área de Trabajo Social y nos permitirá descubrir los temas y áreas temáticas de investigación que han centrado la atención de la comunidad científica del área de Trabajo Social desde principios del S. XX, identificar los temas de mayor impacto, y analizar como ha evolucionado la estructura conceptual científica del área.
- Realización de un estudio bibliométrico del área de Trabajo Social de acuerdo al WoS y al JCR usando indicadores bibliométricos de rendimiento y actividad. Para ello se presenta una nueva técnica de identificación de trabajos altamente citados basada en el índice H, llamada *H-Classics* y se aplica en este estudio bibliométrico con objeto de identificar a los *clásicos de la literatura en el área de Trabajo Social*.

4. Discusión de Resultados

Esta sección muestra un resumen de las distintas propuestas y publicaciones que se recogen en la presente memoria y describe una breve discusión sobre los resultados obtenidos por cada una de ellas.

4.1. Analizando La Evolución Científica del Área de Trabajo Social Mediante el Uso de Análisis de Mapas de Ciencia

En este trabajo se presenta el primer estudio bibliométrico sobre el área de Trabajo Social realizado mediante indicadores bibliométricos relacionales basados en análisis de mapas de ciencia. En este estudio se muestra cuáles han sido los temas y las áreas temáticas que han centrado la investigación del área de Trabajo Social de acuerdo a las publicaciones científicas en revistas JCR del área indexadas en el Web of Science desde 1930. El estudio se ha realizado mediante la aplicación informática para análisis de mapas de ciencia desarrollado por el grupo SECABA de la UGR, SciMAT. Antes de mostrar los resultados que se obtienen en el trabajo, vamos a explicar algunos detalles técnicos del estudio realizado:

Revista	Primera Edición	#(Publicaciones) Recuperadas	FI (2012 JCR)
RESEARCH ON SOCIAL WORK PRACTICE	1991	958	1.355
JOURNAL OF SOCIAL WORK	2008	118	1.233
958 HEALTH & SOCIAL WORK	1994	537	1.178
SOCIAL SERVICE REVIEW	1956	1559	1.140
BRITISH JOURNAL OF SOCIAL WORK	1971	1794	0.995
INTERNATIONAL JOURNAL OF SOCIAL WELFARE	1991	532	0.956
SOCIAL WORK	1956	2997	0.867
CHILD & FAMILY SOCIAL WORK	2007	265	0.831
SOCIAL WORK RESEARCH	1994	398	0.800
SOCIAL WORK IN HEALTH CARE	1975	1407	0.698
JOURNAL OF SOCIAL WORK PRACTICE	1994	383	0.695
INTERNATIONAL SOCIAL WORK	1995	722	0.653
ADMINISTRATION IN SOCIAL WORK	1980	817	0.566
JOURNAL OF SOCIAL WORK EDUCATION	1985	852	0.548
EUROPEAN JOURNAL OF SOCIAL WORK	2008	164	0.517
AUSTRALIAN SOCIAL WORK	2009	124	0.500
CLINICAL SOCIAL WORK JOURNAL	1974	1053	0.494
JOURNAL OF SOCIAL SERVICE RESEARCH	1994	446	0.449
FAMILIES IN SOCIETY-THE JOURNAL OF CONTEMPORARY SOCIAL SERVICES	2005	457	0.442
AFFILIA-JOURNAL OF WOMEN AND SOCIAL WORK	1994	453	0.383
SMITH COLLEGE STUDIES IN SOCIAL WORK	1930	908	0.361
SOCIAL WORK IN PUBLIC HEALTH	2009	155	0.354
ASIA PACIFIC JOURNAL OF SOCIAL WORK AND DEVELOPMENT	1995	242	0.107
LJETOPIS SOCIJALNOG RADA	2007	121	0.095
INDIAN JOURNAL OF SOCIAL WORK	1975	1332	0.014 (2011 JCR)

Tabla I.1: Selección de revistas core del área de Trabajo Social del JCR-2012

- El estudio se realizó en Junio de 2013.
- No se usaron en el estudio todas las 38 revistas de la categoría de Trabajo Social indexadas en el JCR-2012. Se hizo una selección de revistas de acuerdo a las recomendaciones de algunos relevantes autores (Profs. Hodge y Thyer) [57, 119, 120] que indican que no todas las

revistas indexadas en la categoría Trabajo Social del JCR son representativas de investigaciones realizadas en el área de Trabajo Social. Por ejemplo, comentan que tanto las revistas *Journal of Community Psychology* como *American Journal of Community Psychology* son revistas de fuera de la disciplina, cuyo contenido es ajeno a la práctica del Trabajo Social y está más relacionado con la práctica de la Psicología. Siguiendo sus recomendaciones y siempre moviéndonos en el entorno de trabajo marcado por las bases de datos WoS y el JCR, seleccionamos 25 revistas de Trabajo Social mostradas en la Tabla I.1.

- Un total de 18794 artículos de investigación publicados entre los años 1930 y 2012, entre artículos y reviews, fueron recuperados para el estudio. La distribución de las publicaciones por revista se muestra en la Tabla I.1 y por año se muestra en la Figura 4. Como puede verse siete revistas concentran el 60 % de la producción científica: *Social Work, British Journal of Social Work, Social Service Review, Social Work in Health Care, Indian Journal of Social Work, Clinical Social Work Journal, Research on Social Work Practice.*

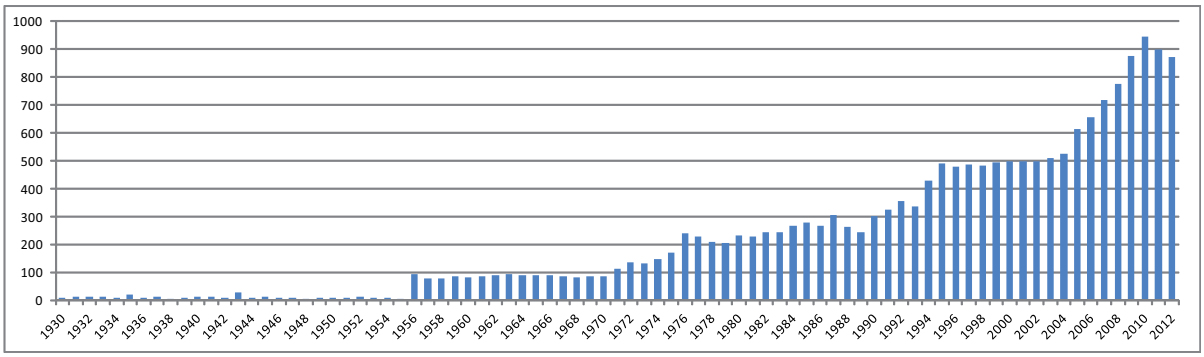

Figura 4: Distribución de publicaciones por años

Palabra clave	Frecuencia de aparición
HEALTH-CARE	1459
CHILDREN	1242
FAMILIES	943
WOMEN	829
MENTAL-HEALTH	739
SERVICES	729
SOCIAL-WORKERS	706
PERSPECTIVE	505
EDUCATION	499
ADOLESCENTS	483
POLICY	467
SOCIAL-WORK-EDUCATION	399
COMMUNITY	395
STRESS	394
WELFARE	386
OUTCOMES	354
RISK	348
ATTITUDES	335
DEPRESSION	329
PARENTS	325
HIV/AIDS	322
POVERTY	317
SOCIAL-SUPPORT	315
PSYCHOTHERAPY	311
CHILD-WELFARE	301
MOTHERS	300

Tabla I.2: Palabras clave con una frecuencia de aparición superior a 300

- Para cada publicación se recuperó los datos bibliográficos como autores, título, revista, palabras clave, palabras clave plus ISI, citas, referencia, etc.

- Todas los datos de las publicaciones fueron cargados en SciMAT, donde se realizaron algunas tareas de preprocesamiento con las palabras clave de las publicaciones que son las unidades de análisis que se usaron en nuestro estudio. Entre estas operaciones tenemos: se agruparon palabras que representan el mismo concepto, se añadieron manualmente palabras clave desde los títulos a aquellas publicaciones más antiguas que no presentaban palabras clave, se borraron las palabras vacías y algunas muy genéricas como la propia "Social Work", y se calculó su frecuencia de aparición en los documentos. Al final se creo una base de datos de palabras clave compuesta de 22140 expresiones. En la Tabla I.2 se muestran una lista de las palabras clave con una frecuencia superior a 300.
- Después configuramos los periodos de tiempo a estudiar buscando que hubiera una buen cubrimiento de publicaciones en cada uno de ellos, y fijamos tres periodos: 1930-1989, 1990-2002 y 2003-2012, cada uno con 5725, 5676, 7393 publicaciones, respectivamente. Lógicamente el primer periodo contiene un mayor número de años.
- Luego configuramos en SciMAT las técnicas a usar para desarrollar el estudio siguiendo la metodología de análisis de mapas de ciencia definida en [29]. En concreto se usó lo siguiente: como hemos dicho se fijaron las palabras clave como unidad de análisis; el análisis de co-ocurrencias para construir las redes de palabras; el índice de equivalencia como medida de similaridad para normalizar las redes de palabras; el algoritmo de clustering de los centros simples para detectar los clusters o temas de investigación; y como indicadores bibliométricos para enriquecer los mapas de ciencia fijamos el número de citas de los documentos y el H-index asociados a los temas y a las redes temáticas.

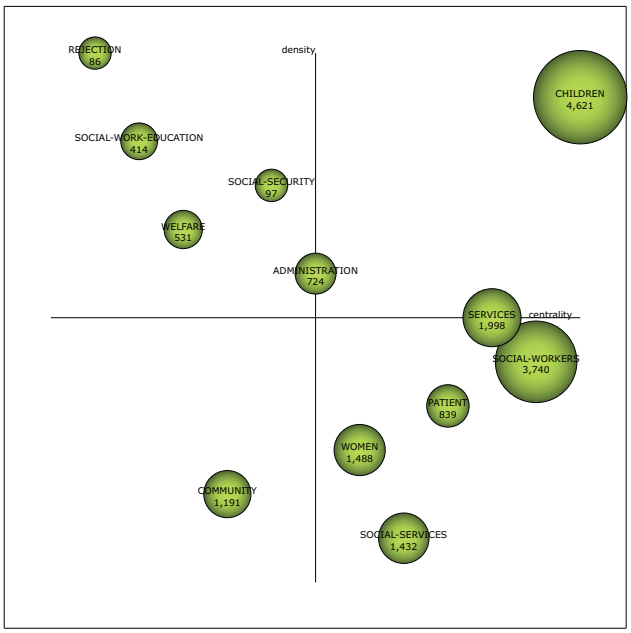

Figura 5: Diagrama estratégico del periodo 1930-1989

A continuación presentamos los dos principales resultados que hemos obtenido en este estudio bibliométrico del área de Trabajo Social basado en mapas de ciencia:

1. Hemos identificado los temas de investigación que han centrado el interés de la comunidad científica del área de Trabajo Social en cada uno de los periodos, descubriendo aquellos que han concitado el mayor interés e impacto científico:

Temas de investigación	#(Publicaciones)	#(Citas)	H-index
CHILDREN	816	4,621	28
SOCIAL-WORKERS	726	3,740	23
SERVICES	405	1,998	17
WOMEN	368	1,488	18
SOCIAL-SERVICES	313	1,432	16
COMMUNITY	222	1,191	16
PATIENT	190	839	13
ADMINISTRATION	156	724	13
WELFARE	99	531	13
SOCIAL-WORK-EDUCATION	98	414	11
SOCIAL-SECURITY	45	97	6
REJECTION	17	86	6

Tabla I.3: Indicadores bibliométricos de rendimiento e impacto para el periodo 1930-1989

1.1 Periodo 1930-1989

De acuerdo al diagrama estratégico de la Figura 5 las investigaciones desarrolladas durante este periodo se han centrado en doce temas de investigación, siendo siete de ellos (los temas motor y temas básicos) los más importantes: *Children, Social-workers, Services, Patient, Social-services, Administration,* y *Women*. Los indicadores bibliométricos de rendimiento e impacto asociados a estos temas de investigación son dados en la Tabla I.3. Concretamente mostramos para cada tema el número de publicaciones asociadas, las citas recibidas y el H-index del tema de investigación calculado desde las publicaciones. De acuerdo a las medidas de rendimiento seis son los temas de mayor relevancia: *Children, Social-workers, Services, Women, Social-services*, y *Community*.

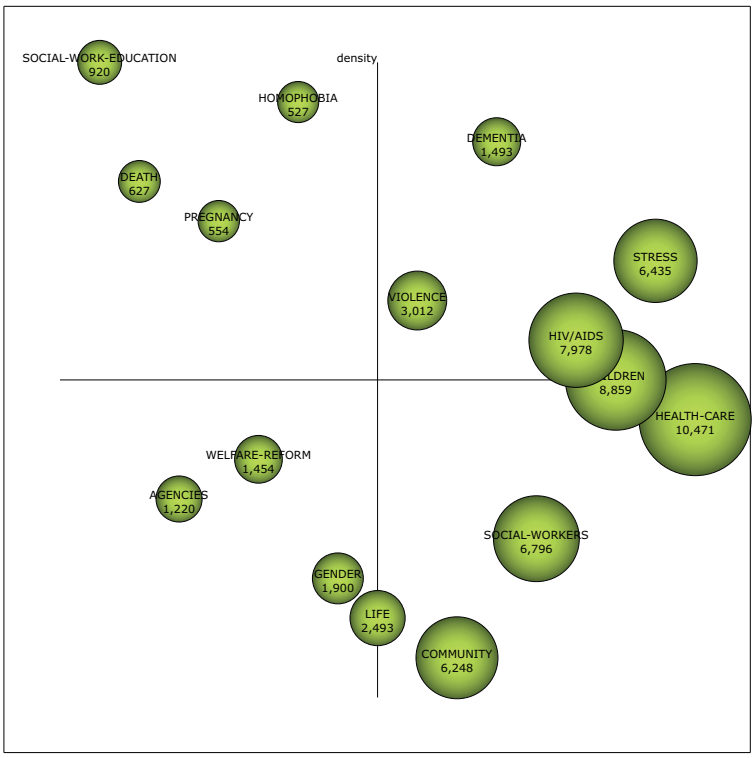

Figura 6: Diagrama estratégico del periodo 1990-2002

1.2 Periodo 1990-2002

De acuerdo al diagrama estratégico de la Figura 6 las investigaciones desarrolladas durante este periodo se han centrado en dieciséis temas de investigación, siendo ocho de ellos (los

temas motor y temas básicos) los más importantes: *Dementia, Stress, Violence, HIV/AIDS, Children, Health-care, Social-workers,* y *Community*. De acuerdo a las medidas de rendimiento e impacto mostrados en la Tabla I.4 seis son los temas de mayor relevancia: *Health-care, Children, Social-workers, HIV/AIDS, Community*, y *Stress*.

Temas de investigación	#(Publicaciones)	#(Citaciones)	H-index
HEALTH-CARE	942	10,471	40
CHILDREN	910	8,859	36
SOCIAL-WORKERS	785	6,796	33
HIV/AIDS	738	7,978	36
COMMUNITY	607	6,248	34
STRESS	436	6,435	37
VIOLENCE	290	3,012	26
LIFE	239	2,493	25
GENDER	186	1,900	21
AGENCIES	175	1,220	19
WELFARE-REFORM	153	1,454	18
SOCIAL-WORK-EDUCATION	138	920	16
DEMENTIA	107	1,493	22
DEATH	65	627	13
PREGNANCY	58	554	14
HOMOPHOBIA	40	527	14

Tabla I.4: Indicadores bibliométricos de rendimiento e impacto para el periodo 1990-2002

1.3 Periodo 2003-2012

De acuerdo al diagrama estratégico de la Figura 7 las investigaciones desarrolladas durante este periodo se han centrado en dieciséis temas de investigación, siendo nueve de ellos (los temas motor y temas básicos) los más importantes: *Foster-care, Depression, Abuse, Women, Education, Policy,Older-people, psychotherapy,* y *Services*. De acuerdo a las medidas de rendimiento e impacto mostrados en la Tabla I.5 diez son los temas de mayor relevancia: *Depression, Women, Foster-care, Services, Education, Policy, Abuse, Older-people, Psychotherapy*, y *Social-workers*.

Temas de investigación	#(Publicaciones)	#(Citaciones)	H-index
DEPRESSION	1,921	7,880	28
WOMEN	1,426	5,377	23
FOSTER-CARE	1,339	5,393	24
SERVICES	1,227	4,700	23
EDUCATION	1,003	4,028	23
POLICY	942	3,479	22
ABUSE	864	3,510	22
OLDER-PEOPLE	699	2,756	20
PSYCHOTHERAPY	575	2,178	20
SOCIAL-WORKERS	482	2,003	19
PREVENTION	403	1,653	18
DISABILITY	357	1,385	15
POSTTRAUMATIC-STRESS-DISORDER	252	1,050	15
IMMIGRANTS	173	590	11
RACE	149	490	11
LESBIANS	75	331	10
GRIEF	73	309	9

Tabla I.5: Indicadores bibliométricos de rendimiento e impacto para el periodo 2003-2012

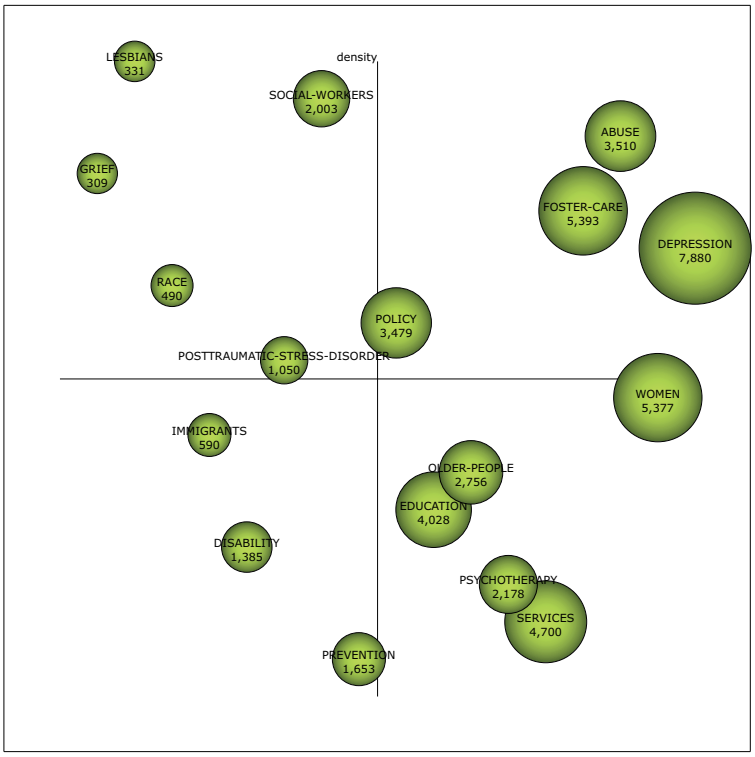

Figura 7: Diagrama estratégico del periodo 2003-2012

Áreas temáticas	**#(Publicaciones)**	**#(Citaciones)**	**H-index**
SOCIAL-SERVICES	4651	29183	49
HEALTH-CARE	3879	26335	48
CHILDREN	3295	19772	42
WOMEN	2800	16516	39
SOCIAL-WORKER	2534	14603	37
HIV/AIDS	2164	13355	38
VIOLENCE	1564	8003	31
EDUCATION	1239	5362	26
GRIEF	138	936	15
LGBT	115	858	16

Tabla I.6: Indicadores bibliométricos de rendimiento e impacto de las áreas temáticas

2. Hemos mostrado como ha evolucionado conceptualmente la estructura científica de la investigación desarrollada en el área de Trabajo Social durante el periodo 1930-2012 e identificado las áreas temáticas de investigación en las que se agrupan la mayoría de las investigaciones realizadas, descubriendo aquellas que han concitado mayor interés e impacto y aquellas que podrían ser la base de los futuros trabajos de investigación que se desarrollen en el área. En la Figura 8 se muestra el mapa de evolución científica y las áreas temáticas identificadas, mientras en la Tabla I.6 se presentan los indicadores bibliométricos de rendimiento e impacto asociados a cada área. Como vemos hay diez áreas temáticas que han centrado el interés de la comunidad: *Children, Social-services, Health-care, Violence, Women, HIV/AIDS, LGBT (Lesbian, Gay, Bisexual and Transgender), Social-workers, Education,* y *Grief*. De acuerdo al mapa de evolución científica y a los indicadores de rendimiento e impacto podemos resaltar los siguientes aspectos:

   - La estructura científica del área de Trabajo Social presenta una gran cohesión (la mayoría de los temas de investigación están agrupados en un área tematica), y ha evolucionada

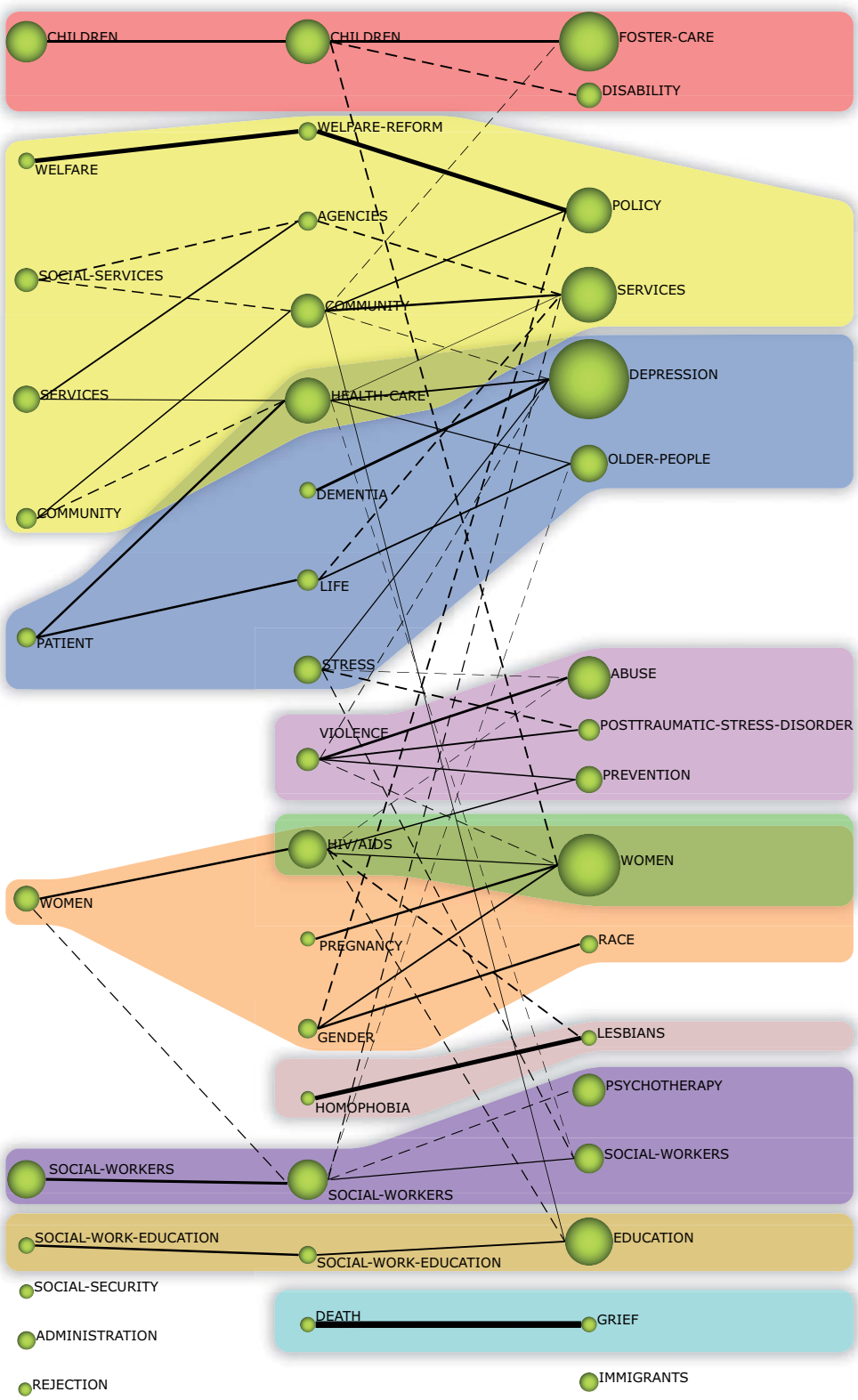

Figura 8: Mapa de evolución científica y de las área temáticas del periodo 1930-2012

sin grandes discontinuidades.

- Hay seis áreas temáticas que están presentes en todos los periodos, por lo que pueden ser consideradas como *áreas temáticas clásicas*: *Children, Social-services, Health-care, Women, Social-workers,* y *Education.*
- Hay ocho áreas que presentan un crecimiento constante y continuo desde su inicio, tanto en número de documentos como en temás de investigación: *Children, Social-services, Health-care, Violence, Women, HIV/AIDS, Social-workers,* y *Education*. Por tanto, podemos afirmar que el desarrollo de la investigación en el área de Trabajo Social se ha producido principalmente a través de ocho áreas temáticas.
- De acuerdo a los indicadores bibliométricos de impacto dos áreas resaltan sobre las demás: *Social-services* (con 29183 citas y H-index=49) y *Health-care* (26335 citas y H-index=48).
- Si analizamos la evolución del H-index de los temas que componen las áreas temáticas, observamos que cuatro áreas temáticas despiertan más el interés de la comunidad científica de Trabajo Social y continuarán haciéndolo en el futuro (los H-index de sus temas los sitúan entre los temas más impactantes de cada periodo): *Social-services, Health-care, Children* y *Women*.

De acuerdo a este estudio bibliométrico del área de Trabajo Social basado en mapas de ciencia podemos destacar las siguientes características de la investigación desarrollada:

- Las revistas científicas de calidad que predominan en el área de Trabajo Social son de origen americano o británico. Por tanto, como pasa en muchas disciplinas científicas, las investigaciones desde USA y UK tienen más posibilidades de ser publicadas y son dominantes por las facilidades del idioma.
- El número de publicaciones científicas ha crecido considerablemente a lo largo de los años.
- Analizando en detalle los temas de investigación y las áreas temáticas detectadas, podemos decir que las investigaciones realizadas en el área de Trabajo Social se han centrado en cuatro frentes de investigación principalmente:

  1. *Investigaciones desarrolladas sobre los individuos más vulnerables de la sociedad*: Este frente de investigación está representado por las áreas temáticas *Children, Women, LGBT,* y por los temás de investigación representados por *Older-people* y *Immigrants*.
  2. *Investigaciones desarrolladas sobre los servicios sociales ofertados a la sociedad*: Este frente de investigación está representado por el área temática más importante *Social-services.*
  3. *Investigaciones desarrolladas sobre los problemas importantes que afectan a la sociedad*: Este frente de investigación está representado por las áreas temáticas *Health-care, Violence, HIV/AIDS,* y *Grief*.
  4. *Investigaciones desarrolladas sobre la propia disciplina de Trabajo Social*: Este frente de investigación está representado por las áreas temáticas *Social-workers* y *Education*.

