Professional competences: Intellectual structure of research

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Grecia, 31 Octubre 2012

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Abstract

This work aims to visualize the structure of research around professional competences through social network analysis of its research literature, taking into account the relationships among the authors who have written on the professional competences.

The research sample includes publications in journals listed in the Web of Science database since 1950 to beginning of 2012. Maps made with the software Citespace II. The results obtained allow us to visualize the trends in the investigation of professional competences to present the conclusions.

Keywords: Professional competences; Social Networks; mapping science.

1. Introduction

Professional competences have gained great value in short time (Van Der Klink, Boon, & Schlusmans, 2007), nonetheless they tend to be conceptualized in a reductionist and fragmented way; generated by their multi-disciplinary, transversal, multi-dimensional and transnational nature (Tobón, 2006). This leads to inconsistency and lack of clarity of the intellectual structure of this term, easily mistaken it with other terms in despite of the abundant research literature referred to professional competences (labor and directive) (Guerrero, De los Ríos, & Díaz-Puente, 2008).

Consequently, the objective of the present research is to visualize the structure of research around professional competences through the analysis of social networks of research literature, to then identify and analysis the relationships among the most outstanding documents and in this way support the intellectual basis of professional competences.

2. Research methodology

Table 1 states the initial conditions of research for the present study.

Table 1. Initial considerations

Factor	Initial considerations
Object of study	Professional competences (labor and directive).
Scope of research	Visualize the intellectual structure of professional competences of the last 60 years through scientific publications.
Sources of information	Initial source: books, journals, articles.
	Fuente principal: base de datos bibliográfica Web of Science.
Research method	Synthetic/deductive method.

Technique for recollection of data	Analysis of documents (Lafuente, 2001, pág. 1) advanced search and exportation of registers from bibliographical data bases.
Data analysis and interpretation	For the scale analysis of bibliographical registers unit measures, space and analysis reduction techniques described in the first section are used.

The process followed to comply with the planned objective is divided in 6 steps: traditional bibliographical analysis, selection of main source of information, search configuration in main source, treatment of data obtained from main source, selection of visualizing software, and finally, interpretation and analysis of domain visualization.

The 6 steps are now summarized:

2.1. Traditional bibliographical analysis

Consists on revising research related to professional competences which Support further interpretations and which also allow a definition of the characteristics of the main source of information and the advanced search configuration of bibliographical registers. The main sources revised were extracted from the works of: Sergio Tobón (2006), Fotis and Mentzas (2006), Weinert (2004), Guerrero, De los Ríos and Díaz-Puente (2008), Schneckenberg & Wildt (2006).

2.2. Selection of sources

A selected source of information for our study is the Web of Science (WoS) data base, mainly because of its relevance and its multi-disciplinary content necessary to cover the study of professional competences.

2.3. Search configuration

Being the concept of competences a complex term categorized as "wicked words" (Lévy-Leboyer, 2003, pág. 8) (Van Der Klink, Boon, & Schlusmans, 2007) (Martens, Stoof, & Merrienboer, 2000) and considering that it is necessary to use the widest term possible to assure an analysis which will cover all main components of the scientific domain (Chen C. , 2006), a series of search describers and exclusions have been elaborated from the traditional bibliographical analysis (See Table 2).

Table 2. Search descriptors for the term "professional competences"

N°	Search descriptor	Detailed descriptors
1	Professional competences	"Profession* competenc*" , "Competenc* profession*", "Develop* competenc*" professional, "human competence", "intelligen* competenc*", "competenc* intelligen*", "Competenc* develop*" professional
2	Competence models	"Competenc* model*", "Models of competence","Model* competenc*", "competenc* base*", Concept* of Competenc*.
3	Learning of competences	"Learn* competenc*", "Competenc* learn*".

4	Development of competences	"Competenc* identif*", "Identif* competenc*", "Competenc* develop*" professional, "Develop* Competenc*" Professional, "profession* assessm*".
5	Competence profiles	"Competence at work", "competenc* profil*".
Terms exclusions		
Health, Biology, Children, Agriculture, Market, Genetic		
Note: (*) = Retrieves texts which contain the different variations of the Word including singular and plural forms. (" ") = Retrieves texts which contain the exact word written inside quotation marks.		