Antes de alcanzar este importante resultado de la memoria en el área de Trabajo Social, realizamos un estudio bibliométrico basado en mapas de ciencia de las mismas características pero

para analizar la investigación publicada en una revista internacional del JCR del área de Computer Science en conmemoración de sus diez años de actividad científica (2002-2011): *International Journla of Information Technology & Decision Making*. Este estudio me permitió comprender como realizar este tipo de estudios bibliométricos y experimentar el uso de la herramienta de SciMAT. Trabajamos con un número menor de documentos (415 publicaciones) y un número menor de palabras clave (330 palabras). En este trabajo fundamentalmente nos centramos en dentificar los principales temas de investigación que han centrado las investigaciones publicadas en la revista, que han sido diecisiete como se muestra en el diagrama estratégico de la Figura 4.1: *Agents, Analytical-hierarchy-process,Consensus, Data-envelopment-analysis, Data-mining, Decision-support-system, Group-decision-making, Internet-quality-ofservice, Interpretive-structural-modeling, Management, Optimization, Performance-evaluation, Shapley-value, Software-defect-prediction, Technology-acceptance, Time-series, Uncertainty.*

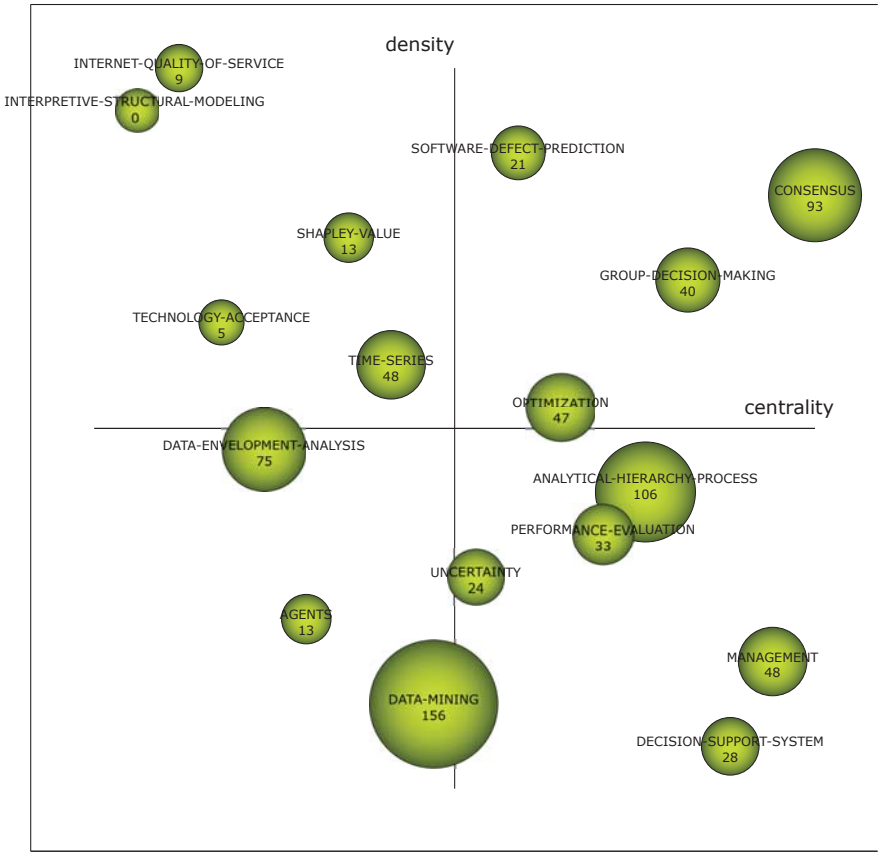

Figura 9: Diagrama estratégico de los temas del journal IJITDM basados en citas (2002-2011).

Los artículos asociados a esta parte son:

- M.A. Martínez-Sánchez, M.J. Cobo, M. Herrera, E. Herrera-Viedma. **Analyzing the Scientific Evolution of Social Work Using Science Mapping**. *Research on Social Work Practice*. Doi: 10.1177/1049731514522101, in press (2014).
- A.G. López-Herrera, E. Herrera-Viedma, M.J. Cobo, M.A. Martínez, G. Kou, Y. Shi. **A Conceptual Snapshot of the First 10 Years (2002-2011) of the International Journal of Information Technology & Decision Making**. *International Journal of Information Technology & Decision Making* 11:2 (2012) 247-270. Doi: 10.1142/S0219622012400020.

4.2. Identificando los Clásicos de la Literatura en Trabajo Social a través del Concepto de H-Classics

En esta memoria se desarrolla la nueva metodología *H-Classics* para identificar los clásicos de la literatura de un área científica usando el famoso indicador bibliométrico H-index. Como previamente hemos comentado, Eugene Garfield definió el concepto de *clásico de la literatura o clásico de la citación* para identificar a aquellos trabajos científicos que marcan las pautas y más destacan en el desarrollo de una disciplina científica [45]. Existen en la literatura dos procedimientos para identificar los trabajos clásicos o altamente citados:

1. *Definir un umbral de citación a ser superado por los trabajos altamente citados:* Siguiendo las recomendaciones del Prof. Garfield [49], se estable como válido un valor de umbral 400 citas para aquellas disciplinas con un tamaño grande (Física, Química,...), mientras se recomienda un valor de 100 citas para aquellas disciplinas de menor tamaño (Trabajo Social, Comunicación Audiovisual, Fisioterapia,...). El problema es que los umbrales de citación dependen de cada disciplina, de su antigüedad, de las prácticas de citación de la disciplina, del número de investigadores trabajando, etc. Y, por tanto, los valores de umbrales deberían de variar de unas a otras disciplinas.

2. *Seleccionar un número específico de trabajos de entre los de mayor citación*: De nuevo, siguiendo las recomendaciones del Prof. Garfield [45, 47], podemos o especificar un número concreto de trabajos a seleccionar como clásicos (100, 50, 25 son valores usados) o especificar un porcentaje de entre los más citados (top 1 %). Pero de nuevo encontramos inconvenientes, como todas las áreas no presentan la misma estructura científica, quizás en algunas fijar un valor concreto tenga sentido, pero en muchas otras ese valor pudiera necesitar ser mayor o menor.

En la Tabla I.7 se muestran algunos ejemplos de estas estrategias en diferentes áreas científicas.

Por tanto, como hemos visto, los procedimientos de identificación de literatura altamente citada en ambos casos se han basado en estrategias estáticas para identificar los trabajos altamente citados, consistentes en establecer umbrales fijos bien en cuanto a las citas recibidas o bien en cuanto al número de publicaciones buscadas. Estrategias que no se ajustan a la realidad de la producción científica en las áreas de conocimiento, que gracias al desarrollo de las nuevas tecnologías están teniendo un notable crecimiento en los últimos años, tanto en cantidad de trabajos publicados como en la citación. Para solucionar este problema, hemos definido la metodología H-Classics, que es una nueva estrategia más dinámica y flexible de identificación de Clásicos de la Literatura y de trabajos altamente citados que permite identificar la literatura altamente citada mediante un método que se adapta mejor a las condiciones de crecimiento tanto en publicaciones como en citación de cada área mediante el uso del índice H. La idea es usar las buenas cualidades del índice H para caracterizar la calidad de los investigadores en la identificación de las publicaciones más significativas de un área de investigación.

Dicha metodología la hemos aplicado en el área de Trabajo Social para identificar los trabajos que son referencia de las investigaciones desarrolladas en la disciplina. Antes de presentar los resultados obtenidos en el área de Trabajo Social, vamos a presentar la metodología H-Classics, sus ventajas, y un estudio comparativo con las otras técnicas.

La metodología H-Classics comprende los siguientes pasos:

Disciplina	**Ref.**	**Umbral de Citación**	**#(Clássicos)**
Epilepsy	[64]	400	89
Neurosurgery	[92]	400	106
Parkinson	[93]	400	107
Critical Care Med.	[97]	100	1187
Occupational Med.	[50]	100	85
Suicidology	[112]	96	12
Deviant Behav.	[111]	43	10
Inf.& Lib. Sci.	[72]	118	82
Soc. Work	[58]	41	100
Pain Med.	[74]	302	100
Plastic and Rec. Surg.	[129]	165	100
Vascular Surgery	[89]	194	100
Pancreatology	[23]	163	100
Endodontology	[41]	87	100
Dentistry	[42]	326	100
Orthodontist	[62]	89	100
Integ. & Comp. Med.	[115]	52	50
Respirology	[116]	615	50
Orthopedics	[85]	192	50
Arthroscopy	[25]	189	25

Tabla I.7: Algunas ejemplos de estudios de clásicos de la citación

1. *Escoger la base de datos bibliográfica o fuentes de información para recuperar las publicaciones y las citas.*

2. *Configurar la muestra del estudio.* Normalmente se usan trabajos publicados en revistas (artículos y reviews). Por tanto, tenemos que fijar las revistas que representan al área de investigación y luego recuperar las publicaciones asociadas y las citas recibidas. Para ello, podemos identificar un conjunto de revistas que representen el área, o si coincide con un área científica de alguna base de datos pues recuperar las revistas asociadas, o si no se da ninguno de los anteriores casos, entonces configurar una búsqueda sobre la base de datos bibliográfica. Usando el WoS y el JCR esto lo podemos hacer muy fácilmente.

3. *Calcular el H-index de un área de investigación.* Esto se hace fácilmente cogiendo todos los trabajos publicados del área y ordenándolos por sus citas. Si usamos WoS el procedimiento es muy sencillo de realizar mediante la utilidad que tiene para ello. Por ejemplo en la Tabla I.8 se muestra resultados del H-index de varias áreas científicas de acuerdo al WoS(consulta hecha el 22 de Junio de 2013): "Social Work","Family Studies", "Transplantation", "Dentistry", "Computer Science", "Mathematics.ªnd "Physics". **Cr** representa el umbral de citación o el número de citas recibidas por el último trabajo incluido en el H-core, #**(Publicaciones)** representa el número de publicaciones entre 1900-2013 considerando sólo artículos y reviews. "Articles".

Disciplina	**Cr**	**H-index**	**#(Publicaciones)**
Social Work	126	125	46.402
Family Studies	168	168	46.117
Transplantation	224	224	116.623
Dentistry	246	246	184.646
Computer Science	624	624	824.198
Mathematics	642	640	1.104.332
Physics	1.171	1.171	3.256.681

Tabla I.8: H-index de algunas categorías del JCR

4. *Recuperar el H-core del área de investigación of the research.* El H-core de un área de investigación representa sus clásicos de la literatura.

Algunas ventajas de la metodología H-Classics son las siguientes:

- La metodología H-Classics combina publicaciones e impacto en la identificación de los trabajos altamente citados, por lo que ofrece un método más completo que los existentes.
- La metodología H-Classics se basa en el indicador H-index por lo que es una metodología robusta, transparente y reproducible para desarrollar estudios de trabajos altamente citados.
- La metodología H-Classics es fácil de aplicar, especialmente cuando usamos algunas de las bases de datos bibliográficas más importantes commo WoS: Primero calculamos el H-index del área, siendo el H-core el conjunto de trabajos altamente citados.
- La metodología H-Classics es sensible a las dimensiones del área de investigación.

- La metodología H-Classics es también sensible a los patrones de citación del área de investigación. Por ejemplo como puede verse en la Tabla I.8 si comparamos dos áreas con iguales dimensiones como "Social Work"(46.402 publicaciones) y "Family Studies"(46.117 publicaciones), H-Classics identifica cantidades diferentes de trabajos altamente citados, 125 y 168, respectivamente, porque H-Classics detecta los diferentes patrones de citación como se muestra en la Figura 10 donde se ve que "Family Studies"presenta más citaciones que "Social Work"para las publicaciones en el WoS entre 2005-2010.

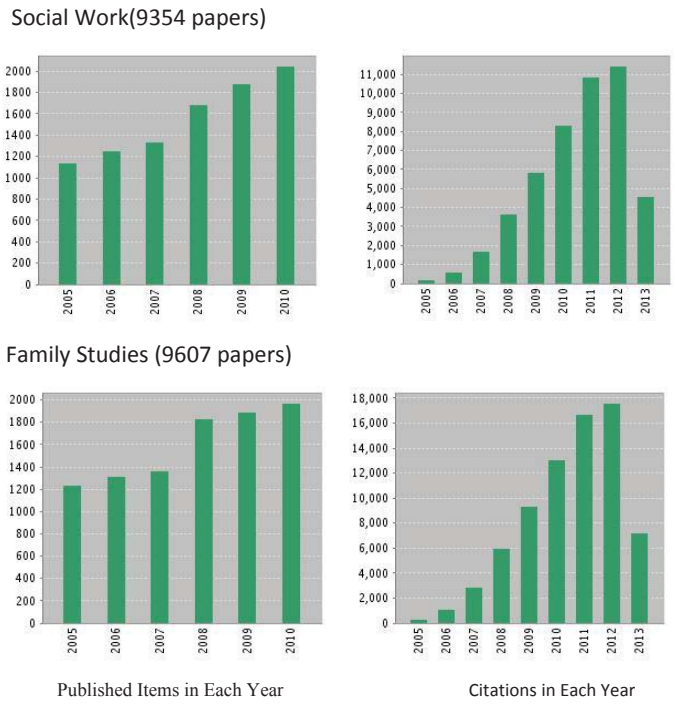

Figura 10: "Social Work"versus "Family Studies"

En la Tabla I.9 mostramos una comparación de los resultados de la metodología H-Classics con respecto a algunos estudios basados en las metodologías clásicas (denominadas en la tabla "T-Classics") que se presentaron en la Tabla I.7. En concreto, con respecto a los siguientes estudios realizados recientemente contra el WoS: "Epilepsy"[64], "Parkinson"[93], "Suicidology"[111], "Pain Medicine"[74], "Plastic and Reconstructive Surgery"[129], "Dentistry"[42], "Orthodontist"[62], "Respirology"[116], "Arthroscopy"[25]. Como se muestra en la Figura 11, la metodología H-Classics arroja resultados muy diferentes, como se refleja por el valor de correlación entre ambas de 0.45. Por tanto, ambas estrategias muestran visiones diferentes de los clásicos de la literatura. Si miramos con más detalle, vemos que solamente en el caso de "Orthodontist" ambas estrategias arrojan resultados similares, i.e., 100 y 98 clásicos de la literatura. En las otras disciplinas la metodología H-Classics siempre recupera un número mayor de clásicos dando una visión más completa de los trabajos altamente citados. Además, si comparamos los resultados de T-Classics y H-Classics con respecto a la dimensión de cada área expresada por el número de publicaciones, obtenemos unos índices de correlación de 0.27 y 0.72, respectivamente. La débil correlación de T-Classics justifica claramente el uso de la metodología H-Classics, que combina las estrategias tradicionales de identificar los clásicos y recoge mejor las dimensiones de las áreas de investigación.

Para realizar el estudio de clásicos de la literatura en el área de Trabajo Social seguimos las mismas recomendaciones sobre las revistas científicas que usamos en el estudio anterior [57, 120],

Disciplina	#(T-Classics)	#(H-Classics)	#(Publicaciones)
1. Epilepsy	89	323	99109
2. Parkinson	107	383	63471
3. Suicidology	12	58	1307
4. Pain Med.	100	271	106050
5. Plastic and Rec. Surg.	100	154	29439
6. Dentistry	100	246	181513
7. Orthodontist	100	98	8163
8. Respirology	50	358	185563
9. Arthroscopy	25	109	7680

Tabla I.9: T-Classics versus H-Classics

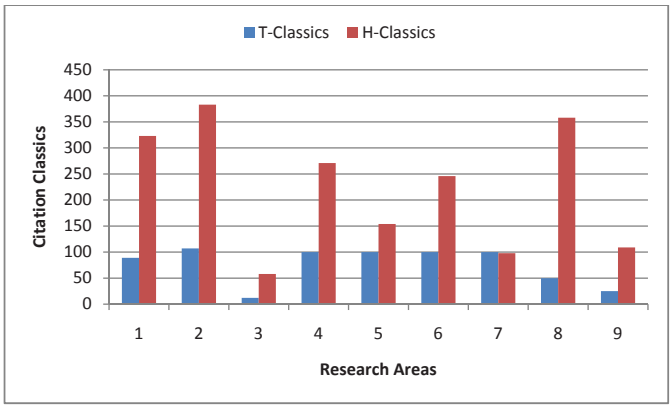

Figura 11: T-Classics versus H-Classics

es decir, usamos las 25 revistas JCR de la Tabla I.1 y el WoS. Entonces utilizamos la siguiente consulta:

su=(social work) Refined by: Document Types=(ARTICLE OR REVIEW) AND Source Titles=(SOCIAL WORK OR JOURNAL OF SOCIAL WORK PRACTICE OR SOCIAL WORK WITH GROUPS OR CHILD FAMILY SOCIAL WORK OR BRITISH JOURNAL OF SOCIAL WORK OR SOCIAL SERVICE REVIEW OR SOCIAL CASEWORK OR EUROPEAN JOURNAL OF SOCIAL WORK OR SOCIAL WORK IN HEALTH CARE OR SOCIAL WORK IN PUBLIC HEALTH OR INDIAN JOURNAL OF SOCIAL WORK OR CLINICAL SOCIAL WORK JOURNAL OR HEALTH SOCIAL CARE IN THE COMMUNITY OR RESEARCH ON SOCIAL WORK PRACTICE OR SMITH COLLEGE STUDIES IN SOCIAL WORK OR AUSTRALIAN SOCIAL WORK OR JOURNAL OF SOCIAL WORK EDUCATION OR ADMINISTRATION IN SOCIAL WORK OR JOURNAL OF SOCIAL WORK OR INTERNATIONAL SOCIAL WORK OR LJETOPIS SOCIJALNOG RADA OR ASIA PACIFIC JOURNAL OF SOCIAL WORK OR HEALTH SOCIAL WORK OR JOURNAL OF SOCIAL SERVICE RESEARCH OR AFFILIA JOURNAL OF WOMEN AND SOCIAL WORK OR SOCIAL WORK RESEARCH) AND [excluding] Source Titles=(SOCIAL WORK WITH GROUPS OR SOCIAL CASEWORK) AND [excluding] Source Titles=(HEALTH SOCIAL CARE IN THE COMMUNITY)

Como este estudio fue hecho en Mayo de 2013 obtuvimos un número menor de publicaciones, concretamente 17992 publicaciones. El H-index asociado al área fue de 66, con lo cual identificamos los siguientes 66 clásicos de la literatura en el área de Trabajo Social:

1. E. Greewood. Attributes of a profession. *Social Work* 2(3):45-55, 1957. Citas:**263**
2. F. Riessman. The helper therapy principle. *Social Work* 10(2):27-32, 1965. Citas:**228**
3. J. Fischer. IS casework effective-review. *Social Work* 18(1):5-20, 1973. Citas:**183**
4. L.M. Gutierrez. Working with women of color - an empowerment perspective. *Social Work* 35(2):149-153, 1990. Citas:**169**
5. D. Sleebey. The strengths perspective in social work practice: Extensions and cautions. *Social Work* 41(3):296-305, 1996. Citas:**139**
6. A.B. Hatfield. Psychological costs of schizophrenia to family. *Social Work* 23(5):355-359, 1978. Citas:**135**
7. S. Jayaratne; W.A. Chess. Job-satisfaction, burnout, and turnover - a national study. *Social Work* 29(5):448-453, 1984. Citas:**132**
8. L. Bergman. Dating violence among high-school-students. *Social Work* 31(1):21-27, 1992. Citas:**130**
9. N. Finkelstein. Treatment issues for alcohol-dependent and drug-dependent pregnant and parenting women. *Health & Social Work* 19(1):7-15, 1994. Citas:**122**
10. M.E. Courtney. Factors associated with the reunification of foster-children with their families. *Social Service Review* 68(1):81-108, 1994. Citas:**121**
11. A. Pines; D. Kafry. Occupational tedium in social-services. *Social Work* 23(6):499-507, 1978. Citas:**116**
12. M.E.M. Barak; J.A. Nisly; A. Levin. Antecedents to retention and turnover among child welfare, social work, and other human service employees: What can we learn from past research? A review and metanalysis. *Social Service Review* 75(4):625-661, 2001. Citas:**115**
13. S.A. Webb. Some considerations on the validity of evidence-based practice in social work. *British Journal of Social Work* 31(1):57-79, 2001. Citas:**114**
14. J.A. Pollard; J.D. Hawkins; M.W. Arthur. Risk and protection: Are both necessary to understand diverse behavioral outcomes in adolescence?. *Social Work Research* 23(3):145-158, 1999. Citas:**111**
15. R.M. George. The reunification process in substitute care. *Social Service Review* 64(3):422-457, 1990. Citas:**107**
16. A. Weick; C. Rapp; W.P. Sullivan; et al. A strengths perspective for social-work practice. *Social Work* 34(4):350-354, 1989. Citas:**106**
17. G. Holden. The relationship of self-efficacy appraisals to subsequent health related outcomes - a metaanalysis. *Social Work in Health Care* 16(1):53-93, 1991. Citas:**103**

18. L. Nelsonzlupko; E. Kauffman; M.M. Dore. Gender differences in drug-addiction and treatment - implications for social-work intervention with substance-abusing women. *Social Work* 40(1):45-54, 1995. Citas:**100**

19. J. Finn. An exploration of helping processes in an online self-help group focusing on issues of disability. *Health & Social Work* 24(3):220-231, 1999. Citas:**96**

20. C.A. Smith. Factors associated with early sexual activity among urban adolescents. *Social Work* 42(4):334-346, 1997. Citas:**95**

21. M.L. Polinsky. Functional status of long-term breast-cancer survivors - demonstrating chronicity. *Helath & Social Work* 19(3):165-173, 1994. Citas:**94**

22. M. Ungar. Resilence across cultures. *British Journal of Social Work* 38(2):218-235, 1973. Citas:**91**

23. C. Jones. Voices from the front line: State social workers and new labour. *British Journal of Social Work* 31(4):547-562, 2001. Citas:**91**

24. A. Bebbington; J. Miles. The background of children who enter local-authority care. *British Journal of Social Work* 19(5):349-368, 1989. Citas:**91**

25. W.J. Reid; P. Hanrahan. Recent evaluations of Social-Work - grounds for optimism. *Social Work* 27(4):328-340, 1982. Citas:**89**

26. J. Arches. Social-structure, burnout, and job-satisfaction. *Social Work* 36(3):202-206, 1991. Citas:**88**

27. A. Rosenblatt. Practitioners use and evaluation of research. *Social Work* 13(1):53-59, 1968. Citas:**88**

28. K.L. Hackl; A.M. Somlai; J.A. Kelly; et al. Women living with HIV/AIDS: The dual challenge of being a patient and caregiver. *Health & Social Work* 22(1):53-62, 1997. Citas:**86**

29. B. Drake; G.N. Yadama. A structural equation model of burnout and job exit among child protective services workers. *Social Work Research* 20(3):179-187, 1996. Citas:**86**

30. M.E. Courtney. Reentry to foster-care of children returned to their families. *Social Service Review* 69(2):226-241, 1995. Citas:**86**

31. E.Z. Brodkin. Inside the welfare contract: Discretion and accountability in state welfare administration. *Social Service Review* 71(1):1-33, 1997. Citas:**84**

32. L. Quine; J. Pahl. Examining the causes of stress in families with severely mentally-handicapped children. *British Journal of Social Work* 15(5):501-517, 1985. Citas:**82**

33. N. Parton. Risk, advanced liberalism and child welfare: The need to rediscover uncertainty and ambiguity. *British Journal of Social Work* 28(1):5-27, 1998. Citas:**81**

34. Y. Hellstrom; I.R. Hallberg. Perspectives of elderly people receiving home help on health, care and quality of life. *Health & Social Care in the Community* 9(2):61-71, 2001. Citas:**80**

35. J.S. Wodarski; P.D. Kurtz; J.M. Gaudin; et al. Maltreatment and the school-age child - major academic, socioemotional, and adaptive outcomes. *Social Work* 35(6):506-513, 1990. Citas:**80**

36. T. Borkman. Experimental knowledge - new concept for analysis of self-help groups. *Social Service Review* 50(3):445-456, 1976. Citas:**80**

37. F.H. Wulczyn; R.M. George. Foster-care in New York and Illinois - the challenge of rapid change. *Social Service Review* 66(2):278-294, 1992. Citas:**79**

38. N.K. Okeeffe; K. Brockopp; E. Chew. Teen dating violence. *Social Work* 31(6):465-468, 1986. Citas:**79**

39. J.C. McMillen; R.H. Fisher. The Perceived Benefit Scales: Measuring perceived positive life changes after negative events. *Social Work Research* 22(3):173-187, 1998. Citas:**78**

40. N. Weinberg; J. Schmale; J. Uken; et al. Online help: Cancer patients participate in a computer-mediated support group. *Health & Social Work* 21(1):24-29, 1996. Citas:**78**

41. C.A. Rapp; R. Chamberlain. Case management services for the chronically mentally-ill. *Social Work* 30(5):417-422, 1985. Citas:**78**

42. E. Peled; Z. Eisikovits; G. Enosh; et al. Choice and empowerment for battered women who stay: Toward a constructivist model. *Social Work* 45(1):9-25, 2000. Citas:**77**

43. R.J. Taylor; L.M. Chatters. Patterns of informal support to elderly black adults - family, friends, and chruch members. *Social Work* 31(6):432-438, 1986. Citas:**77**

44. M. Lipsky. Bureaucratic disentitlement in social-welfare programs. *Social Service Review* 58(1):3-27, 1984. Citas:**77**

45. C.S. Berkman; G. Zinberg. Homophobia and heterosexism in social workers. *Social Work* 42(4):319-332, 1997. Citas:**76**

46. E.C. Killian. Effect of geriatric transfers on mortality rates. *Social Work* 15(1):19-26, 1970. Citas:**76**

47. K.M. Wood. Casework effectiveness - new look at research evidence. *Social Work* 23(6):437-458, 1978. Citas:**75**

48. S.A. Kirk; M.J. Osmalov; J. Fischer. Social-workers involvement in research. *Social Work* 21(2):121-124, 1976. Citas:**75**

49. M.I. Singer; J. Bussey; L.Y. Song; et al. The psychosocial issues of women serving time in jail. *Social Work* 40(1):103-113, 1995. Citas:**74**

50. M. Delgado; D. Hummdelgado. Natural support systems - source of strength in hispanic communities. *Social Work* 27(1):83-89, 1982. Citas:**74**

51. L.H. Staples. Powerful ideas about empowerment. *Administration in Social Work* 14(2):29-42, 1990. Citas:**73**

52. J. Fischer. The social-work revolution. *Social Work* 26(3):199-207, 1981. Citas:**73**

53. T. Evans; J. Harris. Street-level bureaucracy. social work and the (Exaggerated) death of discretion. *British Journal of Social Work* 34(6):871-895, 2004. Citas:**72**

54. M.O. Howard; C.J. McMillen; D.E. Pollio. Teaching evidence-based practice: Toward a new paradigm for social work education. *Research on Social Work Practice* 13(2):234-259, 2003. Citas:**72**

55. A. Al-Krenawi; J.R. Graham. Culturally sensitive social work practice with Arab clients in mental health settings. *Health & Social Work* 25(1):9-22, 2000. Citas:**72**

56. R.J. Taylor; C.G. Ellison; L.M. Chatters; et al. Mental health services in faith communities: The role of clergy in black churches. *Social Work* 45(1):73-87, 2000. Citas:**71**

57. B.W. Lundahl; C. Kunz; C. Brownell; et al. *Research on Social Work Practice* 20(2):137-160, 2010. Citas:**70**

58. B. Berkman. The emerging health care world. Implications for social work practice and education. *Social Work* 41(5):541-551, 1996. Citas:**70**

59. W.D. Harrison. Role strain and burnout in child-protective service workers. *Social Service Review* 54(1):31-44, 1980. Citas:**70**

60. M.M. McKay; J. Stoewe; K. McCadam; et al. Increasing access to child mental health services for urban children and their caregivers. *Health & Social Work* 23(1):9-15, 1998. Citas:**69**

61. M.R. Daley. Burnout - smoldering problem in protective services. *Social Work* 24(5):375-379, 1979. Citas:**69**

62. M.E. Courtney; R.P. Barth. Pathways of older adolescents out of foster care: Implications for independent living services. *Social Work* 41(1):75-83, 1996. Citas:**68**

63. D. Howe. Modernity, postmodernity and social-work. *British Journal of Social Work* 24(5):513-532, 1994. Citas:**68**

64. S. James. Why do foster care placements disrupt? An inestigation of reasons for placement change in foster care. *Social Service Review* 78(4):601-627, 2004. Citas:**67**

65. A. Scharlach; J. Damron-Rodriguez; B. Robinson; et al. Educating social workers for an aging society a vision for the 21st century. *Journal of Social Work Education* 36(3):521-538, 2000. Citas:**67**

66. P. Sable. Pets, attachment, and well-being across the life-cycle. *Social Work* 40(3):334-341, 1995. Citas:**67**

Algunos datos interesantes son los siguientes:

- La revista *Social Work* es la que atesora el mayor número de clásicos de la literatura, 32, lo que representa aproximadamente el 50 %.
- Le siguen en el escalafón de clásicos de la literatura en el área de Trabajo Social las revistas *Social Service Review (10), British Journal of Social Work (8) y Health Social Work (7).*
- Los autores con más clásicos de la literatura son J. Fischer y M.E. Courtney, ambos con tres publicaciones clásicas, y L.M Chatters y R.J. Taylor, ambos con dos publicaciones clásicas.
- Como era de esperar, 54 de estos clásicos fueron desarrollados en universidades americanas, siendo El Reino Unido el siguiente país con más clásicos, 7 clásicos.
- Las dos universidades que destacan en la producción de clásicos son Wisconsin con 5 y Michigan con 4.

El artículo asociado a esta parte es:

- M.A. Martínez, M. Herrera, J. López-Gijón, E. Herrera-Viedma. **H-Classics: Characterizing the Concept of Citation Classics Through H-index**. *Scientometrics*, 98 (2014) 1971-1983. Doi: 10.1007/s11192-013-1155-9.

5. Comentarios Finales y Líneas Futuras de Trabajo

A lo largo de esta memoria de tesis hemos analizado las investigaciones científicas desarrolladas en el área de Trabajo Social de acuerdo a dos de las bases de datos bibliográficas más prestigiosas existentes, WoS y JCR, y mediante los dos tipos de técnicas bibliométricas más importantes existentes para ello, los indicadores bibliométricos de rendimiento e impacto y los indicadores bibliométricos relacionales basados en mapas de ciencia.

Los resultados obtenidos han sido fundamentalmente dos:

- Se ha presentado un estudio bibliométrico del área de Trabajo Social de acuerdo al WoS y al JCR usando indicadores bibliométricos relacionales basados en mapas de ciencia mediante la herramienta de mapas de ciencia SciMAT. De este modo, hemos descubierto los temas y áreas temáticas de investigación que han centrado la atención de la comunidad científica del área de Trabajo Social desde principios del S. XX, los frentes de investigación más importantes, y hemos identificado los temas de mayor impacto y proyección futura.
- Por otro lado, se ha presentado un estudio de los clásicos de la literatura que han suscitado mayor interés en la comunidad científica del área de Trabajo Social. Para ello se ha definido una nueva técnica basada en el H-Index para identificar trabajos altamente citados en áreas científicas, llamada H-Classics. De este modo no sólo hemos descubierto cuales han sido los trabajos que han centrado el interés de la comunidad científica sino también a los principales actores que han aportado las mejores trabajos de investigación.

A través del estudio bibliométrico basado en mapas de ciencia hemos podido identificar cuales son los temas de investigación más activos y de mayor impacto en el área de Trabajo Social, aquellos que están estancados, y también aquellos que tienen mejores perspectivas futuras. Conocimientos muy importante para aquellos miembros de la comunidad científica que quieran empezar su investigación o continuar con nuevos retos, y también para los grupos o centros de investigación que quieran planificar su futura estrategia de investigación.

Por otro lado, con la identificación de los clásicos de la literatura científica de Trabajo Social, hemos descubierto los trabajos que mayor peso han tenido en las investigaciones científicas desarrollados, por tanto, los trabajos que han despertado mayor interés, y en consecuencia, los trabajos que uno debe de conocer si quiere iniciar una investigación en los tópicos relacionados. Al mismo tiempo se han identificado los principales investigadores del área de Trabajo Social, es decir, los autores que más han contribuido al desarrollo del área de Trabajo Social con sus propuestas. Conocimientos muy importante para desarrollar, por ejemplo, la internacionalización de la investigación, un valor en alza en la evaluación de la calidad de la investigación.

A la vista de los resultados obtenidos, nos planteamos algunas líneas de trabajo futuro que nos permitirán ahondar en el conocimiento científico del área de Trabajo Social:

- Realizar un estudio bibliométrico de la red social de investigadores que han soportado los temas de investigación del área de Trabajo Social mediante SciMAT.
- Desarrollar nuevos estudios bibliométricos del área de Trabajo Social, tanto con indicadores bibliométricos de rendimiento e impacto como basados en mapas de ciencia, de acuerdo a otras de las bases de datos más importantes existentes, Scopus y SJR.

- Desarrollar nuevos estudios bibliométricos de acuerdo a Google Scholar.
- Analizar bibliométricamente las investigaciones en el área de Trabajo Social desarrolladas en España.
- Analizar con técnicas bibliométricas de mapas de ciencia las investigaciones en Trabajo Social desarrolladas en USA y en Europa.

Parte II. Publicaciones: Trabajos Publicados, Aceptados y Sometidos

1. Analizando La Evolución Científica del Área de Trabajo Social Mediante el Uso de Análisis de Mapas de Ciencia

Las publicaciones en revista asociadas a esta parte son:

- M.A. Martínez-Sánchez, M.J. Cobo, M. Herrera, E. Herrera-Viedma, Analyzing the Scientific Evolution of Social Work Using Science Mapping. Research on Social Work Practice. doi: 10.1177/1049731514522101, in press (2014).
  - Estado: Publicado online.
  - Índice de Impacto (JCR 2012): 1.355
  - Área de Conocimiento: Social Work. Ranking 5 / 38 (Q1).
- A.G. López-Herrera, E. Herrera-Viedma, M.J. Cobo, M.A. Martínez, G. Kou, Y. Shi, A Conceptual Snapshot of the First 10 Years (2002-2011) of the International Journal of Information Technology & Decision Making. International Journal of Information Technology & Decision Making 11:2 (2012) 247-270. Doi: 10.1142/S0219622012400020.
  - Estado: Publicado
  - Índice de Impacto (JCR 2010): 3.139.
  - Área de Conocimiento: Computer Science, Artificial Intelligence. Ranking 7 / 108 (Q1).
  - Área de Conocimiento: Computer Science, Interdisciplinary Applications. Ranking 7 / 97 (Q1).

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Analyzing the Scientific Evolution of Social Work Discipline Using Science Mapping

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Analyzing the Scientific Evolution of Social Work Using Science Mapping

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Abstract

Objectives: This article reports the first science mapping analysis of the social work field, which shows its conceptual structure and scientific evolution. Methods: Science Mapping Analysis Software Tool, a bibliometric science mapping tool based on co-word analysis and h-index, is applied using a sample of 18,794 research articles published from 1930 to 2012 in 25 main social work journals indexed in the *Journal Citation Reports* of the *Web of Science*. Results: Published research social work field concentrated in eight main thematic areas: children, social services, health care, violence, women, HIV/AIDS, social workers, and education. HIV/AIDS and violence have recently attracted the interest of the social word scientific community, while the rest are classical thematic areas that still attract the interest and efforts of the researchers. Conclusion: This conceptual and empirical analysis shows how research themes have evolved in social work.

Keywords

bibliometrics, science mapping, h-index, social work, information discovering, thematic evolution

Bibliometrics is an important tool to assess and analyze the academic research developed in countries, universities, research centers, research groups, and journals (Holden, Rosenberg, & Barker, 2005a). It provides objective criteria to evaluate research developed by scientists, and, therefore, it is increasingly valued as a tool for assessing scholarly quality and productivity (Moed, De Bruin, & Van Leeuwen, 1995). Bibliometrics contributes to the progress of science in many different ways: allowing assessing progress made, identifying the most reliable sources of scientific publication, laying the academic foundation for the evaluation of new developments, identifying major scientific actors, developing bibliometric indices to assess academic output, and so on. Therefore, bibliometrics has become an essential tool in most scientific areas that aims to progress (medicine, mathematics, economics, computer science, physics, sociology, psychology, etc.), which is also the case with the social work area (Holden et al., 2005a).

In bibliometrics, there are two main approaches to explore a research field: performance analysis and science mapping (Noyons, Moed, & Luwel, 1999a; van Rann, 2004). The former is focused on the citation-based impact of the scientific production. For example, some popular performance metrics are the Journal Impact Factor (Garfield, 1972) and Hirsch index (h-index; Hirsch, 2005). The second approach is focused on the discovering of the conceptual structure of the scientific production by means of science maps. More particularly, it is focused on monitoring a scientific field and delimiting research areas to determine its conceptual structure and scientific evolution (Cobo, López-Herrera, Herrera-Viedma, & Herrera, 2011b; Noyons, Moed, & van Rann, 1999b).

Science mapping analysis aims to discover the structural and dynamic aspects of scientific research (Börner, Chen, & Boyack, 2003; Morris & Van Der Veer Martens, 2008; Noyons et al., 1999a). Science maps or bibliometric maps can be built by means of co-word analysis that uses the most important words or keywords of research documents of a field to study its conceptual structure (Callon, Courtial, Turner, & Bauin, 1983). Although an expert on a particular research field could discover and analyze its different subtopics, it is obvious that the high volume of research documents that are available makes this a difficult and daunting task to be carried out effectively and efficiently. For this reason, it would be helpful and necessary to have the support of intelligent techniques to make easier the analysis of a research area by automatically classifying its research outputs/results into different themes and topics. That

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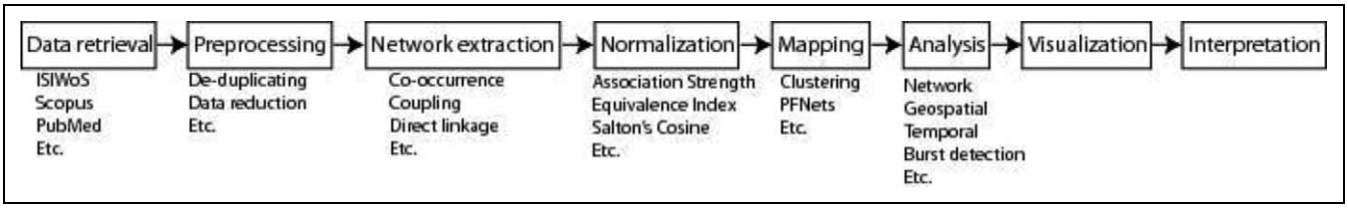

Figure 1. Work flow of science mapping analysis.

is, scientific support tools to uncover the conceptual structure of a research area of interest are worth and necessary. Science mapping tools play that important role within bibliometrics.

As aforementioned, there exists a great interest in developing bibliometric studies in the scientific field of social work to help the understanding of its scientific progress. Most of these bibliometric approaches are mainly focused on the performance analysis based on publication and/or citation analysis applied to journals (Hodge & Lacasse, 2011; Holden, Rosenberg, Barker, & Liol, 2010; Sellers, Perry, Mathiesen, & Smith, 2004; Spivey & Wilks, 2004; Thyer, 2010), researchers (Slater, Scourfield, & Sloan, 2012; Thyer & Bentley, 1986), articles (Blyth et al., 2010; Hodge, Lacasse, & Benson, 2012; Holden, Rosenberg, & Barker, 2005b), or faculties (Bloom & Klein, 1995; Green & Baskind, 2007; Lacasse, Hodge, & Bean, 2011). However, no science mapping analysis has been conducted in the social work field to complete those previous bibliometric studies. The use of science mapping tool could provide us new findings and important information on the dynamic of social work as a scientific discipline, for example, how the social work knowledge base has been formed, which are its scientific knowledge strengths and which topics could be the knowledge base of the social work discipline in the future. Therefore, the use of science mapping tools to analyze the social work field is still in need.

In this article, the first science mapping analysis of the whole social work research field is presented over time. This analysis discloses the field's structure and evolution. The results show which themes have attracted the interest of the social work scientific community from its origins, according to the articles published in the major social work journals, the themes with the highest impact, as well as potential themes for future research. Other relevant research questions that could be answered are what thematic areas have vertebrate the research conducted in the social work discipline, what were the key themes or marginal themes in the different periods of scientific development of the social work area, how different social work research themes are conceptually related in different time periods, what research themes have achieved the greatest impact and attracted the greater interest of the social work scientific community in different time periods, and what thematic areas have achieved the greatest impact and visibility. To do that, the social work research documents published during the period 1930–2012 in the most important social work journals, according to the Thomson Reuters's *Journal Citation Reports* (JCR) and *Web of Science* (WoS), are used. The science mapping analysis is performed using the science mapping software tool Science Mapping Analysis Software Tool (SciMAT; Cobo et al., 2012b) designed and developed by the SECABA Laboratory at the University of Granada (Spain).

Science Mapping Analysis

Science mapping or bibliometric mapping is a spatial representation of how disciplines, fields, specialties, and documents or authors are related to one another (Small, 1999). Science mapping analysis has been widely used to show and uncover the hidden key elements (documents, authors, institutions, topics, etc.) in different research fields (Bailón-Moreno, Jurado-Alameda, & Ruíz Baños, 2006; Cobo et al., 2012a; Gao-Yong, Ji-Ming, & Hui-Ling, 2012; López-Herrera et al., 2012; Peters & Van Raan, 1993; Porter & Youtie, 2009; Tang & Shapira, 2011; Van Eck & Waltman, 2007). The general work flow in a science mapping analysis has a number of different steps (Börner et al., 2003; Cobo et al., 2011a; Cobo et al., 2012b; see Figure 1): data retrieval, preprocessing, network extraction, normalization, mapping, analysis, and visualization. At the end of this process, the analyst has to interpret and obtain conclusions from the results.

There are several possible online bibliographic databases to retrieve data, the most important ones being the WoS (www.webofknowledge.com), Scopus (www.scopus.com), and Google Scholar (scholar.google.com). These databases do not cover the scientific fields and journals in the same way and have their respective advantages and limitations, which are somewhat discipline dependent (Bar-Ilan, 2010; Falagas, Pitsouni, Malietzis, & Pappas, 2008). WoS is the world's leading scholarly literature database in the sciences, social sciences, arts, and humanities, and it also contains proceedings of international conferences, symposia, seminars, colloquia, workshops, and conventions. It is a reference database that provides the most complete current and retrospective quality coverage in the sciences, social sciences, arts, and humanities, going back to 1900. Scopus has the second largest coverage, in terms of citations. Many authors argue that Google Scholar seems to offer greater access to relevant, citable content in the social sciences (Auffhammer, 2009; Harzing & van der Wal, 2008; Hodge et al., 2012; Jacobs, 2009). However, Google Scholar is less rigorous and captures more noise (e.g., nonacademic citations), and it is not adequate for our study mainly because as pointed out in Harzing and van der Wal (2008, p. 65), "Google Scholar does not perform as well for older publications as these publications and the sources that cite them have not (yet) been posted on the web."

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Usually, science mapping analysis cannot be applied directly to the retrieved data from the bibliographic sources because they contain errors. Thus, to improve the quality of the data, a preprocessing step needs to be applied. Different preprocessing methods can be applied, among which it is worth mentioning those that detect duplicate and misspelled items, time slicing (it consists of dividing the data in different periods of time or slices of time, in order to analyze the evolution of the research field under study), and data reduction. Maybe the most important preprocessing method is deduplicating because it is usual to find items spelt differently that represent the same entity. For example, it is common to find the same author's name written in different ways (e.g., Smith, T. E.; Thomas E. Smith). Data reduction is carried out in order to select the most representative data for the analysis, so it is done after the deduplicating process.

Once the data have been preprocessed, a network is built using a unit of analysis, as for example, journals, documents, cited references, authors, author's affiliation, and descriptive terms or words (Börner et al., 2003). Usually, words are the most common. The words can be selected from the title, abstract, author's keywords, the body of documents, or some combinations of them. Furthermore, we can select the indexing provided by the bibliographic data sources (e.g., ISI Keywords Plus) as words to analyze. Several relations among the units of analysis can be established, such as co-occurrence, coupling, or direct linkage. A co-occurrence relation is established between two units (authors and terms or references) when they appear together in a set of documents, that is, when they cooccur throughout the corpus. A coupling relation is established between the documents when they have a set of units in common. A direct linkage establishes a relation between documents and references, particularly a citation relation. In addition, different aspects of a research field can be analyzed depending on the selected units of analysis. For example, using words a co-word analysis can be performed to obtain the conceptual structure of a discipline and the main topics researched in that knowledge field.

When the network of relationships between the selected units of analysis has been built, a normalization process is needed to correct the data for differences in the number of occurrences of units of analysis (van Eck & Waltman, 2009). In bibliometrics, the normalization process is carried out by using similarity measures (van Eck & Waltman, 2009), such as *Salton's cosine*, *Jaccard's index*, or *equivalence index* (Cobo et al., 2012b). Once the normalization process of the network is completed, different techniques could be applied to build science maps, such as *principal component analysis* or *clustering algorithms* (Börner et al., 2003).

Analysis methods of science maps allow the discovery of useful knowledge from data (Cobo et al., 2011b). For example, a *network analysis* (Cook & Holder, 2006) allows to perform a statistical study over the generated maps in order to show different measures of the relationship or overlapping of the different detected clusters, or *a temporal or longitudinal analysis* (Garfield, 1994) aims to show the conceptual, intellectual, or social evolution of a research field, discovering patterns, trends, seasonality, and outliers.

Visualization techniques are used to represent both science maps and the results of the different analysis applied. The visualization technique employed is very important in order to allow a good understanding and better interpretation of the output. For example, the networks resulting from the mapping step can be represented with *thematic networks*; the clusters detected in a network can be categorized using a *strategic diagram*; the evolution of detected clusters in successive time periods (temporal or longitudinal analysis) can be represented by means of *thematic areas.* Furthermore, visualization can be improved using the results of a performance analysis, which allows us to add a third dimension to the visualized elements. For example, a strategic diagram could show spheres where its volume could be proportional to the citations achieved by the documents of cluster. For more information on visualization tools, see Cobo, López-Herrera, Herrera-Viedma, and Herrera (2011a).

Finally, when the science mapping analysis is completed, the analyst has to interpret the results and maps using their experience and knowledge. In the interpretation step, the analyst looks to discover and extract useful knowledge that could be used to make decisions.

SciMAT

Science mapping analysis can be carried out with different software tools. A list of important science mapping software tools were analyzed in Cobo et al. (2011b) Bibexcel, CiteSpace II, CoPalRed, IN-SPIRE, Loet Leydesdorff's Software, Network Workbench Tool, Science of Science (Sci2) Tool, VantagePoint, and VOSViewer. SciMAT was presented in Cobo et al. (2012b). It is a powerful science mapping software tool that integrates into a single software tool the majority of the advantages of available science mapping software tools. SciMAT was designed according to the work flow shown in Figure 1 and also using the science mapping analysis approach presented in Cobo et al. (2011a). SciMAT can be freely downloaded, modified, and redistributed according to the terms of the GPLv3 license. The downloading of the executable file, user guide, and source code can be done via the following website (http://sci2s.ugr.es/scimat).

The science mapping analysis approach defined in Cobo et al. (2011a) is based on a co-word analysis (Callon et al., 1983) and the h-index (Hirsch, 2005), which are applied in a longitudinal framework. The construction of maps using co-word analysis in a longitudinal framework, on the one hand, provides information on the themes or topics of a research field and, on the other hand, enables to analyze and track the evolution of a research field throughout consecutive periods of time (Garfield, 1994). The h-index is used to measure the impact of the different identified themes and thematic areas. Four phases are established to analyze a research field in a longitudinal framework:

1. *Detection of research themes:* This phase summarizes the first five steps of the work flow of mapping science analysis presented in Figure 1. In each studied period of time, the corresponding research themes are detected by

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applying the co-word analysis on raw data for all the published documents on the research field, followed by a clustering of keywords to topics/themes using the simple centers algorithm (Coulter, Monarch, & Konda, 1998). Formally, the methodological foundation of co-word analysis is based on the idea that the co-occurrence of keywords describes the content of the documents in a corpus (i.e., the set of documents belonging to the research field under study; Callon, Courtial, & Laville, 1991). These co-occurrence of keywords can be used to build co-word networks (Krsul, 1998) and these networks can be associated with research themes using clustering tools. The co-word analysis is based on the computation of the co-occurrence frequencies of keywords. The co-occurrence frequency of two keywords is extracted from the corpus of documents by counting the number of documents in which the two keywords appear together. Usually, when co-occurrence data are used, first a transformation function is applied in order to normalize data and, then, similarities from the data are obtained (van Eck & Waltman, 2009). Once the co-word network is built, each arc will have as its weight the co-occurrence value of the linked terms. Next, the weight of each edge is transformed in order to normalize it (extract the similarity relations between terms) using their keyword and co-occurrence frequencies. The similarity between keywords is obtained using the equivalence index (Callon et al., 1991; Michelet, 1988), $e_{ij} = \frac{c_{ij}^2}{c_i c_j}$, where c_{ij} is the number of documents in which both keywords i and j co-occur, and and c_i and c_j represent the number of documents in which each one appears. Note that when two keywords always appear together, the equivalence index equals unity; while it is zero when they are never associated. Research themes are identified by means of a process of clustering which locates the subgroups of keywords that are strongly linked to each other and which correspond to centers of interest or research themes that are the object of significant investment by researchers (Callon et al., 1991).

2. *Visualizing research themes and thematic networks:* In this phase, the detected themes are visualized by means of two different visualization instruments: strategic diagram and thematic network. Each theme is characterized by two parameters defined on its respective network (Callon et al., 1991): *centrality* and *density*. A strategic diagram is achieved by plotting themes using two dimensional spaces based on their centrality and density values. Centrality measures the degree of interaction of a theme with other themes, and it is defined as $c = 10 \times \sum e_{kh}$, with k a keyword belonging to the theme and h a keyword belonging to other themes. The centrality of a theme can be seen as a measure of the importance of that theme in the development of the entire research field analyzed. Density measures the internal strength of the theme, and it is defined as $d = 100\frac{\sum e_{ij}}{w}$, with i and j keywords belonging to the theme and w the number of keywords in the theme. The density of a research theme can be understood as a measure of the development of theme. For example, suppose a co-word network composed of 16 nodes as it is shown in Figure 2, in which three different themes were detected (nodes under a circular shadow) and 3 nodes were free, so that they might be associated with any theme. Density is computed using the intracluster edges, that is, edges linking nodes of the same theme (solid edges inside the circular shadow). For instance, the density values of Theme A, Theme B, and Theme C, shown in Figure 2, are 46.67, 30, and 40, respectively. On the other hand, centrality is computed using the extracluster edges, that is, edges that connect nodes of a specific theme with nodes that do not belong to it (dotted lines). In this sense, the centrality values of the Theme A, Theme B, and Theme C, shown in Figure 2, are 17, 4, and 2, respectively. Then, using a strategic diagram to represent the themes of a research field, a classification into four groups is obtained (see Figure 3; Callon et al., 1991; Cobo et al., 2011a; Coulter et al., 1998):

   a. *Motor themes:* The placement of the motor themes is the upper right quadrant and they present both strong centrality and high-density values. They are both well developed and important or central for the structuring of a research field.
   b. *Highly developed and isolated themes:* The placement of the highly developed and isolated themes is the upper left quadrant. They have well-developed internal ties but unimportant external ties and so are of only marginal importance for the field. These themes are very specialized and peripheral in nature.
   c. *Emerging or declining themes:* The placement of the emerging or declining themes is the lower left quadrant and they present both low density and low centrality. They are both weakly developed and marginal with respect to the research field, mainly representing either emerging or disappearing themes.
   d. *Basic and transversal themes:* The placement of the basic and transversal themes is the lower right quadrant. These themes are important for the development of a research field but internally they are not sufficiently developed.

Note that the addition of a third dimension can enrich the strategic diagrams as this will allow for the representation of further informative data (Cobo et al., 2011a). So, for example, the themes could be represented using spheres with volume proportional to another alternative measure, such as the number of documents associated with the theme or the total number of citations to the documents associated with the theme. On the

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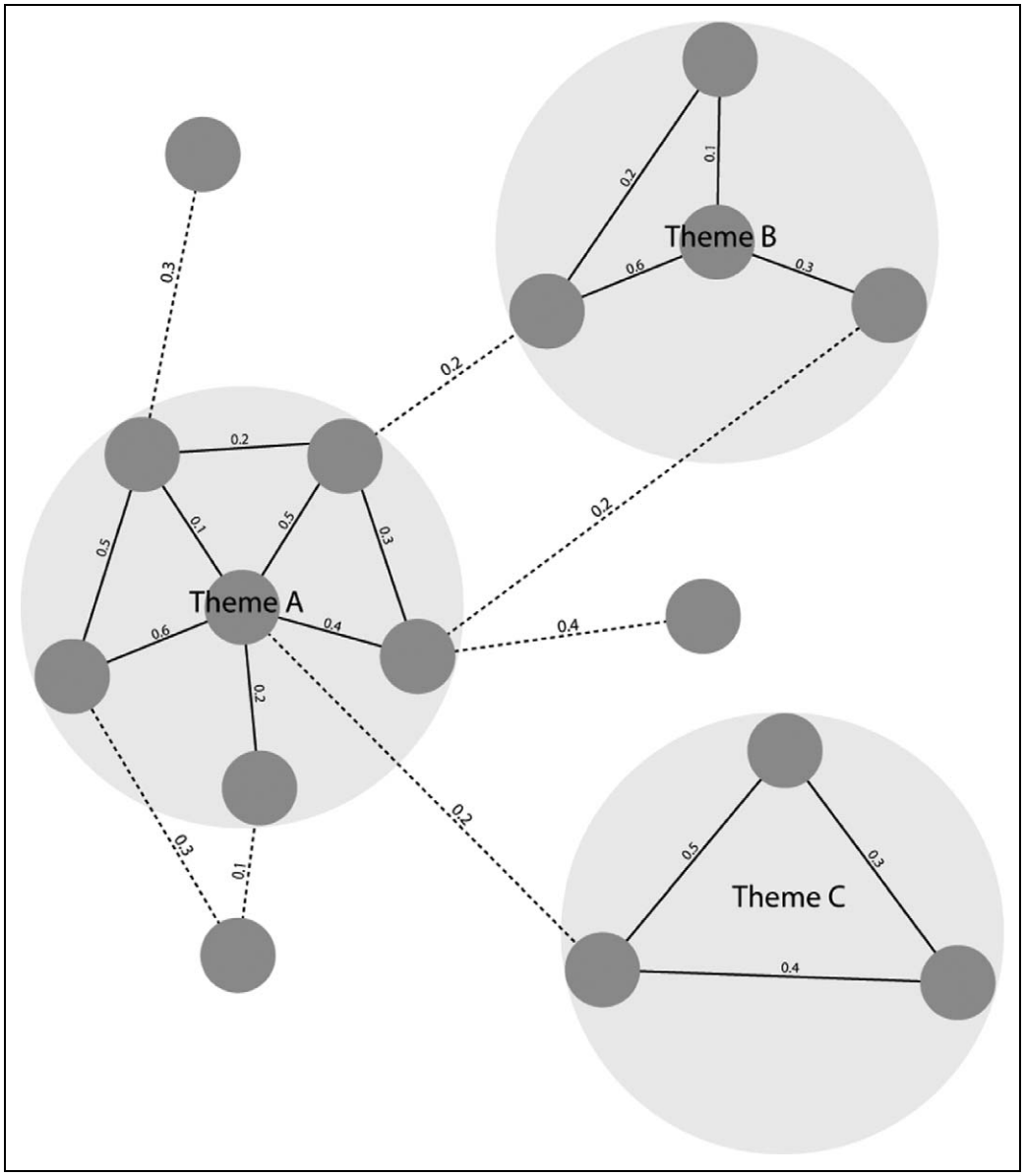

Figure 2. A co-word network to compute centrality and density.

other hand, the keywords of a detected theme together with their interconnections draw a network graph, which is called a thematic network. Each thematic network is labeled using the name of the most significant keyword in the associated theme (usually its most central keyword). An example of a thematic network representing a theme is drawn in Figure 4. Here, several keywords are interconnected, where the volume of the spheres is proportional to the number of documents corresponding to each keyword, the thickness of the link between two spheres i and j is proportional to the equivalence index e_{ij}. The whole network of interconnected themes can also be represented.

1. *Discovery of thematic areas.* In this phase, the evolution of the research themes is analyzed to detect the thematic areas of the research field, their origins, as well as their interrelationships. A thematic area is defined as a group of themes evolving across different periods of time. Note that, depending on the interconnections among them, one theme could belong to a different thematic areas, or could not come from any. An evolution map is built in order to detect the thematic areas. So, if the raw data are divided into different consecutive periods of years, the evolution of the research field could be analyzed in a longitudinal study. An inclusion index is used to detect conceptual nexus between research themes of different periods of time (Cobo et al., 2011a). Let T^t be the set of detected themes of period of time t, with $U \in T^t$ representing each detected theme in the period of time t. Let $V \in T^{t+1}$ be each detected theme in the next period of time $t + 1$. It is said that

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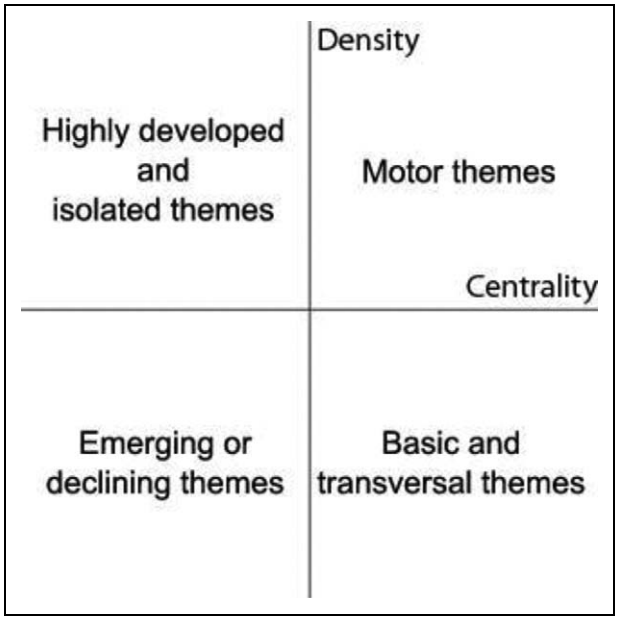

Figure 3. Meaning of a strategic diagram.