2.4. Treatment of data

In this step a series of tasks related to quality control of the data are conducted, this is due to the fact that normally some bibliographical registers extracted contain mistakes (Web of Science, 2006). The treatment of data conducted is related to the normalization of authors, of journal titles and normalization of categories.

2.5. Selection of software

The criteria for the selection of domain visualization software, is based on the studies made by Cobo et al. (2011), who analyzes 9 of the main tools: Citespace II, Science of Science tool, VantagePoint, BibExcel, Network Workbench Tool, Leydesdorff's Software, CopalRed, In-Spire and VosViewer. The criteria adopted for the present study are: compatibility, pre-processing of data, units of measure, and analysis techniques.

Compatibility is the ability of software to directly process registers exported from the Web of Science data base.

Pre-processing of data is referred to the ability of software to divide data in time intervals, to apply data reduction techniques and trimming techniques.

Units of measure quantify the relationships between units of analysis to achieve representation of the scientific domain. Among them, we are interested in: Co-citation of authors (White, 2003), Co-citation of documents (Small & Garfield, 1986), Co-citation of categories (Moya Anegón, et al, 2004) and Co-words (Leydesdorff & Welbers, 2011).

Analysis techniques: in our case, we are interested in: Burst detection (Chen C. , 2006), Network analysis (Wasserman & Faust, 1998) and Temporal analysis.

For the present study software Citespace II has been selected due to the fact that it complies with the selection criteria and also supports an analysis of heterogeneous node nets (terms, institutions, countries) and relationships (Co-citation, co-occurrence and direct quotation relationships), which offers a complete representation of the domain's dynamic (Chen C. , 2006).

3. Visualization of Domain

In order to analyze the graphs we must keep in mind that in Citespace II software the size and color of the node's rings which respectively represent its frequency and interval of years of occurrence, besides the nodes with high degrees of centrality are represented with an external pink ring, and emergent concepts (Burst terms) are represented with red rings (Synnestvedt, Chen, & Holmes, 2005).

In all graphs nets have been simplified through the pathfinder algorithm through trimming of isolated nets, to represent the main relationships among nodes.

3.1. Analysis of documents Co-citation

Applying Kleimberg's explosion algorithm we detect the work of Schon. The impact of his contribution is due to a concept revolutionary in its time: "professionals who receive training in real time and stimulus to think carefully (about what they do while they are doing it) develop their competences in a more profound way" (Schon, 1987).

Figure 1 shows the main documents and the relationships established among them, from which we can group documents according to their characteristics: The Works of McClelland (1973), Boyatzis (1982) were centered on studying the behavior elements more than the human intellect for the development of the individual; in the studies by Prahalad (1990), Senge and Hamel(1994) it is desired to create a competitive and of learning organization through the linkage of individual competences; research made by Schon (1987), Bandura (1986) are focused on integrating all aspects of people.

Besides, the relationship and impact of Taylor's research can be observed (1911) in later research conducted by authors: McClelland, Boyatzis, Schon and Prahalad, and a more direct and current impact in the work of Spencer (1993): "Competence at Work: Models for Superior Performance".