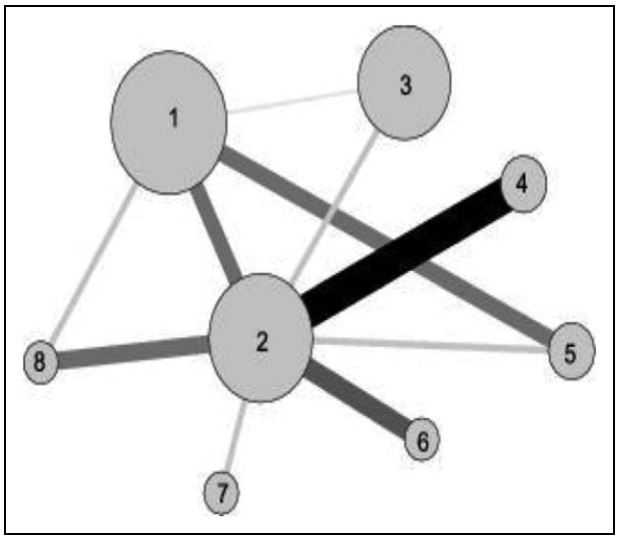

Figure 4. An example of thematic network.

there is a thematic evolution from theme U to theme V if there are keywords presented in both associated thematic networks and, therefore, V can be considered a theme evolved from U. Keywords $k \in U \cap V$ are considered a *thematic nexus*. This can be used to build evolution bibliometric maps by linking themes in T^t with themes in T^{t+1} through the thematic nexus. The importance of a thematic nexus can be weighed by the elements in common to the two themes. An inclusion index is used to carry out this task: Inclusion Index $= \frac{\#(U \cap V)}{\min(\#U, \#V)}$. The inclusion index will be equal to 1 if the keywords of Theme V are fully contained in the Theme U. For example, suppose that we have two different consecutive periods (Period 1 and Period 2) under study, with three detected themes in the first one and four in the second (together with their associated thematic networks). In Figure 5, an example of a thematic evolution bibliometric map is shown. The solid lines (Lines 1 and 2) mean that the linked themes share the same name, both themes are labeled with the same keywords, or the label of one theme is part of the other theme (name of theme $\in$ {thematic nexuses}). A dotted line (Line 3) means that the themes share elements that are not the name of the themes (name of theme $\notin$ {thematic nexuses}). The thickness of the edges is proportional to the inclusion index, and the volume of the spheres is proportional to the number of documents associated with each theme. Vertical lines separate the different periods of time. In Figure 4, two different thematic areas delimited by different color shadows can be observed, one composed of themes Theme A^1 and Theme A^2, and the other composed of themes Theme B^1, Theme B^2, and Theme C^2. Theme D^1 is discontinued, and Theme D^2 is considered a new theme.

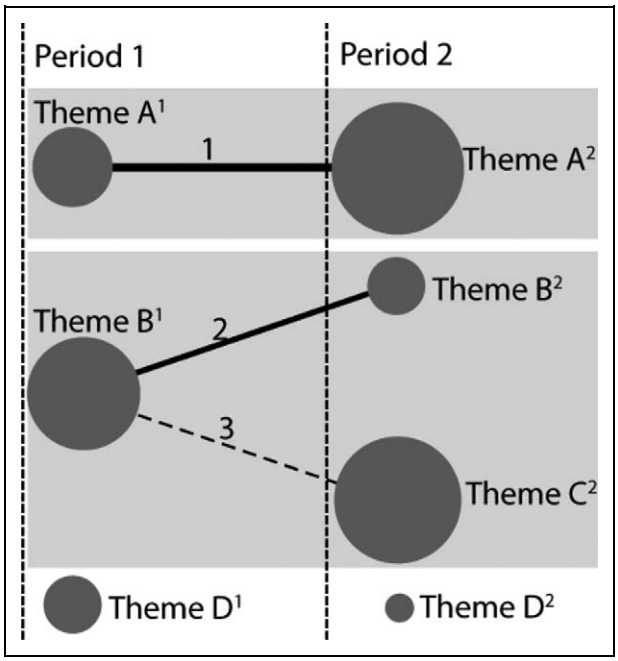

Figure 5. Thematic evolution map.

2. *Performance analysis:* In this phase, the relative contribution of themes and thematic areas to the whole research field is measured using bibliometric performance indicators. In such a way, the most prominent, productive, and highest impact subfields can be established. This performance analysis is developed as a complement to the analysis step of the science mapping work flow shown in Figure 1. Some of the bibliometric indicators to use are number of published documents, number of citations, and different types of h-index (Alonso, Cabrerizo, Herrera-Viedma, & Herrera, 2009; Martínez, Herrera, López-Gijón, & Herrera-Viedma, In Press).

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SciMAT presents three different modules to develop the different steps of the science mapping work flow and also the previous science mapping approach: (i) a module dedicated to the management of the knowledge base and its entities (document, author, affiliation, keyword, reference, author of reference, source of reference, period of time, … etc.), (ii) a module responsible for carrying out the science mapping analysis, and (iii) a module to visualize the generated results and maps. Knowledge base contains the information on the set of scientific documents of the research field under study, as for example, authors, keywords, journal, references, and so on. SciMAT allows importing the data from different bibliographical sources such as WoS and Scopus (RIS format), and cleaning and fixing the possible errors in the five analysis entities considered: author, keyword, reference, author of reference, and source of reference. In the knowledge base, the time slicing process is also established using the period of time entity. On the other hand, the module to carry out the science mapping analysis is implemented through a wizard, where the user can select the methods and algorithms to apply in each step. Although that wizard has been implemented according to the steps of the science mapping work flow described before, some steps are applied in a different order. For example, the deduplicating and time slicing preprocessing has to be carried out first, using the knowledge base manager. So, the work flow of the wizard can be divided into four main stages: (i) selection of the periods of time and unit of analysis, (ii) creation and normalization of the network, (iii) application of a cluster algorithm to get the map, and (iv) performing a set of analysis (e.g., network analysis based on centrality and density criteria, performance analysis based on documents or h-index, evolution bibliometric maps). For more information see Cobo et al. (2012b).

Method

Data Sources

The JCR, provided by Thomson Reuters, is used to construct an adequate list of the core social work journals. The JCR is the most important journal database and provides a yearly ranking of prominent journals in each scientific category, among which the social work category is listed. This ranking is based on the popular journal impact factor (Garfield, 1972). As it is pointed out by Hodge and Lacasse (2011, p. 580) ''Indeed, the JCR is widely recognized as the de facto standard for assessing journal quality across the sciences.'' JCR journals attract the most important contributions of the different scientific disciplines because JCR articles are highly weighted criteria in tenure, promotion, and other professional decisions (Hodge & Lacasse, 2011; Seipel, 2003). Thus, articles accepted in JCR journals are widely viewed as evidence of advances achieved in a scientific discipline. The latest update of the JCR (2012) listed 38 prominent journals in the social work category. However, it is clear that in social work academic circles there is a widespread impression that several JCR social work journals should not be considered true disciplinary journals because their mission and aims are not fully oriented to the social work discipline. For example, extradisciplinary journals like the *Journal of Community Psychology* or the *American Journal of Community Psychology* and interdisciplinary journals like *Family Relations* or *Child Abuse and Neglect* are not usually considered to be social work disciplinary journals. Following this search strategy (Hodge & Lacasse, 2011), a list of 80 disciplinary journals were defined. Within that list it is possible to identify 19 disciplinary journals that were indexed in the social work category of JCR published in 2008. All of them but the *Indian Journal of Social Work* are indexed in the social work category published recently in the 2012 JCR. We have completed that list with six new disciplinary journals indexed in the 2012 JCR social work category. Some of these new disciplinary journals indexed in the JCR 2012 (*Child and Family Social Work*, *European Journal of Social Work*, *Australian Social Work*, and *Social Work in Public Health*) were listed as disciplinary journals in Hodge & Lacasse, 2011), although at that moment they were not indexed in the JCR. Summarizing, 25 social work journals were used in the present study (see Table 1), which were indexed in the social work category of JCR and were selected following seminal articles on how delineating the social work journals (Hodge & Lacasse, 2011; Thyer, 2005, 2010).

To obtain the publications of these journals and their citations, the bibliographic database WoS is used. This bibliographic database provides access to current and retrospective information on the most prestigious, high-impact research journals in the world, and, therefore, it presents the most complete retrospective quality coverage of all scientific disciplines, including the social work discipline (Center for Research Libraries, 1949). A database with this property is appropriate for developing a rigorous science mapping analysis of social work with a longitudinal perspective.

Sample

The first social work articles indexed in the WoS appeared in 1930. Therefore, the sample for this study consists of articles published in the WoS during the period 1930–2012. This sample is further restricted to full-length articles, including literature review articles (e.g., book reviews, editorials, corrections, letters, and notes were excluded). An advanced search was performed on the WoS for articles published in the previous list of 25 social work journals for this period of time. The raw data include 18,794 documents and their citations up to June 2013. The distributions of the documents by years and social work journals are shown in Figure 6 and Table 1, respectively. Seven journals concentrate more than 60% of the scientific production considered in the present study: *Social Work*, *British Journal of Social Work*, *Social Service Review*, *Social Work in Health Care*, *Indian Journal of Social Work*, *Clinical Social Work Journal*, and *Research on Social Work Practice*. For each document, the complete information provided by the WoS was retrieved, that is, authors, affiliations, title, abstract, keywords, keywords plus, references, citations, source, and so on.

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Table 1. List of Core Journals in the Social Work Field.

Journal	First Edition	Number of Articles Retrieved	Impact Factor (2012 JCR)
Research on Social Work Practice	1991	958	1.355
Journal of Social Work	2008	118	1.233
Health & Social Work	1994	537	1.178
Social Service Review	1956	1,559	1.140
British Journal of Social Work	1971	1,794	0.995
International Journal of Social Welfare	1991	532	0.956
Social Work	1956	2,997	0.867
Child & Family Social Work	2007	265	0.831
Social Work Research	1994	398	0.800
Social Work in Health Care	1975	1,407	0.698
Journal of Social Work Practice	1994	383	0.695
International Social Work	1995	722	0.653
Administration in Social Work	1980	817	0.566
Journal of Social Work Education	1985	852	0.548
European Journal of Social Work	2008	164	0.517
Australian Social Work	2009	124	0.500
Clinical Social Work Journal	1974	1,053	0.494
Journal of Social Service Research	1994	446	0.449
Families in Society-the Journal of Contemporary Social	2005	457	0.442
Affilia-Journal of Women and Social Work	1994	453	0.383
Smith College Studies in Social Work	1930	908	0.361
Social Work in Public Health	2009	155	0.354
Asia Pacific Journal of Social Work and Development	1995	242	0.107
Ljetopis Socijalnog Rada	2007	121	0.095
Indian Journal of Social Work	1975	1,332	0.014 (JCR-2011)

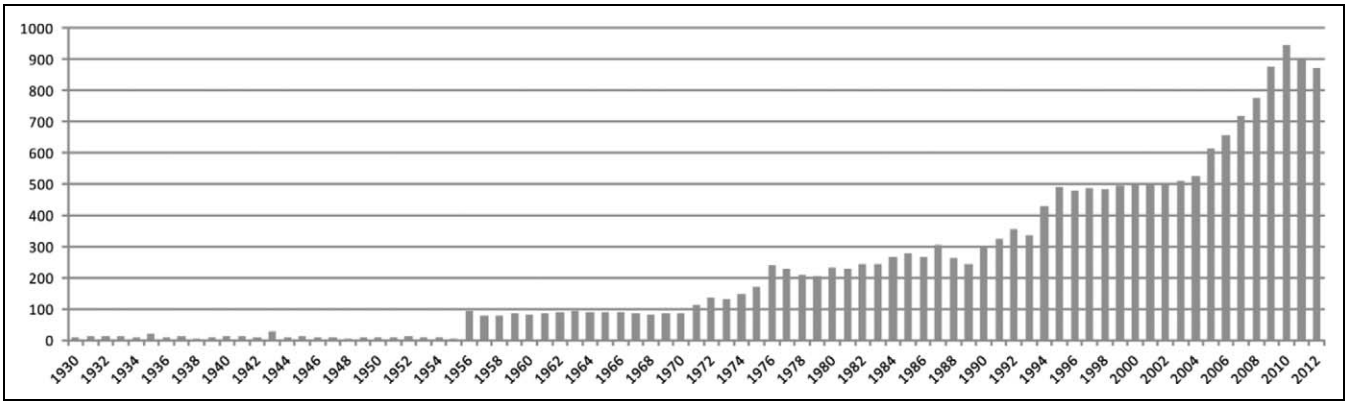

Figure 6. Distribution of documents retrieved by years.

Procedure

The raw data were downloaded from WoS as plain text and entered into SciMAT to build the knowledge base for further science mapping analysis. Thus, it contains the bibliographic information stored by WoS per each research document. For instance, title, abstract, keywords (both author keywords and ISI Keywords Plus), source, issue, number, pages, doi, citations count, authors, affiliations, references, and so on. To improve the data quality, a deduplicating process was applied (the author's keywords and the ISI Keywords Plus were used as unit of analysis). Those words representing the same concept were grouped. Because some documents did not contain any keywords, a manual addition of descriptive keywords matching title words with keywords present in the knowledge base was carried out for completeness purposes. Furthermore, some meaningless keywords in this context, such as stop words or words with a very broad and general meaning, for example, Social Work, were removed. A total number of 22,140 keywords were used in this study. Table 2 shows the top keywords with frequency in the corpus higher than 300.

Next, using the period manager of SciMAT, the periods of time of the longitudinal analysis were established. To avoid data smoothness, the best option would be to choose periods spanning only 1 year. In our case, in a span of 1 year it was found that there was not enough data for a good performance

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Table 2. Top Keywords of the Study.

Keywords	Frequency
Health care	1,459
Children	1,242
Families	943
Women	829
Mental health	739
Services	729
Social workers	706
Perspective	505
Education	499
Adolescents	483
Policy	467
Social work education	399
Community	395
Stress	394
Welfare	386
Outcomes	354
Risk	348
Attitudes	335
Depression	329
Parents	325
HIV/AIDS	322
Poverty	317
Social support	315
Psychotherapy	311
Child welfare	301
Mothers	300

of science mapping analysis. Therefore, the whole time frame (1930–2012) was divided into the following three consecutive periods of time: 1930–1989, 1990–2002, and 2003–2012. In these periods of time, 5,725, 5,676, and 7,393 documents indexed in the WoS were found, respectively. The first period of time encompasses a greater number of years compared to the other two periods of time, but it was decided to make this distribution of years because (i) in the early years of research in the social work field there were few documents per year and, in order to detect correctly the themes of a discipline it is necessary to define more or less homogeneous periods of time with respect to the number of documents (Cobo et al., 2012a, 2012b; López-Herrera et al., 2012); (ii) experience from previous studies of science mapping analysis (Cobo, Chiclana, Collop, de Oña, & Herrera-Viedma, In Press; Cobo et al., 2011a, 2011b, 2012a, 2012b) indicates that an excessive number of periods of time hampers the mapping and interpretation of thematic areas; and (iii) although the three periods of time could be distributed in an alternative way, we believe that it would be interesting for the research community to have an analysis of how the social work discipline has evolved in the last two decades.

When the knowledge base is cleaned up and the groups and periods of time are defined, the next step is to configure the experiment. To perform the analysis, the following configuration in SciMAT was established: word as the unit of analysis, co-occurrence analysis as the tool to build the networks, equivalence index as the similarity measure to normalize the networks, and the simple centers algorithm as the clustering algorithm to detect the clusters or themes. The bibliometric measures chosen were the citation total and the h-index calculated for the documents mapped to each theme. For each period of time, two important parameters were also configured, the threshold of the keyword frequency and the threshold of the co-occurrence frequency: (6, 4), (10, 5), and (20, 7), respectively. The thresholds were increased in each period of time because the number of keywords managed in each period of time was growing significantly from 2,782 to 6,033 and to 13,325, respectively. Thus, the threshold values must be adjusted in order to find the appropriate thematic granularity to allow interpreting the results (Cobo et al., 2012a).

In what follows, the results of present study are shown: The social work research themes detected for each period of time and the thematic evolution of the social work field through periods of time.

Results

Social Work Research Themes

In order to analyze the most highlighted themes of the social work field for each period of time, a strategic diagram is provided. In each diagram, the sphere size is proportional to the number of documents associated with each research theme, and corresponding citations in brackets.

First period (1930–1989). According to the strategic diagram presented in Figure 7, during this period of time the social work research activity pivots on 12 themes, with the following 7 major themes (motor themes plus basic themes): children, social workers, services, patient, social services, administration, and women. The performance measures of the period themes are given in Table 3: the number of documents, the citations to those documents, and h-index of the documents. According to the performance measures, the following six relevant themes are highlighted: children, social workers, services, women, social services, and community. Children is a motor theme of this period of time and it represents the research conducted on children with mental illness, children protection, foster care, children of gays and lesbian, divorce (how to affect . . .), abuses/incest. It is the most important and developed research theme of the social work discipline during the period of time, with the largest number of documents, citations, and highest research impact (h-index = 28). On the other hand, social workers is a basic and transversal theme, and it is the second most important theme of this period of time, also presenting high scores in performance measures. This theme comprises research conducted on different aspects of the social workers, such as bureaucracy, elementary techniques, training, responsibility, how to prepare a good professional, and, moreover, how is the collaboration between social workers and physicians. According to the performance measures, the research achieved on the themes services, women, social services, and community is also very important in this period of time. Services refers to the research conducted on social work agencies

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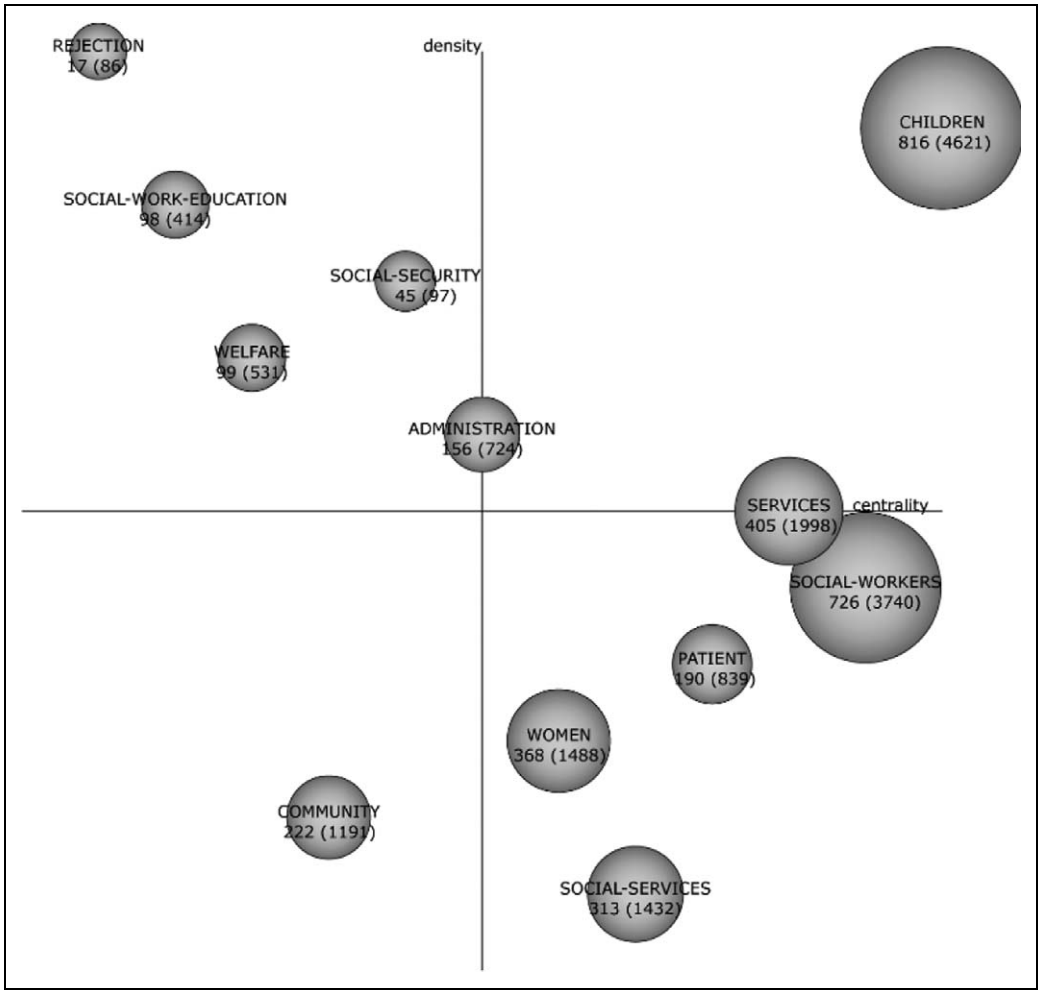

Figure 7. Strategic diagram for the period 1930–1989.

Table 3. Performance Measures for the Themes (1930–1989).

Themes	Documents	Citations	h-Index
Children	816	4,621	28
Social workers	726	3,740	23
Services	405	1,998	17
Women	368	1,488	18
Social services	313	1,432	16
Community	222	1,191	16
Patient	190	839	13
Administration	156	724	13
Welfare	99	531	13
Social work education	98	414	98
Social security	45	97	11
Rejection	17	86	6

and international agencies, activity of voluntary workers, different aspects of case work; women is related to the research conducted on women's liberation, therapist's attitudes, abortion, and the access to social services; social services refers to research conducted on social policy and management, urban problems (poverty in the city, lower class culture, the city's Black community, urban social policy), and the help with personal problems (personal construct theory); community is focused on research aspects related to Black community, the power of social work in the community, work programs for the community, and the power of social intervention in the community. It is worth mentioning that the research conducted on the emerging theme community is highlighted as having fewer documents but achieving a similar impact (measured by the h-index) to basic themes of discipline with more documents as is the case with social services.

Second period (1990–2002). The research was focused on 16 themes (see Figure 8). In this case, according to the strategic diagram, 8 major themes can be identified (motor themes plus basic themes): dementia, stress, violence, HIV/AIDS, children, health care, social workers, and community. However, the motor themes dementia, stress, violence, and HIV/AIDS are the most influential ones for the structuring of the social work research field because they are well developed and they are central to the social work research field during this period. With respect to performance measures, shown in Table 4, six themes stand out for the citation and h-index: the basic theme

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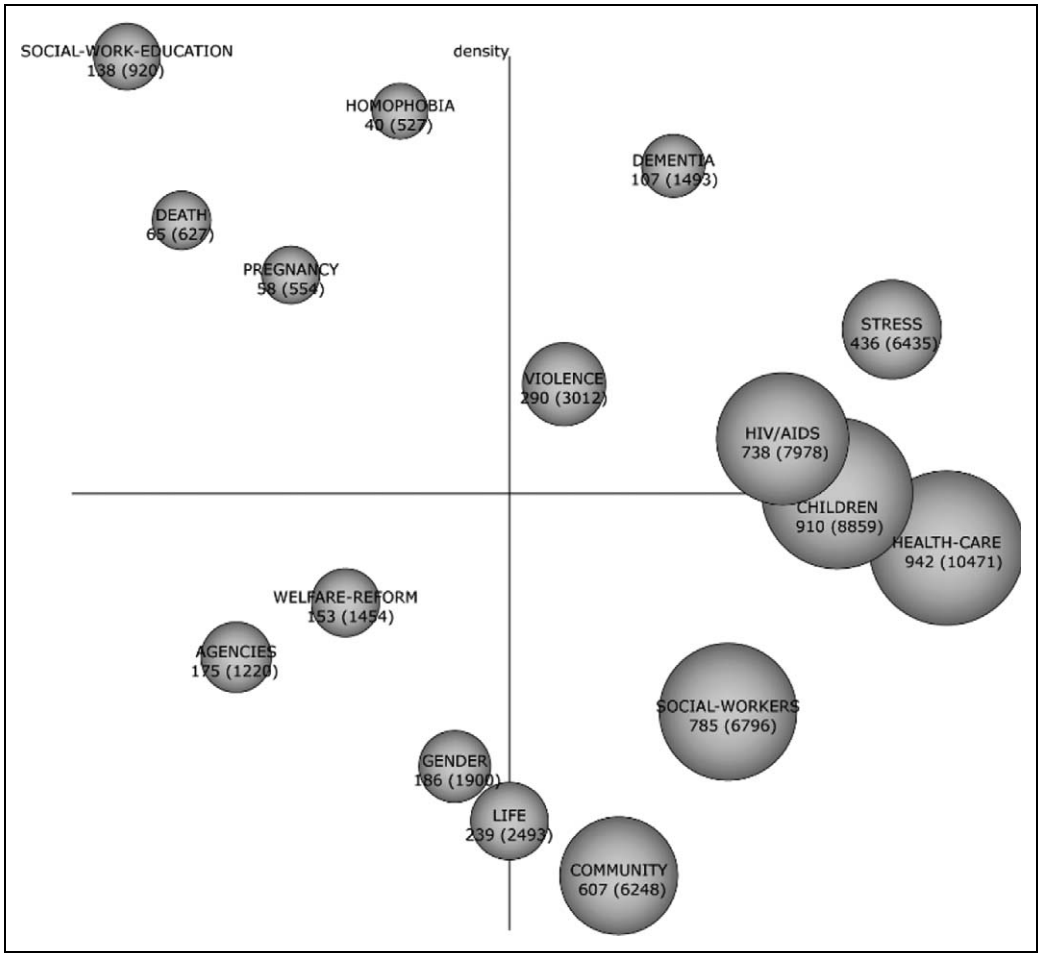

Figure 8. Strategic diagram for the period 1990–2002.

Table 4. Performance Measures for the Themes (1990–2002).

Themes	Documents	Citations	h-Index
Health care	942	10,471	40
Children	910	8,859	36
Social workers	785	6,796	33
HIV/AIDS	738	7,978	36
Community	607	6,248	34
Stress	436	6,435	37
Violence	290	3,012	26
Life	239	2,493	25
Gender	186	1,900	21
Agencies	175	1,220	19
Welfare reform	153	1,454	18
Social work education	138	920	16
Dementia	107	1,493	22
Death	65	627	13
Pregnancy	58	554	14
Homophobia	40	527	14

health care presents the highest performance scores (h-index = 40), and children, social workers, HIV/AIDS, community, stress are also important themes with citations above 6,000 and h-index greater than 33. Health care is focused on the social worker intervention in mental health problems (as depression), chronic health problems, collaboration between social workers and physicians, and older people health problems; children in this period refers to substance abuse such as alcohol or drug in children, early sexual activity, foster care, child mental health, kinship care, custody on divorces, families, foster care reentry, child protective services, children risk factor, and child abuse; social-workers, as in the previous period, represents the research developed on different aspects of the profession, such as, ethical and legal concerns, job satisfaction, therapists, and skills; HIV/AIDS is focused on HIV/AIDS and its relation with drug use and collective gay, prevention rules, and also on how it affects maternity and parenting; community refers to different social problems that affect to the community as substance abuse, poverty, policy, education, home care; stress deals with stress maltreatment, burnout, social and community support as a moderator of stress, social support networks, and stress and burnout in social workers. Notice that there is also a set of themes with acceptable performance indicators: motor themes violence (h-index = 26) and dementia (h-index = 22), and the four emerging themes life, gender, agencies, and welfare reform (h-index = 25, 21, 19, and 18, respectively). Violence is a theme related to the research conducted on violence child

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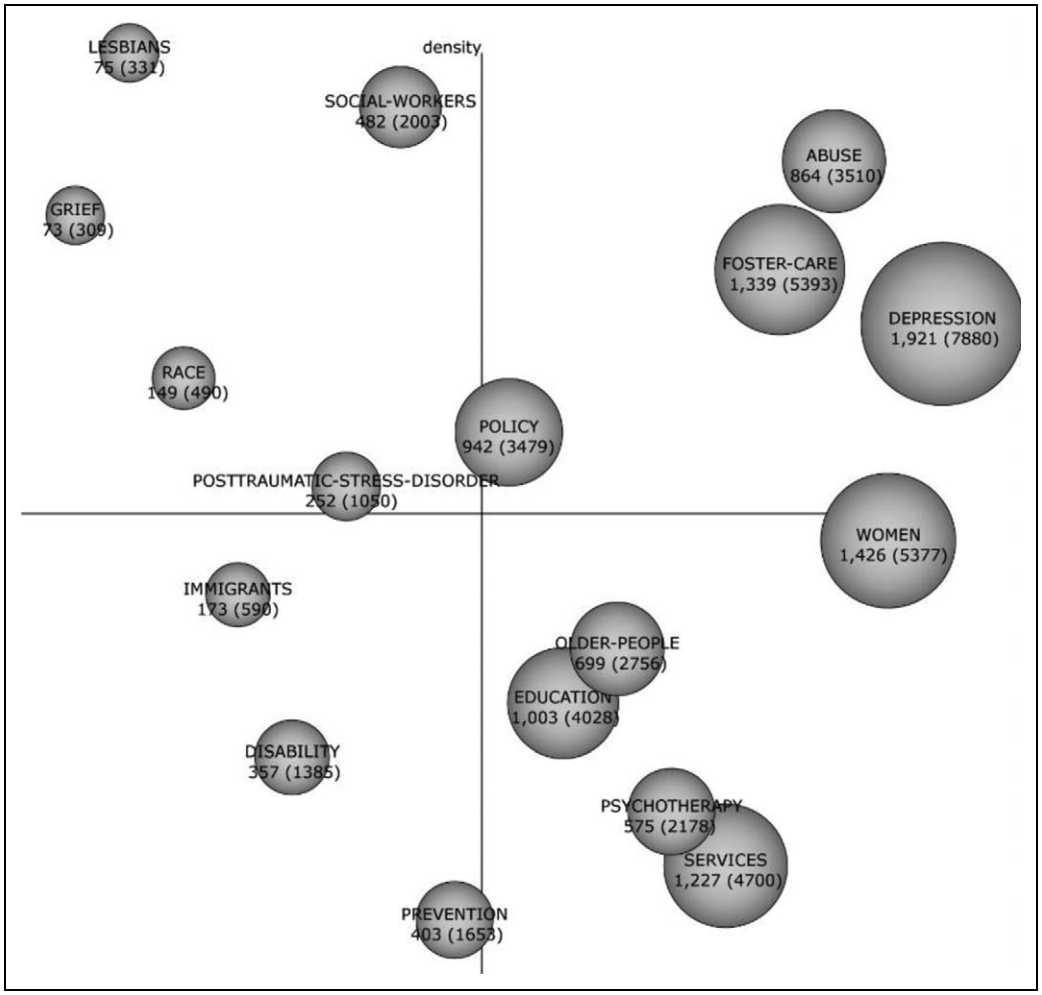

Figure 9. Strategic diagram for the period 2003–2012.

welfare, abuse, battered women, victims, sexual abuse, domestic violence, the posttraumatic stress disorder; dementia represents the research conducted on mental health problems as dementia or Alzheimer's disease, and also the family burdens that cause these mental health problems; life deals with studies on patients and how the illness affects their quality of life; gender refers to research conducted on social problems as racial differences, studies of gender differences in drug addiction and social support, and women problems related to the employment; agencies is a theme focused on social service agencies, administration and social work, and human service organizations (as services in the prior period); welfare reform is related to research conducted on the state of welfare and how the various implemented policies have affected such state. The theme social work education continues appearing as a specific theme like in the previous period, which is internally well structured, but it appears to be rather peripheral to the work being carried out in the research field. The relevance of the research conducted on the motor theme dementia is also highlighted as having few documents but achieving a high impact measured with a 22 h-index.

Third period (2003–2012). The research conducted in this period of time is distributed in 16 social work themes (see Figure 9), with 9 major research themes (motor themes plus basic themes): foster care, depression, abuse, women, education, policy, older people, psychotherapy, and services. In this period of time, the motor themes foster care, depression, abuse, and policy are the most influential ones for the structuring of the social work research field. With respect to performance measures (Table 5), a greater number of research themes (10 themes) stand out for the citation (over 2,000 citations) and h-index (over 19): depression, women, foster care, services, education, policy, abuse, older people, psychotherapy, and social workers. Depression is the leading theme of the period of time, with its research arousing great interest as evidenced by the 7,880 citations and h-index of 28. Depression is a theme that represents research conducted on mental health problems, as it happens with the theme dementia in the previous period of time, but in this case, depression is focused on the problems of depression. The research conducted on a group of four themes reaches significant impact with citation above 4,000 and h-index of 23 or 24: women, foster care, services, and education. Women

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Table 5. Performance Measures for the Themes (2003–2012).

Themes	Documents	Citations	h-Index
Depression	1,921	7,880	28
Women	1,426	5,377	23
Foster care	1,339	5,393	24
Services	1,227	4,700	23
Education	1,003	4,028	23
Policy	942	3,479	22
Abuse	864	3,510	22
Older people	699	2,756	20
Psychotherapy	575	2,178	20
Social workers	482	2,003	19
Prevention	403	1,653	18
Disability	357	1,385	15
Posttraumatic stress disorder	252	1,050	15
Immigrants	173	590	11
Race	149	490	11
Lesbians	75	331	10
Grief	73	309	9

refers to both research conducted on HIV/AIDS and the women (e.g., mothers with HIV/AIDS) and studies on problems to solve during the pregnancy (e.g., depression problems); foster care is related to research conducted on children, home care, child welfare, and youth problems; services is focused on issues related to the management of social services and case management in hospital, in interdisciplinary collaborations, and in substance abuse; education deals with the research conducted on educational and training issues for social workers (challenges and trends). Research conducted on training and educational aspects of the social work discipline is consolidated as an important issue in this period of time, which is represented by the basic theme education. In previous periods, it was called social work education and was considered an isolated issue that concerned an active group of researchers. However, it appears to be rather peripheral to the work being carried out in the social work research field. Other themes of interest that capture good performance indices are policy, abuse, older people, psychotherapy, and social workers: policy deals with research on policies to maintain the welfare state, social protection, poverty reduction, and so on, and also on public funds being allocated to these policies; abuse includes research conducted on maltreatment, child maltreatment, prevention of child abuse, battered women, domestic violence, and child protection; older people refers to research conducted on these topics, caregivers, Alzheimer, home health care, long-term care, community care, and grandparents caring children; psychotherapy includes aspects of psychotherapy and social work and especially with its use to treat schizophrenia problems; social workers is similar to previous periods of time. Social workers is considered a peripheral and isolated theme in this period of time, while in previous periods, it was a basic theme of research in social work. However, social workers achieve good performance scores in the period of time with citations over 2,003 and h-index of 19. The research conducted on prevention, represented by the emerging theme prevention (related to violence prevention and HIV/AIDS prevention) arouses the interest of the community as it is shown by its 1,653 citations and h-index of 18.

Thematic Evolution of the Social Work Research Field

Using SciMAT, an analysis of the themes detected in each period of time by considering their keywords and evolution across time was developed. In such a way, the thematic areas that concentrate the research conducted in the social work discipline were identified. So, 10 thematic areas were detected: children, social services, health care, violence, women, HIV/AIDS, lesbian, gay, bisexual, and transgender (LGBT), social workers, education, and grief (related to chronic illness, hospice, assisted suicide, terminal illness, caregiver grief, and end-of-life decisions). They are shown in the thematic evolution map given in Figure 10. As aforementioned, in this map the solid lines mean a thematic nexus, a dotted line means that the linked themes share keywords different to the name of the themes, the thickness of the edge is proportional to the inclusion index, and the sphere size is proportional to the number of retrieved documents in each theme. Furthermore, the different shadows are used to group the themes that belong to the same thematic area.

Structural analysis of the evolution of the social work scientific field. According to Figure 10, the research developed in the social work field presents a great cohesion due to the fact that the majority of detected themes are grouped under a thematic area and they come from a theme appeared in the previous period of time. Furthermore, there are no gaps in the evolution of the majority of thematic areas. Six scientific areas have been present in the social work scientific discipline in the three periods of time analyzed, and, thus, they could be considered as the classical thematic areas: children, social services, health care, women, social workers, and education. Most of these thematic areas present a positive growth pattern, because since their origin they have been growing in the number of themes discussed. For example, this happens in the cases of children, social services, health care, women, and social workers. However, research conducted in the social work area was not limited only to explore questions in those six thematic areas. The social work scientific community is a dynamic community that has faced new challenges and problems posed by society. Four new research areas have aroused the interest of the social work scientific community: violence, HIV/AIDS, LGBT, and grief. All of them were born in the second period of time. Furthermore, in the third period of time the theme immigrants seems to be the germ of a new thematic area of interest, given that it is an emergent theme according to Figure 9. Regarding the evolution of the number of documents (see the size of spheres that make up each thematic area), most thematic areas show significant growth, except for LGBT and Grief. Therefore, scientific communication has grown consistently around eight thematic areas.

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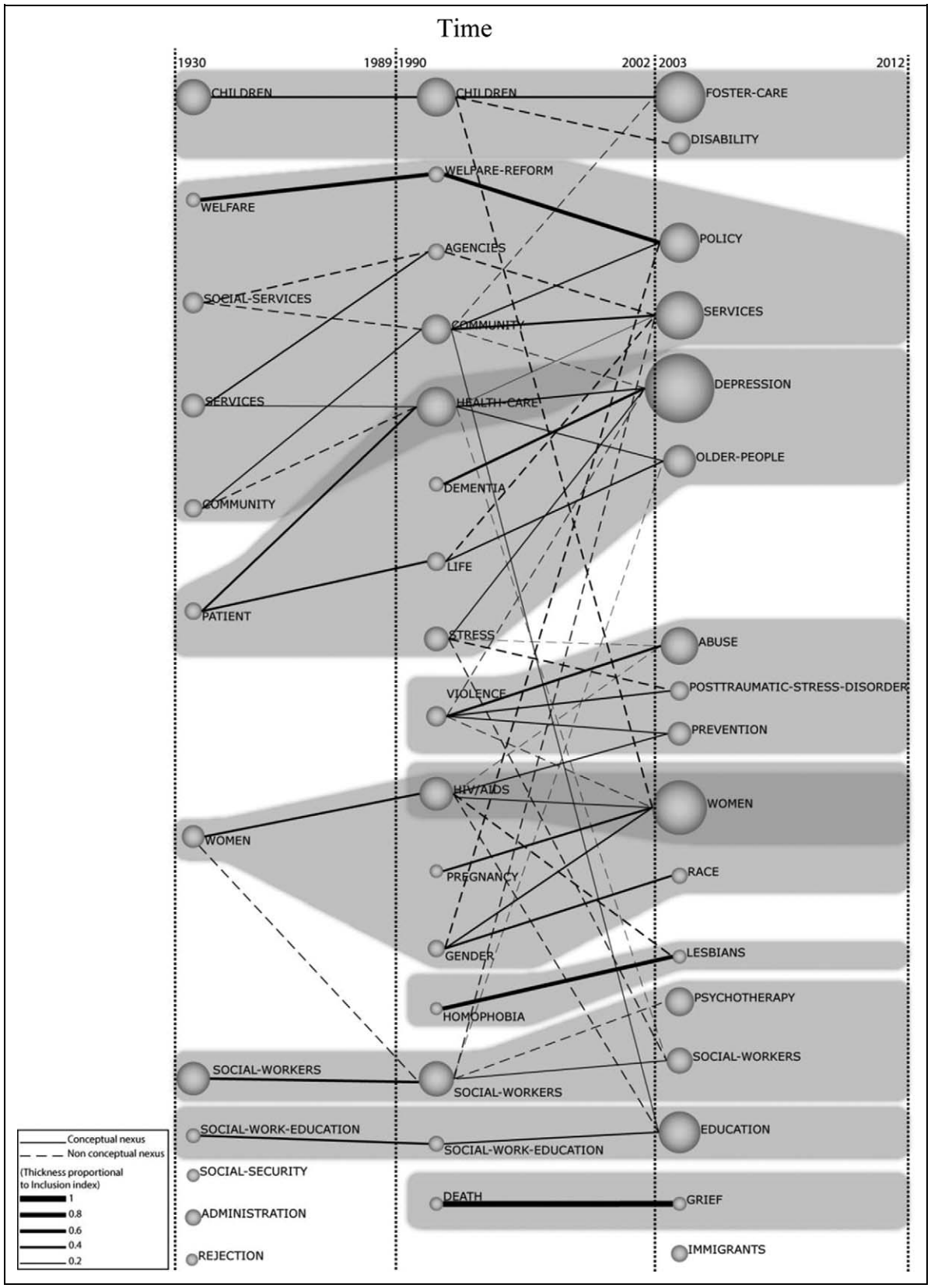

Figure 10. Thematic areas and evolution of the social work research field through periods of time.

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Table 6. Performance Measures for the Thematic Areas.

Themes	Documents	Citations	h-index
Social services	4,651	29,183	49
Health care	3,879	26,335	48
Children	3,295	19,772	42
Women	2,800	16,516	39
Social worker	2,534	14,603	37
HIV/AIDS	2,164	13,355	38
Violence	1,564	8,003	31
Education	1,239	5,362	26
Grief	138	936	15
LGBT	115	858	16

Note. LGBT = lesbian, gay, bisexual, and transgender.

Performance analysis of the evolution of the social work scientific field. In Table 6, performance measures of the thematic areas are provided. Two areas stand out over the rest in terms of citation and h-index, social services (29,183 citations and h-index = 49) and health care (26,335 citations and h-index = 48). In both cases, the evolution of their impacts (h-index) shows a rising trend, that is, in the last periods of time the h-index of their themes put them at the group of leader themes of those periods of time, while this was not the case in the first period of time. Therefore, both themes continue to attract the interest of the social work scientific community according to citations and h-index. There is a second group of thematic areas with good performance scores: children, social workers, women, HIV/AIDS, and violence. However, the evolution of their impact (h-index) is quite different. Both children and women are thematic areas with a stable impact, that is, in all periods the h-index of their themes put them in the group of important themes. Therefore, the research conducted on children and women generated and continues to generate much scientific interest in the social work community. However, the impact of social workers presents a downward trend, that is, in the early periods the h-index of their themes put it at the group of leader themes of the period, while in the last period it does not. Therefore, the research conducted on social workers generated much scientific interest in the social work community, but in recent periods of time the interest seems to be fading. Both thematic areas HIV/AIDS and violence have their origin in the second period of time, and they show a rising impact according to the h-index of their themes associated in the last periods of time. The thematic area education presents an acceptable impact (h-index = 26). In fact, its impact has evolved very positively, especially in comparison with the research developed in the last period, since its h-index placed it in the group of important themes. Therefore, research conducted on education has aroused great interest in the social work scientific community in recent years. Both thematic areas LGBT and grief have the lowest impact values: h-index = 16 and h-index = 15, respectively. They are new social work thematic areas that originated in the second period of time, but they have not had a significant increase in their impact. They could be considered peripheral thematic areas. In fact, all their themes associated are peripheral and isolated according to the strategic diagrams shown in Figures 8 and 9.

Discussion, Limitations, and Application in Social Work

SciMAT was applied to analyze the conceptual structure of social work scientific field. How the research conducted on the social work field has evolved in its research themes between 1930 and 2012 was also analyzed. The coding phase of the analysis led to two interesting findings:

i. *The quality of the social work academic journalism has increased:* 25 social work core journals indexed in the database JCR of Thomson were found, which represents an increase in number compared to the 19 of previous studies (Hodge & Lacasse, 2011; Hodge et al., 2012). Therefore, the quality of social work academic journalism increased according to the hegemonic database JCR. We were surprised by the number (three more journals) of non-U.S. and non-U.K. social work core journals that were indexed in the JCR in comparison with previous studies: *European Journal of Social Work*, *Australian Social Work*, and *Ljetopis Socijalnog Rada*. This would indicate that in other countries, the social work scientific community was working according to the international quality standards and, as a consequence, they were developing quality social work journals that allowed a higher presence of social work scientific research carried out in other countries in the international social work context.
ii. *The quantity of social work scientific publications has increased considerably throughout the years:* The social work academic community increased through time, and the active researchers used the JCR scientific journals more to disseminate their work (see Figure 6). It is believed that this deviation was a result of the promotion policies followed in the social work scholarship (Green & Baskind, 2007; Seipel, 2003).

The study of the evolution of social work research themes led to the discovery of the research conducted on the social work field being focused on 10 main thematic areas: children, social services, health care, violence, women, HIV/AIDS, LGBT, social workers, education, and grief. Combining the science maps (strategic diagrams and evolution maps) with the performance indicators (citations and h-index), eight thematic areas were considered as core areas of social work scientific discipline: children, social services, health care, violence, women, HIV/AIDS, social workers, and education. Furthermore, six of these core thematic areas were identified as classical thematic areas, because they were present in all the time periods analyzed: children, social services, health care, women, social workers, and education. An overall analysis of all strategic diagrams clearly showed an increase in the number of themes over time and, thus, the emergence of a more diverse

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and complex social work scientific discipline. However, the social work field presented a continuous, consistent, and cohesive growth, because there were no gaps in their thematic areas and the most of research themes were grouped in a thematic area.

On the other hand, analyzing the thematic areas in detail, results obtained indicate that research conducted in the social work scientific discipline was primarily focused on four fronts of research:

i. *Investigations on the most vulnerable beings in society:* Thematic areas such as children, women, LGBT, and research themes such as older people and immigrants supported this research front. The primary mission of social work, as articulated in the National Association of Social Workers (NASW, 1996, p. 1) Code of Ethics is "to enhance human well-being and help meet the basic human needs of all people, with particular attention to the needs and empowerment of people who are vulnerable, oppressed, and living in poverty." Therefore, the social work profession is characterized by maintaining its focus on advocating for the needs of the most vulnerable segments of society and improving their well-being. No doubt, in our society children and women are among the living beings considered vulnerable and very sensitive to social changes and life economic crises, and, consequently, they always are and will be of interest to the social work scientific community. For example, in the case of thematic area children, research theme foster care was an important topic because families frequently used foster care and, consequently, different social work research niching that affected children, families, and the public administration appeared (McBeath & Meezan, 2008; Schofield et al., 2011). But, in the 21st century, new big challenges that directly affect the children must be faced. For example, the impact of a population close to overwhelming the earth's natural resources (Newman, Todd, & Ploeg, 2011) or the impact of digital technology, which is transforming how we communicate, consume, learn, and engage (Sen & Broadhurst, 2011). On the other hand, LGBT was other thematic area that also represented a vulnerable segment of the society and thus, it also received the interest of the social work scientific community, although peripherally, as aforementioned. Older people and immigrants were important research themes that represented emergent problems of our society, that is, the challenge of aging populations and the problem of immigration, respectively. Clearly, both themes will have to be faced in the future too, and, therefore, both will continue being interesting for the social work scientific community (Allen & Glasby, 2013; Christie, 2013). Different social work associations, such as the NASW (www.socialworkers.org), the International Federation of Social Workers (http://ifsw.org), and the International Association of Schools of Social Work (http://www.iassw-aiets.org) highlighted the adoption of human rights as a foundation principle upon which all of social work theory and practice rest (Healy & Link, 2012). The existence of this research front, focused on the vulnerable agents of the society, showed that the social work scientific activity was also hardly linked with the defense of the human rights.

ii. *Investigations on the social services provided to the society:* The thematic area social services, which was characterized as the most important thematic area in the social work scientific discipline, supported this research front. This thematic area was also considered as a classical area and was related to the research conducted on the different private and/or public social policies and programs and services implemented to address various social problems that plagued the modern society during the 20th century. As it is noted by National Association of Social Workers (2013), "Social work practice consists of the professional application of social work values, principles, and techniques to one or more of the following ends: helping people obtain tangible services; counseling and psychotherapy with individuals, families, and groups; helping communities or groups provide or improve social and health services; and participating in legislative processes." Therefore, social workers implement the social services to improve the life quality of vulnerable people, but they are also responsible for recommending and helping politicians and managers to define social laws and instruments. In the first decade of the 21st century, much of the research conducted in this research front focused on the theme policy, which is related to the social protection policies, poverty reduction policies, and the use of public funds allocated to these policies. In the future, new forms of social work practice could also be likely to appear as a consequence of new state policies (state could finance the provision of services but delegates their delivery to other sectors; Tannenbaum & Reisch, 2001). Therefore, it is clear that this research front will continue to be a trending theme in the 21st century.

iii. *Investigations on important problems that affected the society:* health care, violence, HIV/AIDS, and grief are the thematic areas that supported this research front. Therefore, in this research front, social work research conducted on health problems (represented by thematic areas health care, HIV/AIDS, and grief) and on social problems (represented by the thematic area violence), was included. The thematic area health care was represented mainly by the health problems related to mental health, such as stress, dementia, and depression and, in early 21st century, also with older people health problems, such as Alzheimer. These health problems were a central research theme for the social work scientific community, and they required always the participation of social workers, sometimes together

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with other experts as physicians, psychiatrists, and psychologists. As aforementioned, the aging populations will continue to be an important problem during the 21st century, and therefore, the social workers' activity will be necessary (Allen & Glasby, 2013). The social problems of the 1990s, such as drugs (crack cocaine epidemic), violence, unemployment, sexual abuse/assault, child abuse, rape, suicide, homelessness, substance abuse, domestic violence, the spread of HIV/AIDS and other social/emotional problems, caused the birth of new research areas of interest to the social work scientific community (as Violence, HIV/AIDS, and Grief). Both thematic areas violence and HIV/AIDS received a great interest from the social work scientific community according to their performance indicators, and both focused on different aspects related to the two vulnerable entities: children and women. Particularly, in the early 21st century, the research conducted on the thematic area HIV/AIDS was mainly focused on the analysis of the women living with HIV/AIDS, in different countries (Kenya, Uganda, Ireland, etc.; Foreman & Hawthorne, 2007; Hodge & Roby, 2010; Mweru, 2008).

iv. *Investigations on the own social work scientific discipline:* Both thematic areas social workers and education supported this research front, which represented the interest of social work scientific community on defining and updating the disciplinary knowledge base that characterized the social work scientific discipline and the activity of social workers and, also on the educational and training issues that affected the social workers. According to the internal dynamic that took place in both thematic areas during the 20th century, it should be pointed out that the social work discipline grew and reinvented itself in response to rapid economic and social changes occurred as a consequence of different events, as for example, two world wars and two economic crises. But, in a world that changes faster than we can learn, it is clear that the social work discipline will continue reinventing, and this research front will continue attracting interest from the scholarship. In the early 21st century, the modern social work required specific education and training for preparing social workers for their work in a global era, and by this reason, the thematic area education was considered as a topic of great interest in the recent research developed in the social work discipline. In this sense, the social work academic community was actively working in the design of international curriculum to ensure that professionals are prepared with requisite knowledge for social work practice in this globalized context (Gilin & Young, 2009; Lough, 2009).

It should be pointed out that this interpretation of the results requires caution because, in some cases, the growing interest on some thematic areas could follow policy interests and investment in certain fields. On the other hand, it is noticed that the social work field was intrinsically related to the main events that happened in our civilized society during the 20th century, since analyzing the thematic areas that were of interest to the social work scientific community, it is possible to identify many of the major problems, crises, and challenges that civilized society has faced: wars, financial crisis, gender inequality, racism problem, immigration, older people, and so on. And as it is noted by the National Association of Social Workers (2000), ''The appalling prevalence of wars, genocide, ethnic cleansing; discrimination and social exclusion, gender inequality, battering, rape, and the sale of women; sweatshops, child labor, and enslavement; and the suppression of human rights, demonstrates that the struggle for human rights remains a high priority for the social work profession in the 21st century.''

Since the h-index was actively used in our study to analyze the science maps, it is worth making some clarifications. The h-index was defined by the physicist Hirsch (2005) to assess the productivity of scientists from their publications and citations per publication. Despite all the criticisms leveled at the usefulness of the h-index as a performance indicator and quality of a scientist, the truth is that the h-index is being used widely by the scientific community because it is easy to calculate and understand (Alonso et al., 2009). Many bibliographic databases, such as the WoS, Scopus, and Google Scholar, include h-index among their utilities. Also many committees are using it during their employment and promotion decisions. The h-index has also been applied to evaluate scientific quality in others cases: journals, research groups, universities, countries, and even scientific topics (Alonso et al., 2009; Martínez et al., In Press). In SciMAT, the h-index is used to assess the impact and quality of research themes and thematic areas (Cobo et al., 2012b). The use of the h-index in this context led to several interesting findings. SciMAT calculates the h-index as if we were evaluating scientists, that is, the number of publications and citations per publication is used, but working on the publications associated with each theme and thematic area. However, the h-index is not interpreted as an indicator of productivity, but as a measure of interest in the immediate community to the research conducted on the research theme, and also as a quality measure of research carried out in the theme. A theme with a high h-index means that the research conducted on the subject is of quality and reflects a high interest of the scientific community. For example, this is the case of the theme children that presents an h-index of 28 and 36 in the early periods of time. Furthermore, this could be used to identify the emerging themes of a scientific discipline, as it was proposed in Banks (2006). In the last period of time, both themes depression and foster care present the highest h-index (28 and 24, respectively), and they could be considered as emerging topics in the social work research. Obviously, low values of h-index do not always mean low quality of the research undertaken. The h-index depends on the citation pattern of a scientific field and the size of the community working in the field. Thus, a theme with a low h-index could indicate an interest in a small

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community of researchers and not necessarily a low-quality research. For example, this could be the case of themes lesbians and grief detected in the last period of time. This analysis is also valid for thematic areas. Now, in the case of thematic areas, the h-index provides a way to discover if the research conducted on the area presents an up or down trend. Analyzing the evolution of the h-index of the themes that composes a thematic area through all periods of time makes possible to detect whether the interest in the scientific community increases (trend up) or decreases (trend down). For example, the interest of the research community in the thematic area children was and is high (its theme foster care presents the second highest value of h-index in the last period). However, in the case of thematic area social workers, the interest was high in early periods of time but not in the most recent period of time. In the early periods of time, its theme social workers presented the second and third position by h-index, while in the last period of time its themes psychotherapy and social workers are in the intermediate positions. Many important applications of the h-index in the social work field were presented in Hodge and Lacasse (2011) and Lacasse, Hodge, and Bean (2011). In this article, an additional application was shown.

There are several limitations to this study. To choose the information sources for our experiment, we have used the international widely acknowledge prestigious databases by scientific community, that is, WoS and JCR produced by Thomson Reuters. There is a great debate on the coverage of WoS in comparison to Scopus and Google Scholar and their use to analyze social science disciplines (Auffhammer, 2009; Bar-Ilan, 2010; Blyth et al., 2010; Falagas et al., 2008; Harzing & van der Wal, 2008; Hodge et al., 2012; Jacobs, 2009). In the social work field, we find studies based on WoS (Green & Baskind, 2007; Holden et al., 2010; Jenson, 2005; Thyer, 2010), and others based on Google Scholar (Hodge & Lacasse, 2011; Hodge et al., 2012). We decided to use WoS because it presents the best retrospective coverage since 1900 (Harzing & van der Wal, 2008), and it provides quality data to develop our study. Similarly, many criticisms have been made about the usefulness of the JCR to assess the quality of the journals (Cameron, 2005; Hodge & Lacasse, 2011; Ligon & Thyer, 2005), although Hodge and Lacasse (2011, p. 580) noted "JCR are widely recognized as the de facto standard for assessing journal quality across the sciences ... including social work ... manuscripts accepted in journals indexed in a given JCR disciplinary category are widely viewed as evidence of publication in a top-tier journal." We have identified the group of most important journals in social work field using the JCR 2012 and using the recommendations to identify social work journals given in Hodge and Lacasse (2011) and Thyer (2005, 2010). Therefore, an alternative choice of databases would likely produce different results. On the other hand, it should be noted that the set of core journals is biased in favor of journals of British and U.S. origin, as it happens in other scientific fields and in the own WoS. Consequently, our study is also biased in favor of social work research published in English language.

Other limitations relate to our methodology. The analysis did not control for self-citations, since there exists bibliometric studies indicating that self-citations are not a great problem for the h-index (Bornmann & Daniel, 2007; Hirsch, 2005). However, the influence of self-citations is field dependent (Lacasse et al., 2011). Other methodological limitation is related to information sources chosen to describe the social work research field, since we use only those documents published in the most important social work journals indexed in JCR in the social work category. Therefore, we are missing the earliest research before the establishment of social work journals indexed in JCR. We are also missing the social work research published primarily outside of social work journals (in interdisciplinary or other disciplinary journals) or in social work journals that are not indexed in JCR/WoS and also those social work dissertations whose findings have not been published in social work journals indexed in JCR/WoS. Similarly, we are losing the research published in books that also are a usual mean to publish important findings in the social work field. Other methodological bias was introduced in the co-words analysis. Many articles published in the early period did not present any keywords; probably because it was not a common publication rule. We have found similar behaviors in other disciplines, for example, computer science (Cobo et al., 2011a). Therefore, we had to search manually those keywords that better described the content of those articles. With respect to the use of SciMAT, we have used our experience to configure it adequately. For example, to avoid the appearance of strategic diagrams too complex to analyze, we established for each period of time the following keyword and co-occurrence thresholds (6, 4), (10, 5), and (20, 7). However, it is clear that other configuration could result in more complex diagrams.