The mentioned main authors maintain a relationship of Co-citation with contemporary authors, that is both are referenced and used to generate new knowledge and that because of the size of their node reflect their current relevance (through the number of quotations). Among contemporary authors (1990-2000) we can mention: Barnett(1994), Lawler(1994), Mansfield(1996), Blancero(1996), Lucia(1999), Athey(1999), Sandberg(2000) and Shippmann(2000), Rodolfa(2005), Epstein(2002), Kaslow(2007), Rodriguez(2002), Sinnott(2002) and Hatcher(2007).
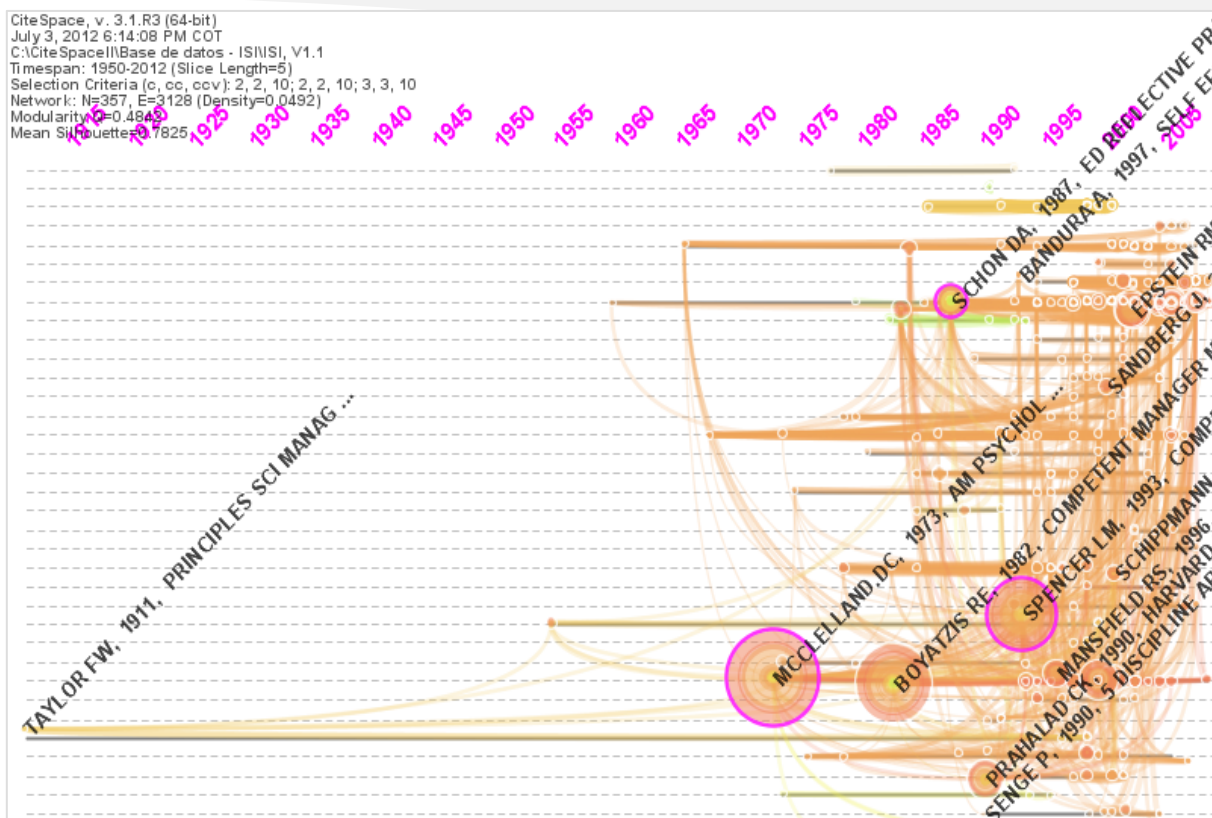
Fig. 1. Co-citation of documents

Lawler, Sandberg and Athey suggest that in order to achieve **strategic benefits in the organization** the starting point should be the development of competences by the personnel. Shippmann and Manfield compare and contrast the **job position approach**. Blancero and Lucia suggest a model of competences for the development of the **competences of personnel of any organization**. Barnett explores the competences in **higher education**. Hatcher, Rodolfa and Kaslow center themselves on the discipline of **psychology.** Epstein suggests a new approach to evaluate competences in the practice of the **medical professional.** In his report, Sinnot describes the competence models in the context of **planning succession in organizations**. Rodriguez presents the competence model for its application in **public organisms**