This article provides the first comprehensive examination of the conceptual evolution of the social work disciplinary knowledge base, offering insights to understand how the social work knowledge base has been formed. A study of this nature aims to understand how a scientific discipline has evolved and grown over time, and, therefore, it also helps in the process of professional self-reflection. In such a way, this bibliometric study complements works on social work knowledge base by others (Hodge & Lacasse, 2011; Hodge et al., 2012; Holden et al., 2005a, 2005b, 2010; Jenson, 2005; Lacasse et al., 2011; Sellers, Mathiesen, Smith, & Perry, 2006; Sellers et al., 2004; Spivey & Wilks, 2004; Thyer & Bentley, 1986; Thyer, 2005). As Hodge, Lacasse, and Benson (2012, p. 15) noted, "By understanding where we have come from and what we have accomplish, we are better positioned to address future challenges." Having said the above, it is clear that different science mapping analysis of social work field focused on its social structure (using authors and coauthors) or intellectual (using cocitations) structure are possible and pending.

The output of the science mapping analysis in the social work field enables to access and assess key data of the discipline to make decisions in different frameworks:

- Libraries: Librarians could identify new needs in the collection to be covered on specific important themes

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and thematic areas of the discipline, and then, they could take into account that information in its investment/purchase policy.

- Editorials: Publishers could monitor the thematic evolution of a discipline to identify new publishing opportunities in the area.
- Journals: Editors could assess the effectiveness of topics covered by their journals, identify new research challenges (by organizing special issues), and make decisions on future editorial policy.
- Academic centers: Researchers could identify new and relevant challenges in their field to research as well as emerging topics and older topics. Furthermore, if they work in any of the major themes identified, then they could use that information as a value of their work in the promotion processes. On the other hand, a PhD student or undergraduate student could use the output of a science mapping to choose a master or PhD topic that could be relevant for their interest and future development. If the student would like to initiate research work, he or she could identify emerging topics to develop his or her thesis or research.

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A CONCEPTUAL SNAPSHOT OF THE FIRST DECADE (2002–2011) OF THE INTERNATIONAL JOURNAL OF INFORMATION TECHNOLOGY & DECISION MAKING

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In this paper, we carry out a study about the main themes treated by the *International Journal of Information Technology & Decision Making* during its first 10 years (2002–2011). The themes are detected, quantified and visualized using an approach that combines performance analysis and science mapping. Bibliometric maps based on co-word analysis will help us to visualize the division of the journal into several subfields and their relationships, providing interesting insight into the main topics being discussed in the journal in these years. In addition, the study will show the most productive themes (according to published papers) and the most impacting ones (according to received citations).

Keywords: Science mapping; authomatic topic detection.

1. Introduction

On March 2002 the *International Journal of Information Technology & Decision Making* (IJITDM) launched its first issue. More than 400 papers have been published. In general, these published papers are research works that show how

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information technology improves decision techniques as well as how the development of decision-making tools affects the information technology era.

A lot of effort has been done by everyone, including authors and co-authors, anonymous reviewers, editorial board and editorial office, in order to increase the quality of the journal. As a result, nowadays IJITDM is indexed in the most important journal ranking, the Journal Citation Reports (JCR) published by the Thompson Institute for Scientific Information (Thompson ISI), appearing in the JCR-2010 in top positions in different categories (Computer Science-Artificial Intelligence, Computer Science-Information Systems, Computer Science-Interdisciplinary Applications, and Operations Research & Management Science) with a high impact factor (3.139).

In the years 2009 and 2010 (at the beginning of each year), the editor in-chief of the IJITDM has published papers describing briefly the content of the main papers published during the year before. These papers[58,59] reported the main research trends of the papers published in 2008 and 2009, respectively. These two works, although are very much oriented and detailed, are very much limited due to the size of the period examined, just one year in each case.

In this paper, we try to complete those previous works,[58,59] in order to offer an expeditious perspective of a bigger period, the first decade (2002−2011), of the IJITDM by identifying themes, predicting emerging trends, and determining relationships with other themes/fields. The analysis is done using co-word as a content technical analysis. Co-word has been proved as a powerfull technique for describing the research trends in other research fields.[7,13,18,36,40,41,44,69,78]

The paper is structured as follows. Section 1 describes the methodological framework and the data used. Section 2 visualizes and describes the main themes treated by IJITDM. Section 3 analyzes and determines the influencing themes of the IJITDM, and predicts future research trends. Finally, some conclusions are drawn.

2. Method: Bibliometric Tool and Data

In bibliometrics, there are two main procedures to explore a research field: performance analysis and science mapping.[68] Performance analysis aims at evaluating groups of scientific *actors* (countries, universities, departments, researchers) and the impact of their activity on the basis of bibliographic data. Science mapping aims at displaying the structural and dynamic aspects of scientific research, delimiting a research field, and quantifying and visualizing the detected subfields by means of co-word analysis[14] or documents co-citation analysis.[61]

2.1. *Bibliometric analysis tool*

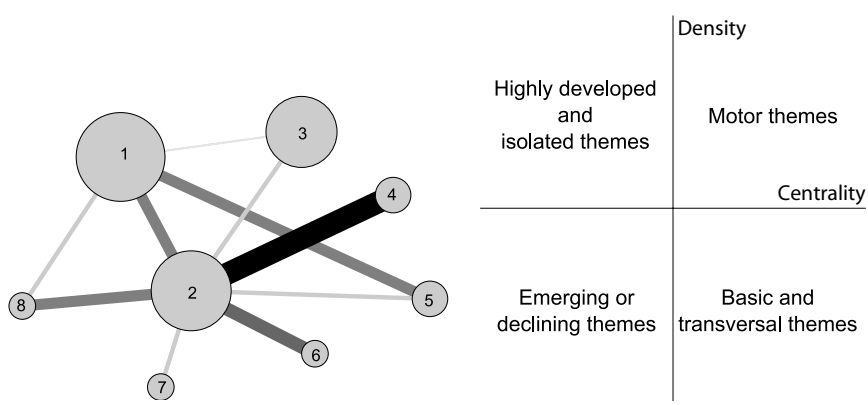
In Ref. 16, we define a bibliometric approach that combines both performance analysis tools and science mapping tools to analyze a research field, to detect and visualize its conceptual subdomains (particular topics/themes or general thematic areas) and its thematic evolution. Co-word analysis is used in a longitudinal

framework which allows us to analyze and track the evolution of a research field.[24] Additionally, we develop a performance analysis of a specific theme or thematic area using different basic bibliometric indicators.

The main steps to develop a bibliometric analysis based on co-word are the following:

(1) *To detect the research themes.* To do so, first we have to compute the co-occurrence matrix by assuming that the co-occurrence frequency of two keywords is extracted from the corpus of documents by counting the number of documents in which the two keywords appear together. Second, we have to compute the equivalence index among keywords,[13] called e_{ij}: $e_{ij} = \frac{c_{ij}^2}{c_i c_j}$, where c_{ij} is the number of documents in which two keywords i and j co-occur, and c_i and c_j represent the number of documents in which each one appears. At the end of this phase, we cluster keywords to topics/themes by using the simple centers algorithm,[20] which automatically returns labeled clusters, so a post-process to label the clusters is not needed. Through this process of clustering we locate keyword networks that are strongly linked to each other and which correspond to centers of interest or to research problems that are the object of significant interest among researchers. Each cluster network or *thematic network* is defined as an interconnected network of keywords as it is shown in Fig. 1(a). In it, several keywords are interconnected, where the volume of the spheres is proportional to the number of documents corresponding to each keyword, the thickness of the link between two spheres i and j is proportional to the equivalence index e_{ij}.

Together with the whole network of interconnected themes and keywords a second network is built, based on the documents linked to each thematic network. In this second network, documents with keywords associated to any detected thematic network are linked to it. Given a thematic network, a document d is associated to it if



(a) (b)

Fig. 1. A thematic network (a), and the strategic diagram (b).

d has at least two keywords presented in the thematic network. These second networks of documents are used in the third phase.

(2) *To build strategic diagrams.* In the clustering process we obtain a set of interconnected networks or themes. Then, in this context each keyword network or theme can be characterized by two parameters (Centrality and Density)[13]:

- *Centrality*: It measures the degree of interaction of a network with other networks and it can be defined as: $c = 10 * \sum e_{kh}$, with k a keyword belonging to the theme and h a keyword belonging to other themes. Centrality measures the strength of external ties to other themes. We can understand this value as a measure of the importance of a theme in the development of the entire research field analyzed.
- *Density*: It measures the internal strength of the network and it can be defined as: $d = 100\frac{\sum e_{ij}}{w}$, with i and j keywords belonging to the theme and w the number of keywords in the theme. Density measures the strength of internal ties among all keywords describing the research theme. This value can be understood as a measure of the theme's development.

A Strategic Diagram is a two-dimensional space built by plotting themes according to their centrality and density rank values. As an example, in Fig. 1(b) a strategic diagram is presented. Thus, with both parameters a research field can be understood to be a set of research themes, mapped in a two-dimensional space and classified into four groups[13]:

- Themes in the upper-right quadrant are both well developed and important for the structuring of a research field. They are known as the *motor-themes* of the specialty given that they present strong centrality and high density.
- Themes in the upper-left quadrant have well-developed internal ties but unimportant external ties and so are of only marginal importance for the field. These themes are very specialized and peripheral in character.
- Themes in the lower-left quadrant are both weakly developed and marginal. The themes of this quadrant have low density and low centrality, mainly representing either emerging or disappearing themes.
- Themes in the lower-right quadrant are important for a research field but are not developed. So, these quadrant groups are transversal and general, basic themes.

Furthermore, the strategic diagrams can be enriched by adding a third dimension in order to show more information. So, for example, the themes can be represented as a sphere, its volume being proportional to different quantitative (or qualitative) data, such as, for example, the number of documents associated with the theme or the number of citations received by the documents associated with the theme.

(3) *To carry out a performance analysis.* In this phase, we can measure (quantitatively and qualitatively) the relative contribution of themes and thematic

areas to the whole research field, detecting the most prominent, productive, and highest-impact subfields. To do so, we use the following bibliometric indicators applied to the different detected themes: the number of published documents, the number of received citations, and the h-index.[3,10,27]

We should point out that the co-word analysis was carried out with the software CoPalRed.[17,19,41] It is based on the simple center algorithm to detect the themes through different subperiods of years. The plotting of the themes in the strategic diagram, the drawing of the thematic networks were done with specific ad-hoc software.

2.2. *Data set*

We downloaded them from ISI Web of Science[a] (ISIWoS) for the years 2004 to 2011 (inclusive). For the two first years (2002 and 2003) data was manually downloaded from the IJITDM's website.[b] The data set includes 415 papers including articles, letters, proceeding papers and reviews. We have not considered editorial material. In Figs. 2 and 3 the distribution of published documents and citations per year are shown.

As mentioned above, the keywords of the documents are used to develop our analysis. Due to the fact that the majority of the data have been downloaded from the ISIWoS, the author-provided keywords and the Keywords Plus of the documents are jointly used. A normalization process is carried out prior to this over the keywords, where the plural and singular forms of the keywords are joined. The acronyms are also joined with the respective keywords. Finally, we have obtained 330 valid

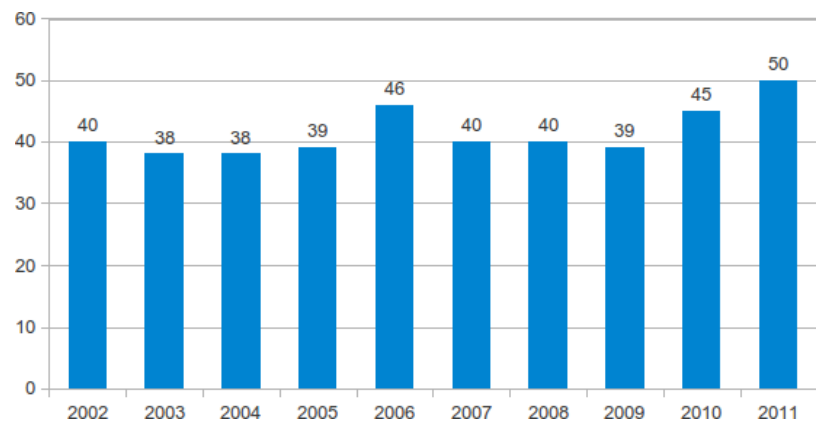


Fig. 2. Documents published in IJITDM from 2002 to 2011.

[a] http://scientifc.thomson.com/products/wos/.
[b] http://www.worldscinet.com/ijitdm/.

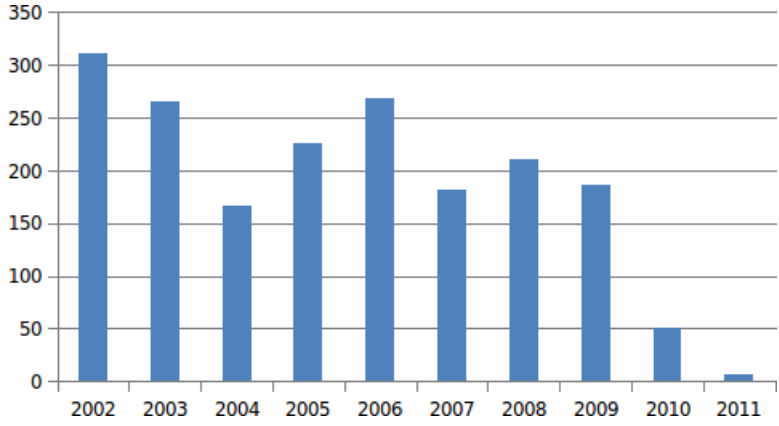


Fig. 3. Citations count for documents published in IJITDM from 2002 to 2011.

keywords for our study. We consider valid keywords to be those that present both frequency and co-occurrence greater than 2.

In this study the citations of the documents are also used. We have considered for each paper the citations received until November 15th 2011 (the data were downloaded on that date). The citations that we take into account proceed from the ISIWoS (for the papers published from 2004) and Scholar Google[c] (for the papers manually downloaded from the journal's website during the years 2002 and 2003).

3. Visualizing the Main Themes Treated by IJITDM

Using the approach described above, 17 themes were automatically detected by CoPalRed, these are: AGENTS, ANALYTICAL-HIERARCHY-PROCESS, CONSENSUS, DATA-ENVELOPMENT-ANALYSIS, DATA-MINING, DECISION-SUPPORT-SYSTEM, GROUP-DECISION-MAKING, INTERNET-QUALITY-OF-SERVICE, INTERPRETIVE-STRUCTURAL-MODELING, MANAGEMENT, OPTIMIZATION, PERFORMANCE-EVALUATION, SHAPLEY-VALUE, SOFTWARE-DEFECT-PREDICTION, TECHNOLOGY-ACCEPTANCE, TIME-SERIES, UNCERTAINTY.

In order to analyze the most highlighted themes treated by IJITDM for the studied period (2002−2011), two kinds of strategic diagrams were built using CoPalRed. In the first one, the volume of the spheres is proportional to the number of documents associated with each theme; and in the second one, it is proportional to the number of citations received by the documents of each theme. These strategic diagrams are shown in Figs. 4 and 5, respectively, and whose main aspects are:

- According to the number of documents, the themes ANALYTICAL-HIERARCHY-PROCESS (19 papers), DATA-ENVELOPMENT-ANALYSIS (17), MANAGEMENT

[c]http://scholar.google.com.

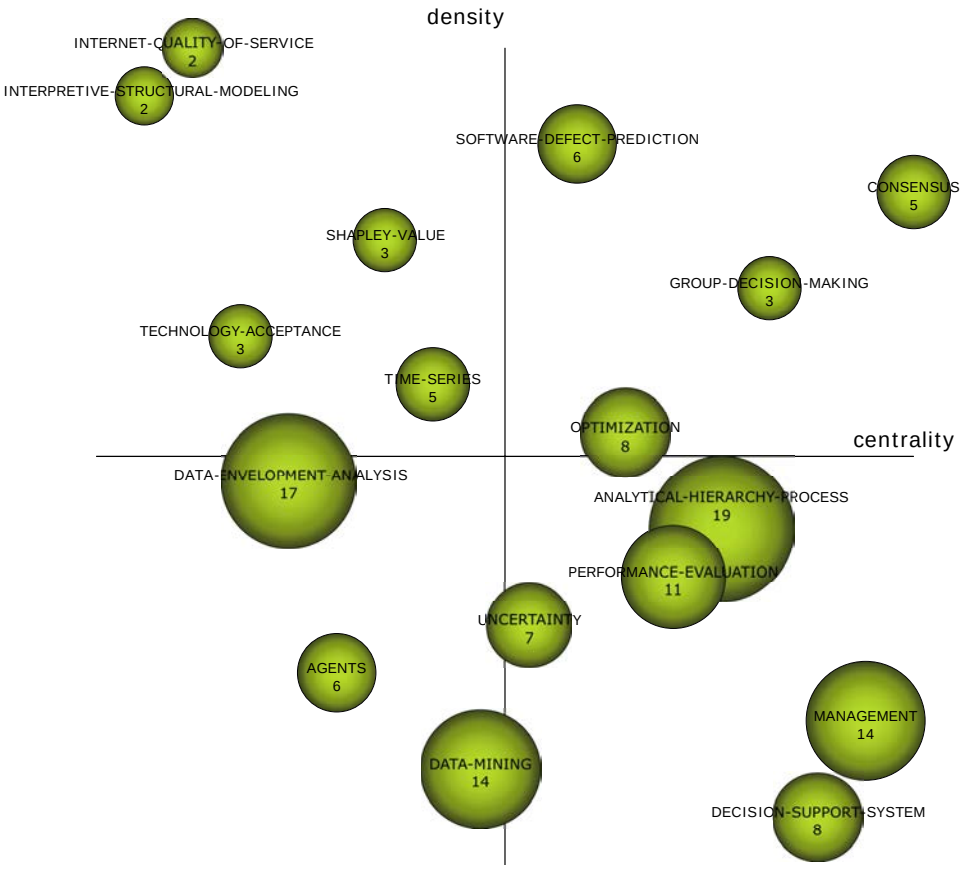


Fig. 4. Strategic diagram based on documents count.

(14), DATA-MINING (14) and PERFORMANCE-EVALUATION (11) are the five more productive one.

- Taking into account the citations, the themes DATA-MINING (with 156 citations), ANALYTICAL-HIERARCHY-PROCESS (106), CONSENSUS (93), DATA-ENVELOPMENT-ANALYSIS (75), MANAGEMENT (48) and TIME-SERIES (48) are the six most cited themes. On the other hand, the documents associated to the theme INTERPRETIVE-STRUCTURAL-MODELING has not cited.
- On the other hand, analyzing the ratio documents/citations, the themes CONSENSUS (with 18.60 citations per paper), GROUP-DECISION-MAKING (13.33), DATA-MINING (11.14) and TIME-SERIES (9.60) have been the most impacting themes.
- With respect to the h-index, the themes ANALYTICAL-HIERARCHY-PROCESS (with 7), DATA-ENVELOPMENT-ANALYSIS (6), CONSENSUS (5) are the three one with higher value. We have to remark that the theme CONSENSUS

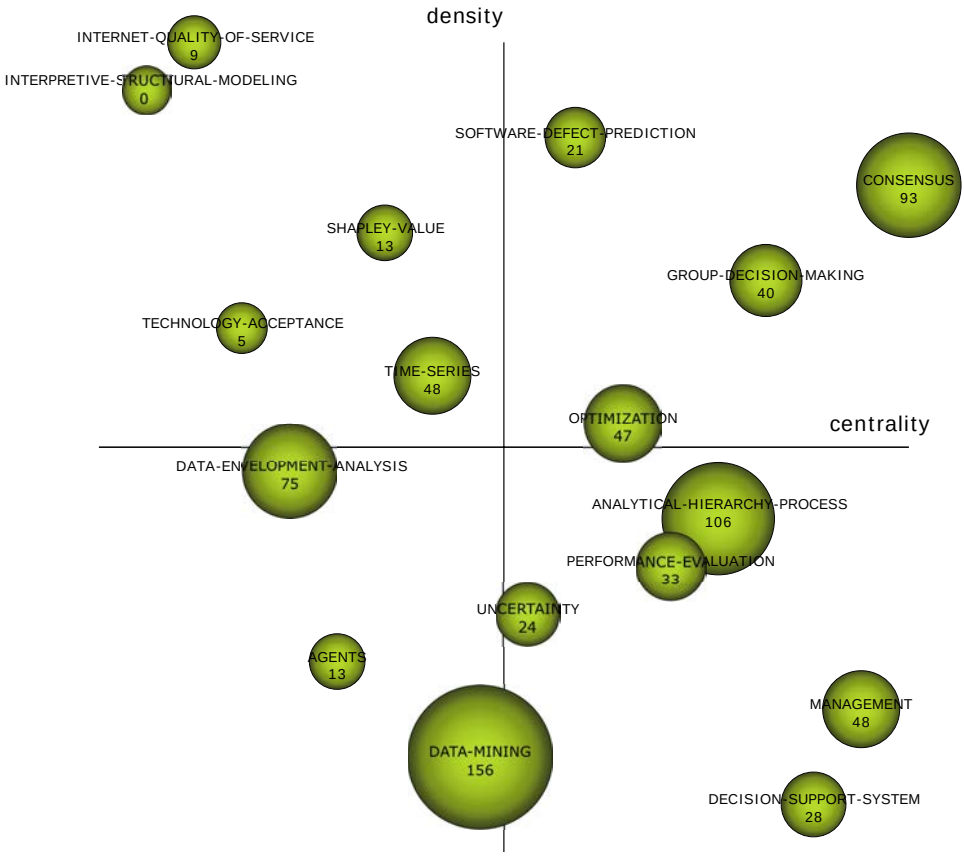


Fig. 5. Strategic diagram based on citations sum.

has obtained the highest h-index value that it is possible with its five associated papers.

- Analyzing their strategic location in the strategic diagrams, the themes ANALYTICAL-HIERARCHY-PROCESS, PERFORMANCE-EVALUATION, MANAGEMENT, DECISION-SUPPORT-SYSTEM AND UNCERTAINTY are supposed transversal and *basic-themes*; whereas CONSENSUS, GROUP-DECISION-MAKING and SOFTWARE-DEFECT-PREDICTION are supposed *motor-themes*, given that they present strong centrality and high density, i.e., they are understood as very much developed themes with also high importance/weight in the development of other themes and of the whole journal in the analyzed period.
- Moreover, themes like: INTERNET-QUALITY-OF-SERVICE, INTERPRETIVE-STRUCTURAL-MODELING, SHAPLEY-VALUE, TECHNOLOGY-ACCEPTANCE and TIME-SERIES are considered as very specialized and low interconnected one, being INTERNET-QUALITY-OF-SERVICE and INTERPRETIVE-STRUCTURAL-MODELING the most isolated ones.

- Due to their strategic location, the themes DATA-ENVELOPMENT-ANALYSIS, AGENTS and DATA-MINING have to be considered as new and emerging themes.
- Attending to the kind of themes, all the detected themes, except SOFTWARE-DEFECT-PREDICTION, INTERNET-QUALITY-OF-SERVICE, PERFORMANCE-EVALUATION and MANAGEMENT are considered as "methodological" or "theoretic" themes rather than "practical" or "applied" one.

Performance data, including quantity of associated documents, sum and average of citations and h-index, for these detected themes are summarized in Table 1.

3.1. *Visualizing the most highlighting themes*

In this section, we draw the most highlighting themes according to the number of associated documents, citations and locations at the strategic diagrams.

- The theme CONSENSUS, whose thematic-network is shown in Fig. 6, is related with the keywords (or topics): *aggregation*, *assessments*, *labels*, *owa-operators*, *consistency* and *operators*.
  The four most cited paper associated to this theme are:
  - Cabrerizo, FJ, Alonso, S, Herrera-Viedma, E, A CONSENSUS MODEL FOR GROUP DECISION MAKING PROBLEMS WITH UNBALANCED FUZZY LINGUISTIC INFORMATION. IJITDM 8:1 (2009) 109–131. Times cited:35
  - Xu, ZS, AN APPROACH TO GROUP DECISION MAKING BASED ON INCOMPLETE LINGUISTIC PREFERENCE RELATIONS. IJITDM 4:1 (2005) 153–160. Times cited:21

Table 1. Basic measures of the themes of the period 2002−2011.

Theme	Documents	h-Index	Average Citations	Total Citations
AGENTS	6	2	2.17	13
ANALYTICAL-HIERARCHY-PROCESS	19	7	5.58	106
CONSENSUS	5	5	18.60	93
DATA-ENVELOPMENT-ANALYSIS	17	6	4.41	75
DATA-MINING	14	4	11.14	156
DECISION-SUPPORT-SYSTEM	8	3	3.50	28
GROUP-DECISION-MAKING	3	2	13.33	40
INTERNET-QUALITY-OF-SERVICE	2	2	4.50	9
INTERPRETIVE-STRUCTURAL-MODELING	2	0	0.00	0
MANAGEMENT	14	4	3.43	48
OPTIMIZATION	8	3	5.88	47
PERFORMANCE-EVALUATION	11	4	3.00	33
SHAPLEY-VALUE	3	2	4.33	13
SOFTWARE-DEFECT-PREDICTION	6	3	3.50	21
TECHNOLOGY-ACCEPTANCE	3	1	1.67	5
TIME-SERIES	5	4	9.60	48
UNCERTAINTY	7	3	3.43	24

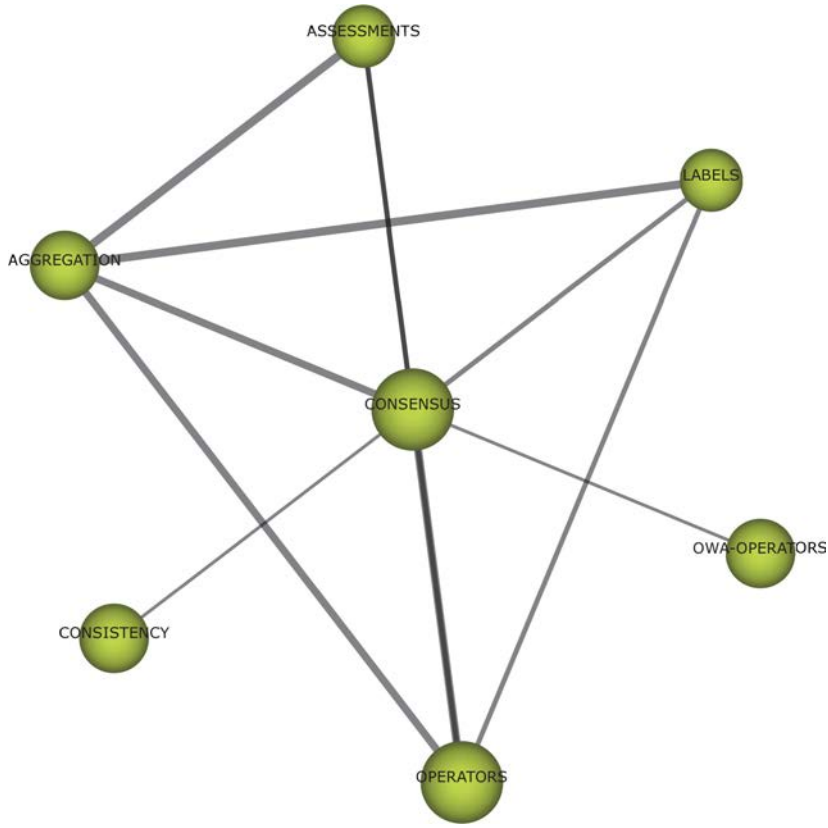


Fig. 6. Thematic network for the theme CONSENSUS.

— Alonso, S, Herrera-Viedma, E, Chiclana, F, Herrera, F, INDIVIDUAL AND SOCIAL STRATEGIES TO DEAL WITH IGNORANCE SITUATIONS IN MULTI-PERSON DECISION MAKING. IJITDM 8:2 (2009) 313–333. Times cited:15
— Xu, ZS, AN APPROACH TO PURE LINGUISTIC MULTIPLE ATTRIBUTE DECISION MAKING UNDER UNCERTAINTY. IJITDM 4:2 (2005) 197–206. Times cited:15

- The thematic-network of the theme ANALYTICAL-HIERARCHY-PROCESS is shown in Fig. 7. This theme was mainly related with the topics: *preference*, *decision* and *multicriteria-decision-making*.
  The three most cited papers:

  — Saaty, TL, Vargas, LG, THE POSSIBILITY OF GROUP WELFARE FUNCTIONS. IJITDM 4:2 (2005) 167–176. Times cited:15
  — Ahmad, N, Berg, D, Simons, GR, THE INTEGRATION OF ANALYTICAL HIERARCHY PROCESS AND DATA ENVELOPMENT ANALYSIS IN A MULTI-CRITERIA DECISION-MAKING PROBLEM. IJITDM 5:2 (2006) 263–276. Times cited:14

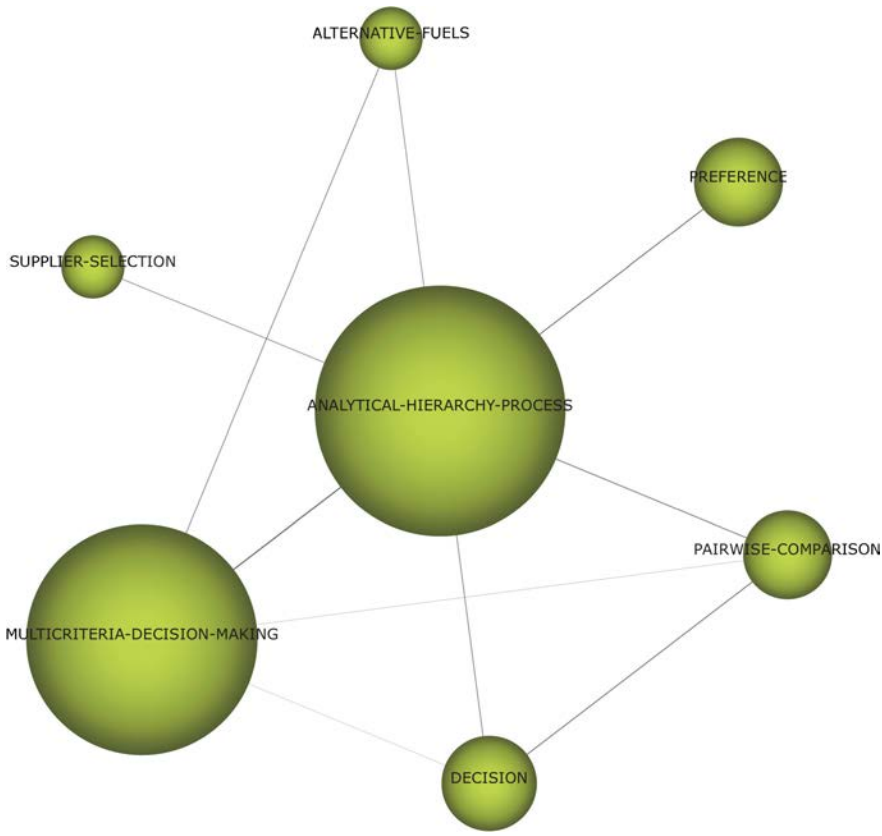


Fig. 7. Thematic network for the theme ANALYTICAL-HIERARCHY-PROCESS.

— Al-Aomar, R, Dweiri, F, A CUSTOMER-ORIENTED DECISION AGENT FOR PRODUCT SELECTION IN WEB-BASED SERVICES. IJITDM 7:1 (2008) 35–52. Times cited:11

- DATA-ENVELOPMENT-ANALYSIS was strongly related with the topics: *benchmarks*, *efficiency* and *banks*. The network of interconnected keywords associated to this theme is shown in Fig. 8.
  The three most cited papers:
  - — Ahmad, N, Berg, D, Simons, GR, THE INTEGRATION OF ANALYTICAL HIERARCHY PROCESS AND DATA ENVELOPMENT ANALYSIS IN A MULTI-CRITERIA DECISION-MAKING PROBLEM. IJITDM 5:2 (2006) 263–276. Times cited:14
  - — Koksalan, M, Tuncer, C, A DEA-BASED APPROACH TO RANKING MULTI-CRITERIA ALTERNATIVES. IJITDM 8:1 (2009) 29–54. Times cited:12
  - — Chen, Y, Motiwalla, L, Khan, MR, USING SUPER-EFFICIENCY DEA TO EVALUATE FINANCIAL PERFORMANCE OF E-BUSINESS INITIATIVE IN THE RETAIL INDUSTRY. IJITDM 3:2 (2004) 337–351. Times cited:8

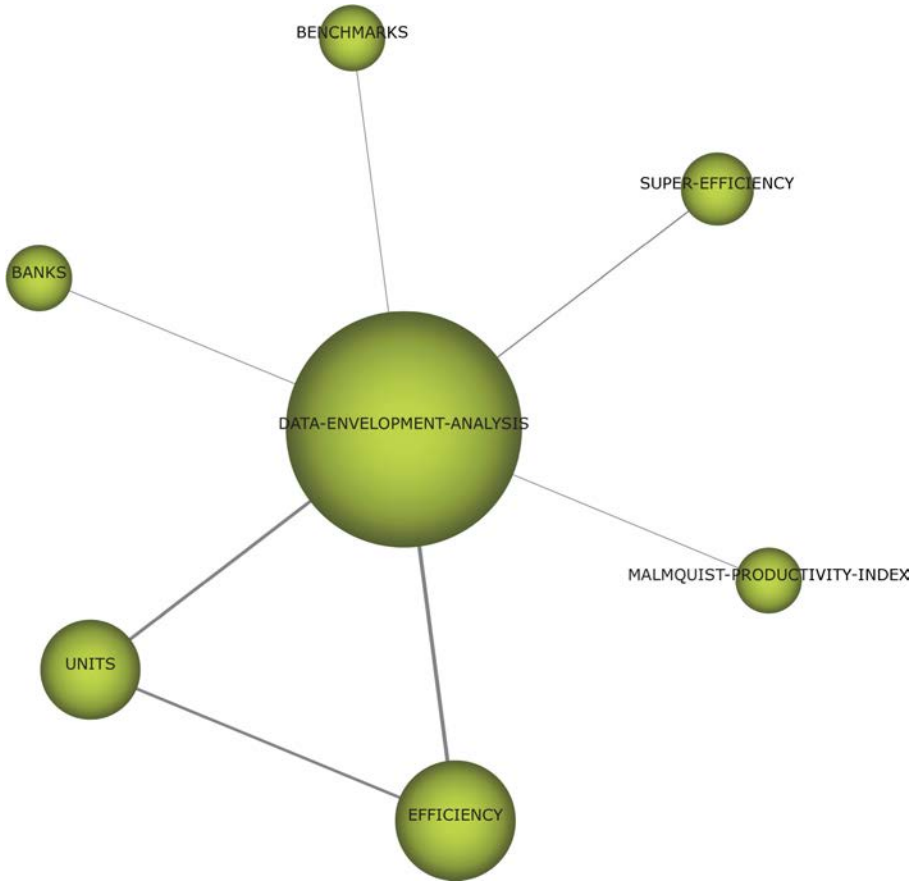


Fig. 8. Thematic network for the theme DATA-ENVELOPMENT-ANALYSIS.

- On the other hand, DATA-MINING was associated with *clustering*, *databases*, *knowledge-management*, *multi-aspect-analysis*, *discovery* and *fuzzy-linear-programming*. The associated thematic network is drawn in Fig. 9.
  The three most cited papers:
  - Peng, Y, Kou, G, Shi, Y, Chen, ZX, A DESCRIPTIVE FRAMEWORK FOR THE FIELD OF DATA MINING AND KNOWLEDGE DISCOVERY. IJITDM 7:4 (2008) 639–682. Times cited:57
  - Yang, Q, Wu, XD, 10 CHALLENGING PROBLEMS IN DATA MINING RESEARCH. IJITDM 5:4 (2006) 597–604. Times cited:53
  - He, J, Liu, XT, Shi, Y, Xu, WX, Yan, N, CLASSIFICATIONS OF CREDIT CARDHOLDER BEHAVIOR BY USING FUZZY LINEAR PROGRAMMING. IJITDM 3:4 (2004) 633–650. Times cited:31

- The theme GROUP-DECISION-MAKING was connected (see Fig. 10) with *words*, *fuzzy-linguistic-modeling* and *preference-relation*.

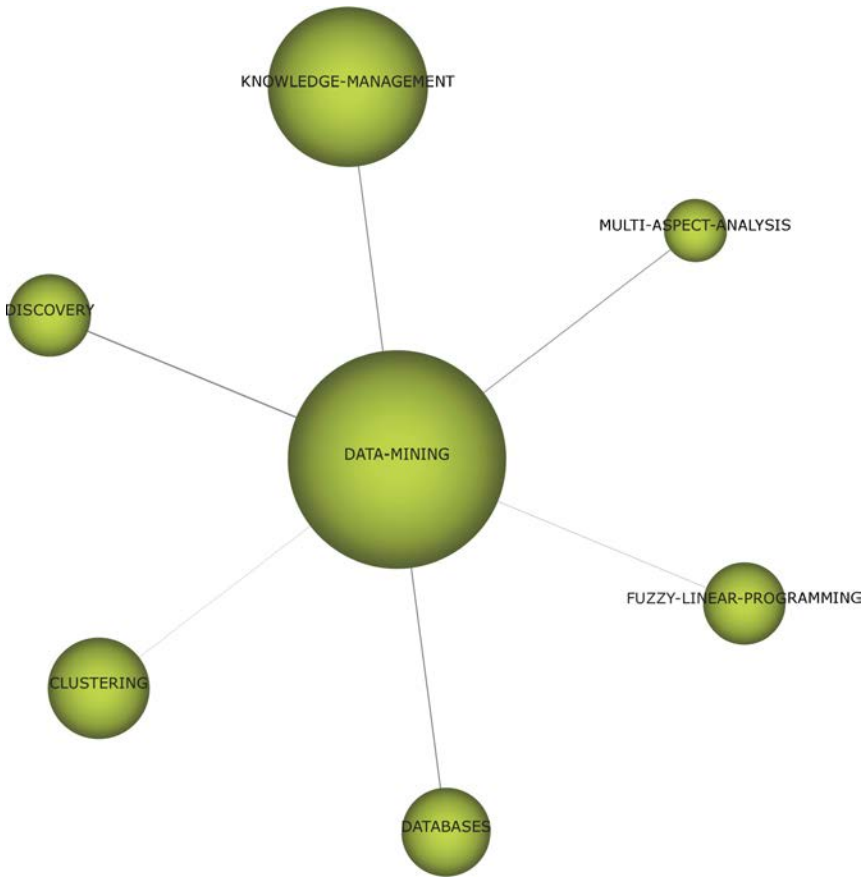


Fig. 9. Thematic network for the theme DATA-MINING.

The two most cited papers:

— Cabrerizo, FJ, Alonso, S, Herrera-Viedma, E, A CONSENSUS MODEL FOR GROUP DECISION MAKING PROBLEMS WITH UNBALANCED FUZZY LINGUISTIC INFORMATION. IJITDM 8:1 (2009) 109–131. Times cited:35

— Cabrerizo, FJ, Lopez-Gijon, J, Ruiz, AA, Herrera-Viedma, E, A MODEL BASED ON FUZZY LINGUISTIC INFORMATION TO EVALUATE THE QUALITY OF DIGITAL LIBRARIES. IJITDM 9:3 (2010) 455–472. Times cited:5

- MANAGEMENT was a practical theme which was related with the topics: *business-strategies*, *project-management*, *simulation*, *systems and sites* and *multicriteria-decision-support-systems*. Its associated thematic network is drawn in Fig. 11.

The three most cited papers:

— Stummer, C, Kiesling, E, A MULTICRITERIA DECISION SUPPORT SYSTEM FOR COMPETENCE-DRIVEN PROJECT PORTFOLIO SELECTION. IJITDM 8:2 (2009) 379–401. Times cited:11

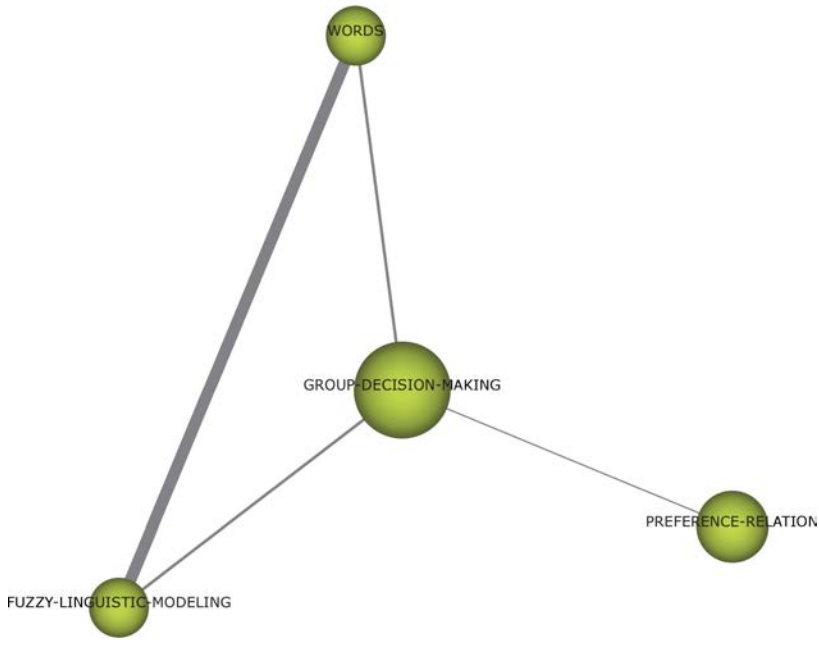


Fig. 10. Thematic network for the theme GROUP-DECISION-MAKING.

— Lee, J, Lee, H, STRATEGIC AGENT BASED WEB SYSTEM DEVELOPMENT METHODOLOGY. IJITDM 7:2 (2008) 309–337. Times cited:7
— Gupta, A, Kalyanaraman, S, Zhang, LY, A SPOT PRICING FRAMEWORK FOR PRICING INTRA-DOMAIN ASSURED BANDWIDTH SERVICES. IJITDM 4:1 (2005) 35–58. Times cited:6

- The theme PERFORMANCE-EVALUATION was mainly related with the topics: *trust*, *acceptance*, *ranking*, *impact* and *market*. Its associated thematic network is drawn in Fig. 12.
  The four most cited documents associated to PERFORMANCE-EVALUATION are:

  — Huang, W, Lai, KK, Nakamori, Y, Wang, SY, Yu, L, NEURAL NETWORKS IN FINANCE AND ECONOMICS FORECASTING. IJITDM 6:1 (2007) 113–140. Times cited:13
  — Ramayah, T, Omar, R, INFORMATION EXCHANGE AND SUPPLY CHAIN PERFORMANCE. IJITDM 9:1 (2010) 35–52. Times cited:6
  — McLain, DL, Aldag, RJ, COMPLEXITY AND FAMILIARITY WITH COMPUTER ASSISTANCE WHEN MAKING ILL-STRUCTURED BUSINESS DECISIONS. IJITDM 8:3 (2009) 407–426. Times cited:4
  — Peng, Y, Kou, G, Wang, GX, Wang, HG, Ko, FIS, EMPIRICAL EVALUATION OF CLASSIFIERS FOR SOFTWARE RISK MANAGEMENT. IJITDM 8:4 (2009) 749–767. Times cited:4

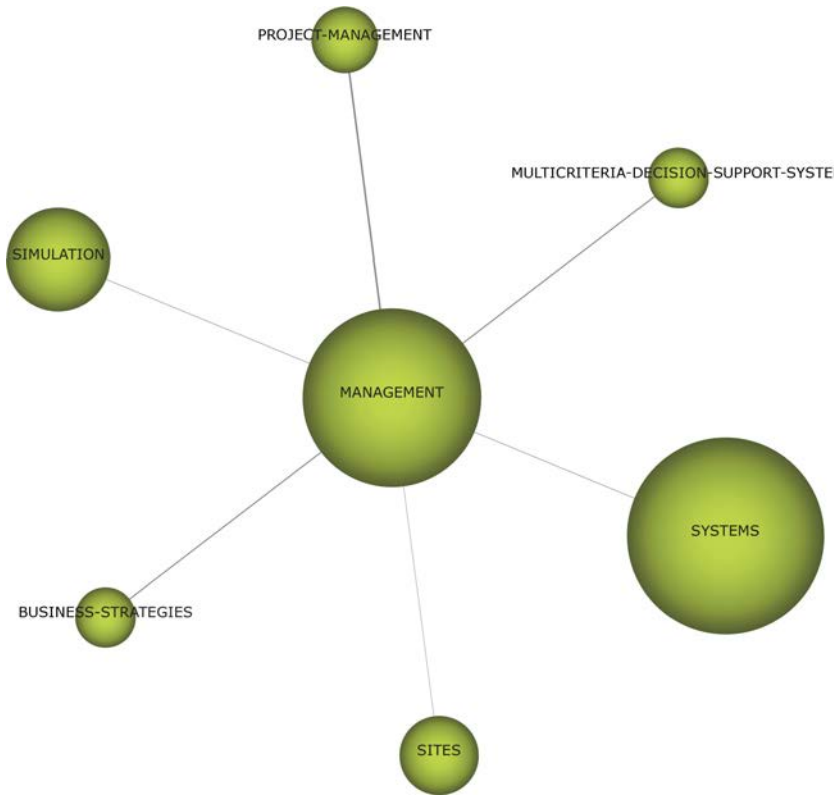


Fig. 11. Thematic network for the theme MANAGEMENT.

- TIME-SERIES was related with *fuzzy-regression*, *forecasting* and *rate-prediction* as it can be observed in Fig. 13.
  The three most cited documents are:
  - Ruey-Chyn Tsaur, Hsiao-Fan Wang, JIA-CHI O.-YANG, FUZZY REGRESSION FOR SEASONAL TIME SERIES ANALYSIS. IJITDM 1:1 (2002) 165–175. Times cited:16
  - Kumar, A, Agrawal, DP, ADVERTISING DATA ANALYSIS USING ROUGH SETS MODEL. IJITDM 4:2 (2005) 263–276. Times cited:14
  - Huang, W, Lai, KK, Nakamori, Y, Wang, SY, Yu, L, NEURAL NETWORKS IN FINANCE AND ECONOMICS FORECASTING. IJITDM 6:1 (2007) 113–140. Times cited:13

4. Estimating the Most Beneficial Themes for the Journal: Future Research Trend

In this section, we introduce a simple analysis that could be done in order to detect the most beneficial themes for the journal. For this analysis, we only use the last two years of the journal, i.e., 2010 and 2011.

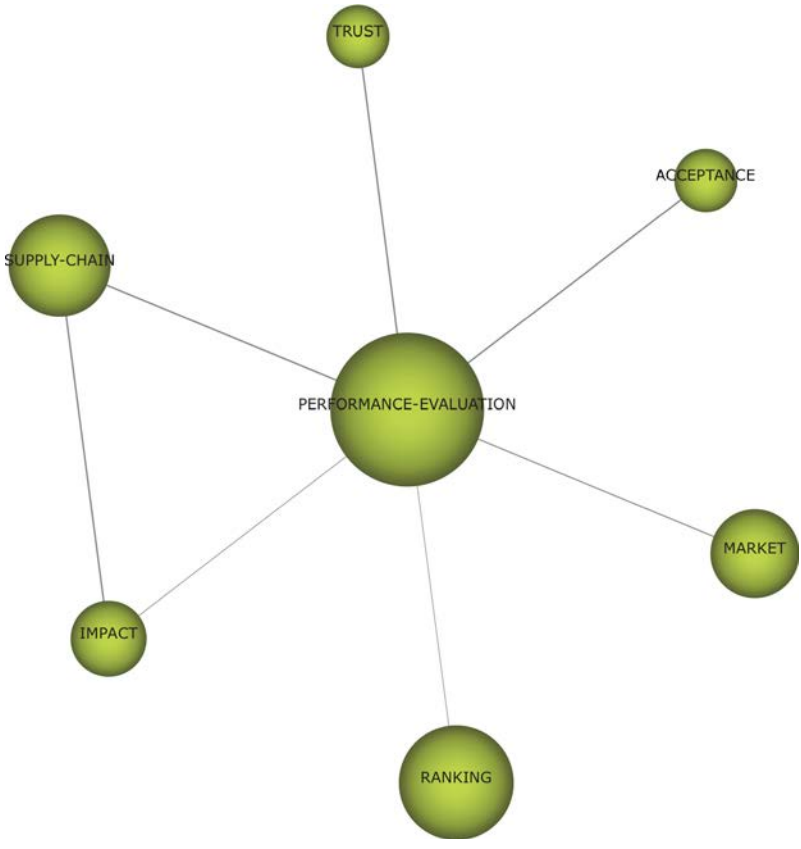


Fig. 12. Thematic network for the theme PERFORMANCE-EVALUATION.

In Table 2 a list of the themes associated to the documents published during 2010 and 2011 is shown. This list includes quantitative and qualitative measures as the number of documents (#Doc) associated to each theme, references of each document, the citations and citation average (Average). The information included in this table allows us to distinguish to type of themes, *hot-themes* and *cold-themes*. For us, a hot-theme is that one with a citation average higher (or equal) to 1.00, i.e., themes with at least one cite per each associated document. These hot-themes are those themes giving positive citation to the journal, helping to increase the impact factor of the journal, whereas, the cold-themes are themes penalizing the journal, decreasing its impact factor. In this sense, themes as SOFTWARE-DEFECT-PREDICTION (with 4.00 cites per document), GROUP-DECISION-MAKING (2.25 cites per document), MANAGEMENT (1.75), ANALYTICAL-HIERARCHY-PROCESS (1.56) and PERFORMANCE-EVALUATION (1.43) are supposed, in general, very beneficial themes for the journal, clearly contributing to a high impact factor.

This *a posteriori* classification could be used by the reader as a predictive estimation about what themes will be beneficial for the journal in next years (2012 or

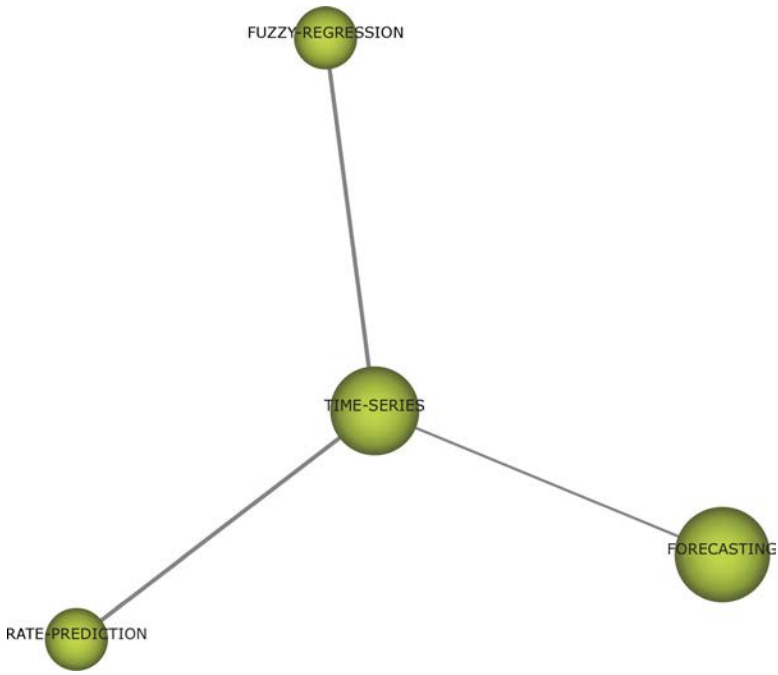


Fig. 13. Thematic network for the theme TIME-SERIES.

Table 2. Basic measures of the themes associated to the documents published during 2010 and 2011.

Theme	#Doc	Citations	Average	References
SOFTWARE-DEFECT-PREDICTION	3	12	4.00	6,50,52
GROUP-DECISION-MAKING	2	5	2.25	12,25
MANAGEMENT	4	7	1.75	31,48,52,64
ANALYTICAL-HIERARCHY-PROCESS	9	14	1.56	9,31,35,38,50,56,62,72,76
PERFORMANCE-EVALUATION	7	10	1.43	15,28,31,46,52,57,79
DECISION-SUPPORT-SYSTEM	3	3	1.00	21,47,53
DATA-ENVELOPMENT-ANALYSIS	2	1	0.50	8,71
AGENTS	2	1	0.50	22,79
TECHNOLOGY-ACCEPTANCE	2	1	0.50	29,66
UNCERTAINTY	3	0	0.00	43,51,70
DATA-MINING	6	0	0.00	37,39,42,45,67,77
OPTIMIZATION	3	0	0.00	33,65,70
INTERPRETIVE-STRUCTURAL-MODELING	2	0	0.00	5,35

even 2013). This predictive analysis could be even done and used by the journal editorial board to help them to select the priority thematics for the journal, given preference to documents associated to presumably hot-themes. Anyway, this predictive analysis (and the associated editorial decisions) has to be carefully done otherwise it is also possible to find cold-themes with some particular highly cited

Table 3. Most cited papers and their associated themes.

Document (Reference)	Year	Citations	Associated Theme/s
49	2008	57	DATA-MINING
75	2006	53	DATA-MINING
11	2009	35	CONSENSUS // GROUP-DECISION-MAKING
26	2004	31	DATA-MINING
60	2005	29	OPTIMIZATION
73	2005	21	CONSENSUS
54	2002	16	TIME-SERIES
4	2009	15	CONSENSUS // UNCERTAINTY
74	2005	15	CONSENSUS
55	2005	15	ANALYTICAL-HIERARCHY-PROCESS
1	2006	14	ANALYTICAL-HIERARCHY-PROCESS // DATA-ENVELOPMENT-ANALYSIS
34	2005	14	TIME-SERIES
30	2007	13	DECISION-SUPPORT-SYSTEM // PERFORMANCE-EVALUATION // TIME-SERIES
32	2009	12	DATA-ENVELOPMENT-ANALYSIS
2	2008	11	ANALYTICAL-HIERARCHY-PROCESS
63	2009	11	MANAGEMENT
23	2007	10	ANALYTICAL-HIERARCHY-PROCESS

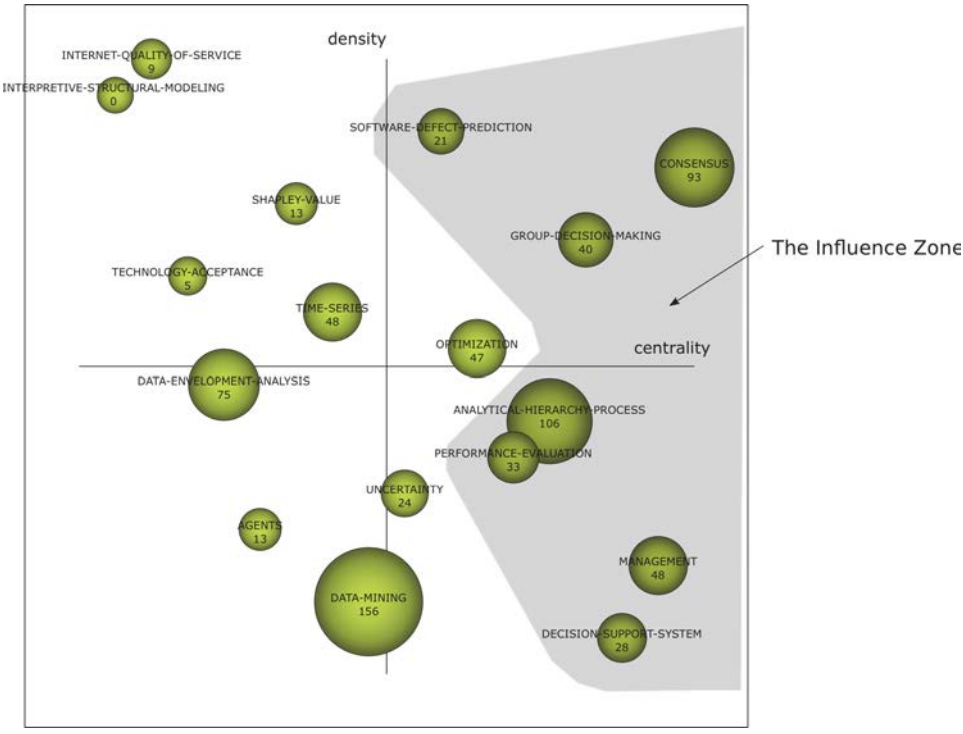


Fig. 14. The influence zone of IJITDM in 2010 and 2011.

documents, as it is shown in Table 3. In Table 3, the historical (considering papers published from 2002 to 2011) most cited papers are shown. We can see as relatively recent papers (2009) as Refs. 4 and 11 (associated to CONSENSUS) and Ref. 63 (associated to MANAGEMENT) are highly cited papers.

We think all this information should be jointly taken into account for determining the "best" themes for the IJITDM. So, we define the *Influence-Zone* as the part of the strategic diagram that groups motor and basic-themes and simultaneously hot-themes with themes with highly cited papers in the last three or four years before 2009, 2010 and 2011 in our case. This influence zone is drawn in Fig. 14.

So, we think that future (mainly 2012 or 2013) papers associated to the influence themes: SOFTWARE-DEFECT-PREDICTION, GROUP-DECISION-MAKING, CONSENSUS, MANAGEMENT, ANALYTICAL-HIERARCHY-PROCESS, PERFORMANCE-EVALUATION and DECISION-SUPPORT-SYSTEM will be very beneficial papers, providing quantity and specially quality and cites to the journal.

5. Conclusion

The purpose of this paper has been to offer an expeditious perspective of the first decade (2002−2011) of the IJITDM by identifying themes, predicting emerging trends, and determining relationships with other themes/fields.

Our analysis has to allow to detect the influence themes of the journal, i.e., those themes with a much relevant role in future years for the journal.

All this has been done using co-word as content analysis technique. However, this task is not free of difficulties due to the biases involved in an analysis of this kind. The main one is that the analysis focuses on priority themes (just those automatically detected by CoPalRed) and will inevitably exclude those that are of only marginal importance. Nonetheless, the analysis serves to legitimize discussions about general trends of the journal.

Since the analysis is constrained by factors such as sample size and the period examined, among others, its "applicability-generalizability" must be further reviewed and tested in the future, preferably at regular intervals.

Finally, experts and novices could use these data, results and maps to understand the current state of the art with regard to IJITDM and predict where future research will lead.

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2. Identificando los Clásicos de la Literatura en Trabajo Social a través del Concepto de H-Classics

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H-Classics: characterizing the concept of citation classics through H-index

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Abstract Citation classics identify those highly cited papers which are an important reference point in a research field. To identify a paper as a citation classic we have to fix a citation threshold value. Usually, this threshold value should not be the same for all research fields because each field presents its respective citation pattern. Studies of citation classics in the literature define particular criteria and methods to set citation thresholds, which are often set arbitrarily and designed ad-hoc, and do not allow the scientific community to validate and compare their results. In this paper we introduce the concept of H-Classics to overcome this problem and provide scientific community a standardization of key constructs. We present a new and systematic method to identify citation classics. This identification method of highly cited papers is based on the H-index and thank to the properties of H-index it is sensitive to the own characteristics of any research discipline and also its evolution. Therefore, the concept of H-Classics allows to systematize search procedure of citation classics for any field of research.

Keywords H-index · Citation classics · Bibliometric measures

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Introduction

Bibliometrics is a science based on the citation analysis of the papers and used mainly to evaluate research performance (Moed 2009). A basic assumption of citation analysis is that the more often a paper becomes cited the greater its influence on the field (Garfield 1979). Bibliometrics uses the citation analysis to develop evaluation metrics that allow to quantify the impact of a journal or an individual or a paper. Some examples of citation based metrics are Journal Impact Factor (Garfield 1979), H-index (Hirsch 2005), Citation Classics (Garfield 1977), respectively.

Citation classics is a bibliometric concept introduced by Garfield (1977) to designate those highly cited papers of a scientific discipline. Citation classics help to discover potentially important information for the development of a discipline and understand the past, present and future of its scientific structure. By this reason, for some authors the citation classics are considered as the *"gold bullion of science"* (Smith 2007; Stack 2012). For example, an analysis of the citation classics of a research field

- allows for the recognition of major advances in the discipline, i.e., to identify emergent or basis or hot or superstar topics in order to inspire other works on the area (Garfield 1977; Tam et al. 2013);
- gives a historical perspective on the scientific progress of the speciality (Smith 2007; Stack 2012); and
- identifies also the main intellectual markers of the research field, which could be journals or researchers or countries or research groups or institutions (Baltussen and Kindler 2004; Garfield 1977; Smith 2007; Stack 2012; Tam et al. 2013).

The citation classic concept is well understood by the scientific community, however there is still no standard way to identify them. There are two approaches to identify citation classics: (i) setting citation thresholds (Gehanno et al. 2007; Ibrahim et al. 2012; Ponce and Lozano 2010, 2011; Rosenberg et al. 2010) and (ii) choosing a number of papers in the top of the list of highly cited papers (Cassar et al. 2012; Feijoo et al. 2013; Garfield 1977; Stack 2012, 2013; Tam et al. 2012). Former is related to the definition of citation thresholds or rates of a discipline that have to meet a paper to be considered a citation classic of that discipline. For example, following Garfield's (2013) recommendations some authors use 400 cites received as citation rate (Ibrahim et al. 2012; Ponce and Lozano 2010, 2011) and others 100 (Gehanno et al. 2007), but without any rigorous scientific argument. And the problem is that citation rates differ for each discipline (Garfield 2013). Furthermore, in the current information society with the increasing use of the Internet the possibilities of dissemination of information is growing and the number of citations received well. Therefore, it makes no sense to set strict thresholds, but rather variable thresholds and adaptable to the particular evolution of each research area. On the other hand, latter is to choose a number of papers from the list of papers sorted by citations. Some authors set a specific number of publications as the ideal number of citation classics (e.g. 100, 50 or 25 are values used) (Cassar et al. 2012; Feijoo et al. 2013; Garfield 1977; Tam et al. 2012) and others set a percentage of papers sorted by citations received (the top 1 % or top 0.1 % are used) (Garfield 1987; Levitt and Thelwall 2009; Stack 2012, 2013). Again, the problem is that there is no serious scientific argument that supports those decisions. Thus, both identification procedures of citation classics lack any scientific support, are made ad-hoc and can bias the choice of the classics.

To overcome those problems, in this paper we introduce the concept of H-Classics. H-Classics are defined as citation classics identified through the H-index defined by Hirsch

(2005). It is well known the value of the H-index to evaluate the scientific quality of a researcher and also it has been successfully applied to evaluate the quality of journals (Braun et al. 2006), institutions (Prathap 2006) and even countries (Jacsó 2009). We propose its application to identify the citation classics of a research area. So, we present a new and systematic methodology to characterize the citation classics and, in such a way, we provide scientific community a standardization of key constructs to identify classics. Thank to the H-index this new methodology is adaptable to the own citation practices of any research discipline and also its evolution. Thus, the concept of H-Classics is an unbiased and fair criterion to systematize search procedure of citation classics for any field of research.

To do so, the paper is set out as follows. "Preliminaries: citation classics and the H-index" section presents the preliminaries, by analyzing the concept of citation classics and introducing the H-index. In "H-Classics: a new concept for analyzing the literature classics" section, we present the concept of H-Classics and the new methodology to identify citation classics. "Cases of study based on the H-Classics" section presents some practical examples of H-Classics in various research areas and some of its benefits are shown. Finally, some concluding remarks are pointed out in "Concluding remarks" section.

Preliminaries: citation classics and the H-index

In this section we present the concept of citation classics and also analyze its problematic. On the other hand, we present the popular bibliometric measure H-index, which is used to characterize the concept of H-Classics in "H-Classics: a new concept for analyzing the literature classics" section.

Citation classics

Garfield (1977) initially defined the concept of citation classics to identify those most frequently cited papers that set the tone for development of a discipline. Then, he and his research team developed the project "Citation Classics Commentaries" to capture more of the human side of science. These citation classics commentaries were published in the periodical publication *Current Contents*. Each citation classic commentary is a two-page essay written by the citation classic author who provided personal information on how the work was developed (basic ideas, obstacles encountered, highlights) (Garfield 2013). The project was discontinued in 1993, but it has laid the foundation for the development of other bibliometric products marketed by Thomson Reuters, as for example, the *Hot Papers* (see http://sciencewath.com) or *The List of Highly Cited Papers or Researchers* (see http://www.highlycited.com/).

Garfield subsequently proposed other definitions of citation classics as "*A citation classic is a work whose citation count placed it in the top 1 % of works*" (Garfield 2013) or "*A citation classic is a highly cited publication as identified by the Science Citation Index(SCI) the Social Sciences Citation Index SSCI), or the Arts & Humanities Citation Index (A & HCI)* (Garfield 2013)". And, the study of the citation classics of a research area has aroused much interest in the scientific community because it helps researchers to understand the scientific structure of a discipline, its evolution and also to discover new knowledge useful for its future scientific progress, including:

- The discovering of research topics of special interest within the scientific community: basic themes, trend or hot themes, emergent themes, etc.
- The identification of highly relevant authors/institutions/groups in the research area.

Some research fields which have recently published analysis on citation classics are: "Social Work" (Hodge et al. 2012), "Integrative & Complementary Medicine" (Tam et al. 2012), "Neurosurgery" (Ponce and Lozano 2010), "Parkinson" (Ponce and Lozano 2011), "Critical Care Medicine" (Rosenberg et al. 2010), "Suicidology" (Stack 2012), "Deviant Behavior" (Stack 2013), "Information & Library Science" (Levitt and Thelwall 2009), "Occupational Medicine" (Gehanno et al. 2007), "Epilepsy" (Ibrahim et al. 2012), "Pain Medicine" (Li et al. 2012), "Plastic and Reconstructive Surgery" (Zhang et al. 2012), "Pancreatology" (Cao et al. 2012), "Endodontology" (Fardi et al. 2011), "Dentistry" (Feijoo et al. 2013), "Respirology" (Tam et al. 2013), "Orthodontist" (Hui et al. 2013), "Orthopedics" (Namdari et al. 2012), "Arthroscopy" (Cassar et al. 2012), "Vascular Surgery" (O'Connor et al. 2011), etc,. An overview of some key features and findings of these analysis are presented in Table 1.

As aforementioned, there are two kinds of identification procedures of citation classics:

1. The first one involves the establishing citation rates or thresholds to be met by the published papers. Following the Garfield's recommendations (Garfield 2013), a publication cited more than 400 times should be considered a classic (Ibrahim et al. 2012; Ponce and Lozano 2010, 2011); but in some fields with fewer researchers, 100 citations might qualify a work (Gehanno et al. 2007; Rosenberg et al. 2010). The problem is that citation rates differ for each discipline (Garfield 2013) given that the citation counts of a scientific field depends on many factors (Albarrán et al. 2011; Bornmann and Daniel 2008): aging of the area, citation distribution, publication and citation practices, the activity rate of the scientific community, the number of scientists, channels of information dissemination, etc. Therefore, if for some fields can be set as citation rate to be considered a citation classic have received 400 citations, for others that score of citations is impossible to be reached for some paper. But furthermore, there is one open question more: why do authors establish 400 citations and not 350 or 399?. Would it be possible to give a common selection guidelines?.
2. The second one involves the choosing a specific number of papers placed in the top of the list of highly cited works. Garfield points out two methods to do it: (i) to set a concrete number of papers (Garfield 1977) or (ii) to set a percentage of papers (top 1 % of highly cited works is a usual percentage) (Garfield 1987). Examples of specific numbers of papers used to study the classics are 100 most highly cited articles (Cao et al. 2012; Fardi et al. 2011; Feijoo et al. 2013; Hodge et al. 2012; Hui et al. 2013; Li et al. 2012; O'Connor et al. 2011; Zhang et al. 2012) or 50 most highly cited articles (Namdari et al. 2012; Tam et al. 2012, 2013) or 25 most highly cited articles (Cassar et al. 2012). On the other hand, some usual percentages used are top 1 % of highly cited works (Stack 2012, 2013) or top 0.1 % (Levitt and Thelwall 2009). Again we find some questions:

- Maybe 100 could be a representative number of citation classics in some research areas (e.g Social Work), but if we have a large research area as Physics, we would need 2000 or more citation classics to represent the classical literature.
- Why would we have to use 100 or 50 or 25 and not 95 or 45 or 35, respectively? or why would we have to use the top 1 % and not the top 2 % or the top 0.5 %?.

Table 1 Data of studies on citation classics

Discipline	References	Citation rate	#(Classics)
Epilepsy	Ibrahim et al. (2012)	400	89
Neurosurgery	Ponce and Lozano (2010)	400	106
Parkinson	Ponce and Lozano (2011)	400	107
Critical Care Med.	Rosenberg et al. (2010)	100	1187
Occupational Med.	Gehanno et al. (2007)	100	85
Suicidology	Stack (2013)	96	12
Deviant Behav.	Stack (2012)	43	10
Inf. & Lib. Sci.	Levitt and Thelwall (2009)	118	82
Soc. Work	Hodge et al. (2012)	41	100
Pain Med.	Li et al. (2012)	302	100
Plastic and Rec. Surg.	Zhang et al. (2012)	165	100
Vascular Surgery	O'Connor et al. (2011)	194	100
Pancreatology	Cao et al. (2012)	163	100
Endodontology	Fardi et al. (2011)	87	100
Dentistry	Feijoo et al. (2013)	326	100
Orthodontist	Hui et al. (2013)	89	100
Integ. & Comp. Med.	Tam et al. (2012)	52	50
Respirology	Tam et al. (2013)	615	50
Orthopedics	Namdari et al. (2012)	192	50
Arthroscopy	Cassar et al. (2012)	189	25

Therefore, in both approaches we find the same problematic. The identification parameters of citation classics are set according to the traditional recommendations, without considering a precise scientific argument and neither the circumstances of the research area when the study is done. Consequently, this could introduce a bias in the choice of the citation classics. Therefore, it would be desirable to find some transparent scientific criterion to support the setting of citation rates and that such criterion could reflect the evolving of the research area too.

H-index

H-index is one of the most popular bibliometrics indicators which was originally introduced by Hirsch (2005) to measure the scientific performance of a researcher through his/her publications. The original definition was:

> A scientist has index h if h of his or her N_p papers have at least h citations each, and the other $(N_p - h)$ papers have $\leq h$ citations each.

Burrell (2007) points out that the *H*-index identifies the most productive core of an author's output in terms of the most cited papers. For this core, consisting of the first h papers, Rousseau (2006) introduced the term *Hirsch core* (*H*-core), which can be considered as a group of high-performance publications with respect to the scientist's career (Jin et al. 2007).

Due to its numerous advantages the H-index has been well received by the scientific community and many research papers on H-index have been developed (for more

information to read the review by Alonso et al. (2009)). Its main advantage is that H-index comprises in a single indicator a measure of quantity and impact of the scientific output of a researcher, aspects that traditionally have been measured separately by using different indicators. Another benefit of this indicator is that it is quite simple to compute from the citation data available through the scientific databases as Web of Knowledge and Scopus. The H-index has been proven to be robust in the sense that it is insensitive to a set of lowly cited papers (Vanclay 2007). Additionally, increasing the *H*-index is difficult as each unit increment implies receiving citations in a larger number of papers. Moreover, the *H*-index is insensitive to one or several outstandingly highly cited papers (which is usually considered as a drawback). H-index is an indicator of the scientific life of a researcher, i.e., H-index is sensitive to the evolution of the scientific career of a researcher, so that it reflects the evolution of his/her publications and citations.

In order to take advantage of the H-index some authors have extended its application to characterize the scientific activity of other entities, as for example, to measure the impact of journals (Braun et al. 2006), the scientific performance of institutions (Prathap 2006) and even the scholarly productivity of countries (Jacsó 2009). In the following section, we study its application to characterize the concept of citation classics of a research area, providing a robust and transparent method to develop studies of literature classics.

H-Classics: a new concept for analyzing the literature classics

In this section, we present the concept of H-Classics as a new tool useful to identify and analyze citation classics of a research area. H-Classics is based on the H-index, and therefore, it provides a rigorous and scientific method to discover the most highly cited papers in a scientific discipline. It is introduced to avoid potential biases that appear in many studies of citation classics that have been made so far.

Suppose that we have retrieved *N* articles and their respective citations subject scientific category of *A*. As we calculate the H-index of a researcher, we could also calculate the H-index of category *A*. Then,

> a paper P of scientific category A is considered a H-Classic of A if and only if P is inside of the H-core of A.

In such a way,

> H-Classics of a research area A could be defined as the H-core of A that is composed of the H highly cited papers with more than H citations received.

Then, the identification process of citation classics of a research area through the concept of H-Classics could be carried out in the following steps:

1. *Choosing the bibliographic database to locate the scientific production and citations*. Three potential databases are known, Google Scholar, Scopus and Web of Science (WoS), latter being the most widely used database that collects as much information more reliably and with more analysis tools to process information.
2. *Set the research area under study*. To do this, citation classics studies focus on analyzing papers published in journals, and furthermore by using two types of papers, "article" and "review". Therefore, the group of journals that are traditionally used to disseminate scientific advances made in the area should be identified, and then, their publications and citations received from the bibliographic database should be

retrieved. In the case of WoS, if we're lucky and the area to analyze matches any of the scientific areas of the Journal Citation Report (JCR), then making a simple search in WoS it is possible to get all the information necessary to characterize the area. If it is difficult to identify the area by means of both a set of magazines or an area of the JCR, then we should define an appropriate query to find all related papers and their respective citations. In any case, an appropriate query to collect our interests should be defined. In Table 2, there are several examples of queries to characterize different disciplines working with WoS, i.e., "Suicidology" (Stack 2012), "Epilepsy" (Ibrahim et al. 2012), and "Dentistry" (Feijoo et al. 2013).

3. *Compute the H-index of the research area*. The computation of H-index of research area is done by establishing a ranking of the papers according to their citations. If WoS is used to retrieve the scientific production, WoS provides us filtering tools to compute easily the H-index of the research area. For example, in Table 3 we show any results to compute the H-Index in several JCR research areas according to the data stored in the WoS (Computation on June 22 2013): "Social Work", "Family Studies", "Transplantation", "Dentistry", "Computer Science", "Mathematics" and "Physics". We also show some key features and findings like the citation rate (*Cr*) or the number of citations received by the last paper included in the H-core, and the number of papers published in the research area (#(*Papers*)) in the Timespan (1900–2013) and by considering only "Articles" and "Reviews".
4. *Compute the H-core of the research area*. This step consists in recovering the H highly cited papers that are included in the H-core of the research area. It is clear that H-core of the research area identifies its H-Classics, and thus, H-index of a research area represents the cardinality of the H-core of the area, i.e., H-index = #(H-Classics). Again, we should point out that using WoS this operation is facilitated.

Table 2 Queries to set research areas in WoS

Discipline	Query type	Query
Suicidology	Journal	SO = (Suicide and Life Threatening Behavior)
Epilepsy	Topic	TS = (epilepsy or epilepsies or epileptic or epilepticus or seizures or seizure),
Dentistry	JCR area	SU = (Dentistry, Oral Surgery & Medicine)

Table 3 Computing H-index of JCR areas

Discipline	Cr	H-index	#(Papers)
Social work	126	125	46402
Family studies	168	168	46117
Transplantation	224	224	116623
Dentistry	246	246	184646
Computer science	624	624	824198
Mathematics	642	640	1104332
Physics	1171	1171	3256681

Some advantages of H-Classics to characterize the more influential papers of a research category are the following:

- H-Classics of a scientific field is the result of the combination of both measures, the number of papers published in the field and the impact of those publications. Therefore, H-Classics comprises in a single procedure both approaches existing in the literature to identify citation classics. In such a way, it provides a more complete view of the highly cited scientific production of a research area.
- As aforementioned, many of the citation classics studies presented so far are based on arbitrary criteria and they could be skewed and even incomplete. H-Classics is based on the H-index and therefore, it provides a scientific, robust and transparent criterion to identify citation classics of the scientific literature. In such a way, we provide scientific community a precise indicator to develop and justify any future studies of citation classics to be done.
- H-Classics is very simple to compute once the list of papers and their respective citations are retrieved. If the production and citation data of research area are available through a popular scientific databases as WoS, the identification of the H-Classics is very easy: Firstly, we compute the H-index of the area and then we retrieve the papers included in its H-core.
- H-Classics is a criterion sensitive to the dimension of the research area. So, in Table 3 those large research areas (as "Computer Science", "Mathematics" or "Physics") present a higher number of citation classics (*H-index*) than those small ones (as "Social Work", "Family Studies", "Transplantation", and "Dentistry").
- H-Classics is also a criterion sensitive to the citation pattern of each research area. For example, in Table 3 if we compare two research areas with similar dimensions as "Social Work" (46.402 papers published) and "Family Studies" (46.117 papers published), H-Classics returns very different quantities of citation classics, 125 and 168, respectively. Therefore, H-Classics is able to detect differences in their respective impacts or citations. In this case, "Family Studies" attracts more citations than "Social Work". This can be contrasted in Fig. 1, where we compare both categories in the period (2005–2010) and we see that although both have similar amounts of publications, however the scientific category of "Family Studies" receives many more citations in each year.

Cases of study based on the H-Classics

In this section, we analyze the behavior of the H-Classics and show its benefits in comparison with some studies of citation classics presented in Table 1, which were developed with traditional tools. We should point out that in this section, the term *T-Classics* represents the citation classics of a research area which were identified using a traditional approach. Therefore, T-Classics could be established by setting citation thresholds or choosing a number of papers in the top of the list of highly cited papers. Specifically, we focus on those studies of citation classics that were developed using WoS and a timespan next to the year 2013, i.e., (1900–2010), (1900–2011), and (1900–2012). We do this so that the citations received up to 2013 affect as little as possible the process of identification of the H-Classics.

In particular, we apply H-Classics to identify the citation classics in the following cases: "Epilepsy" (Ibrahim et al. 2012), "Parkinson" (Ponce and Lozano 2011), "Suicidology"

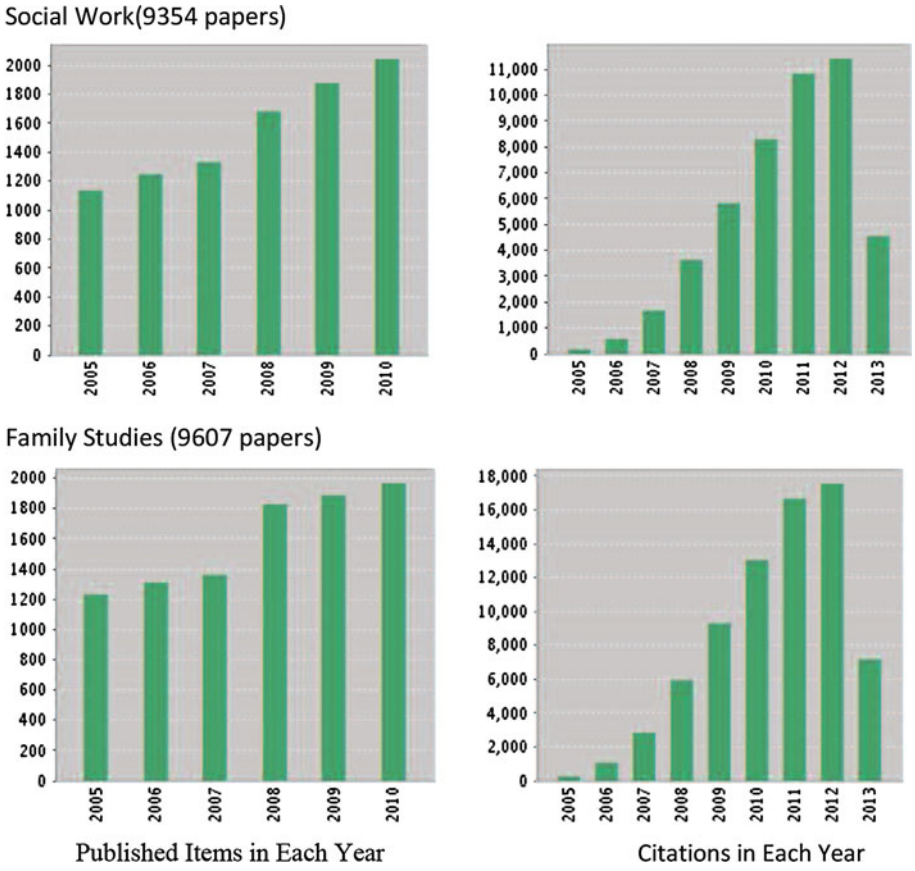

Fig. 1 "Social work" versus "family studies"

(Stack 2012), "Pain Medicine" (Li et al. 2012), "Plastic and Reconstructive Surgery" (Zhang et al. 2012), "Dentistry" (Feijoo et al. 2013), "Orthodontist" (Hui et al. 2013), "Respirology" (Tam et al. 2013), "Arthroscopy" (Cassar et al. 2012). Then, we simulate in WoS the same search process of each case with the same timespan. In Table 4 we show the search strategies followed in each discipline.

In Table 5 we show the results obtained by H-Classics in comparison with the results of T-Classics. In general, if we compare graphically the results of both as it is shown in Fig. 2, we can conclude that H-Classics provides us very different results to T-Classics. And in fact, the correlation coefficient between both is 0.45, which is a low correlation value. Consequently, we might think that both methods show us different views of the citation classics. This happens because in H-Classics we firstly set the citation rates or thresholds to be satisfied by the papers to be considered citations classics and then we identify the citation classics. This identification process is very different to the most of considered procedures of T-Classics that firstly set the specific number of papers that must appear as citation classics (case 4 to case 9) attending to the traditional expert recommendations but not considering any citation criterion.

Except in the research area of "Orthodontist" (where T-Classics and H-Classics provide similar results, i.e., 100 and 98 citation classics), in other disciplines H-Classics always

Table 4 Search strategies

Discipline	Search strategy
Epilepsy	TS = (epilepsy or epilepsies or epileptic or epilepticus or seizures or seizure), timespan = 1900–2011
Parkinson	TS = (Parkinson), timespan = 1900–2010
Suicidology	SO = (Suicide and Life Threatening Behavior), timespan = 1900–2011
Pain Med.	SU = (Anesthesiology) or so = ((Journal of Pain) or (Molecular Pain) or (Journal of Pain and Symptom Management) or (Pain Management Nursing) or (Pain Medicine) or (Journal of Headache and Pain) or (Journal of Musculoskeletal Pain) or (Journal of Orofacial Pain)), timespan = 1900–2010
Plastic and Rec. Surg.	SO = ((Plast Reconstr Surg) or (Arch Facial Plast S) or (J Plast Reconstr Aes) or (Ann Plas Surg) or (Aesthet Plast Surg) or (Clin Plast Surg) or (J Plast Film Sheet) or (Facial Plast Surg) or (Ophthal Plast Recons) or (Can J Plast Surg) or (J Plast Surg Hand Su)), timespan = 1900–2011
Dentistry	SU = (Dentistry, Oral Surgery & Medicine), timespan = 1900–2012
Orthodontist	SO = ((American Journal of Orthodontics and Dentofacial Orthopedics) or (The Angle Orthodontist) or (European Journal of Orthodontics)), timespan = 1900–2011
Respirology	SU = (Respiratory System), timespan = 1900–2011
Arthroscopy	TS = (Arthroscopy), timespan = 1900–2011

Table 5 T-Classics versus H-Classics

Discipline	#(T-Classics)	#(H-Classics)	#(Papers)
1. Epilepsy	89	323	99109
2. Parkinson	107	383	63471
3. Suicidology	12	58	1307
4. Pain Med.	100	271	106050
5. Plastic and Rec. Surg.	100	154	29439
6. Dentistry	100	246	181513
7. Orthodontist	100	98	8163
8. Respirology	50	358	185563
9. Arthroscopy	25	109	7680

gives us a greater number of citation classics. Therefore, H-Classics provides a more complete mapping of the classical literature of a research area than T-Classics. This happens because T-Classics searches the classical literature by setting or a very high citation rate of 400 citations received (as in "Epilepsy" and "Parkinson") or a very low specific number of citation classics as 100, 50 or 25 (as in "Dentistry", "Respirology" and "Arthroscopy", respectively).

On the other hand, if we compare the output of T-Classics and H-Classics with respect to the dimension of the each research area expressed in number of papers (#(*Papers*)), we obtain the following correlations coefficients, 0.27 and 0.72, respectively. Therefore, the weak correlation of T-Classics justifies the use of the H-Classics, which satisfactorily

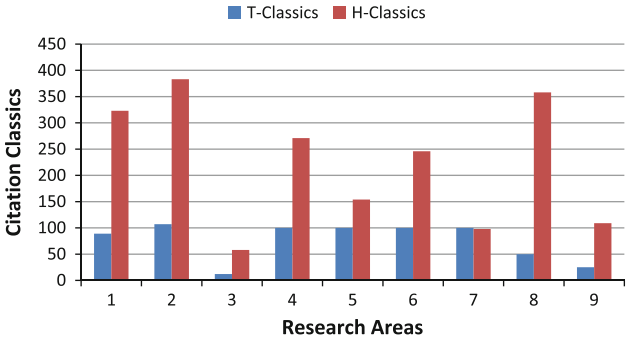

Fig. 2 T-Classics versus H-Classics

combines both traditional approaches to identify the citation classics and reflects better the dimension of the research area.

Concluding remarks

In this paper, we have presented a new concept to characterize the citation classics of a research area, the H-Classics, which is based on the popular and rigorous bibliometric criterion H-index. We have introduced it to overcome the problems detected in recent studies of citation classics developed in different disciplines. We have shown that H-Classics is sensitive to the own citation practices of any research discipline and also its evolution. It is an unbiased and fair criterion to systematize search procedure of citation classics for any research area. Furthermore, we have shown some good properties of H-Classics by means of examples of studies of citation classics published yet.

We should point out that the H-Classics of a scientific category are a valuable information source to develop data analysis in a scientific discipline. In fact, H-Classics can help researchers who want to start their work in a discipline, for example, giving them to know the most important topics and authors who lead these topics. Additionally, H-Classics can enrich other bibliometric analysis that can be developed with other techniques like science mapping (Cobo et al. 2012).

Finally, we should point out the good behaviour of the H-Classics, which provides a more complete mapping of the classical literature than other studies analyzed.

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