3.2. Analysis Co-citation of categories

In this **second** analysis (See Fig. 2) the main categories and their relationships are visualized, from which we identify 8 groupings of categories based on the classification made by Sergio Tobón (2006) and on the high degree of centrality of categories: psychology(#1), social sciences(#2), engineering(#3), administration and businesses (#4), informatics sciences(#5), Education and educational research (#6), Medicine(#7) and Linguistics(#8).
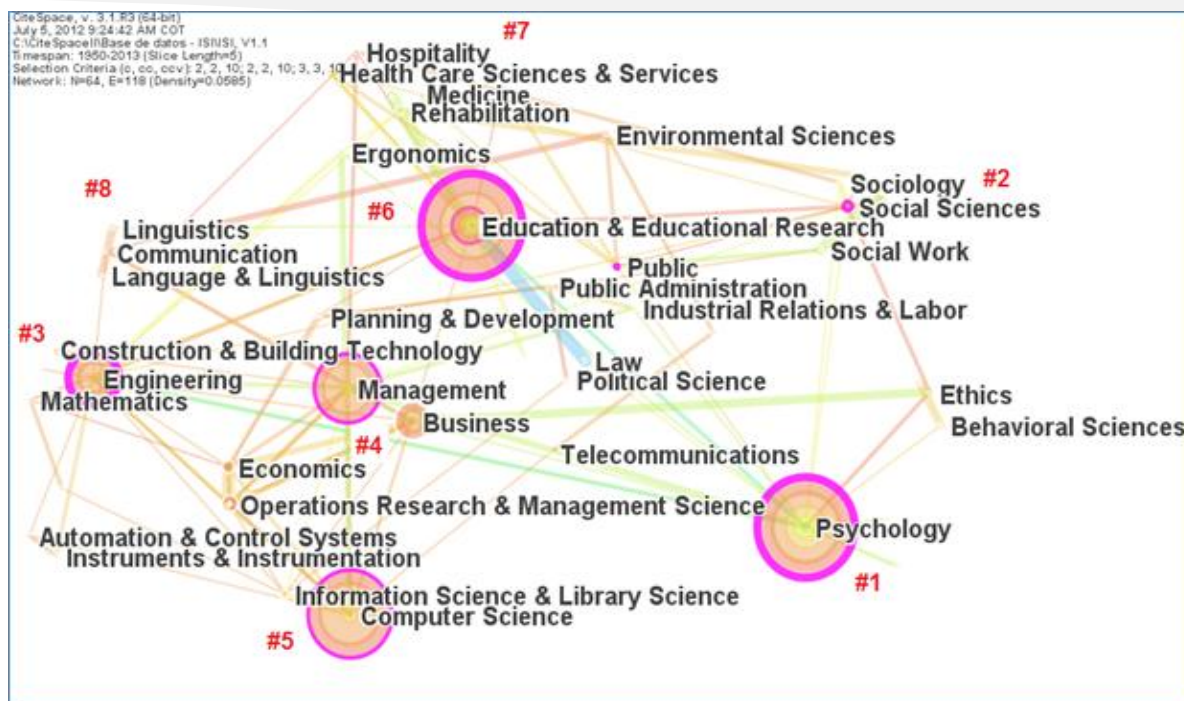
Fig. 2. Co-citation of categories

The group called "Psychology" formed by 260 documents covers categories such as: psychology and psychiatry. It maintains a strong relationship with the other groups of categories, and even when it does not maintain a direct relationship with the "informatics sciences" group, these at the end are related through a third category "ergonomics".

The group called "Engineering" is formed by 160 documents, and covers categories such as: Engineering, Basic Sciences (Mathematics, physics) and science of materials, manufacturing and building technology, transport, acoustics, water resources, instrumentation. The main relationships of Co-citation with the group "social sciences" are a product of the necessity ot include professional competences in the elaboration and execution of policies, programs and strategic plans for sustainable environmental and socio-economic development. With the group called "Informatics sciences" relationships are established as consequence of the necessity and desire to standardize profesional competences in these specialities to achieve efficacy in training and an advance in employability; prosing new models of professional competences. With the group "Administration and Businesses" relationships are established in terms to inclusion of competence models in business strategies, in strategic planning, and in improvement through innovation programs. With the "Medicine" group, relationships are established as a consequence of research related to the use of engineering methods to value and develop programs which will train and assess medical practitioners' competences. Also a relationship is established with the "Education and Educational research" group due to the pedagogical approach given to professional competences in engineering.

Group #6 called Education and educational research is formed by 343 documents. Its high degree

of centrality is due to the strong relationship it maintains during different time phases. In the 60's the relationship with the category of Laws can be observed and in the 70's with the Linguistics and Medicine categories; relationships with the rest of the categories start to take place in the 90's. The main themes found in this category are related to the sear of innovative methods for the identification, training and evaluation of professional competences; curricular design and didactic of disciplines; and the normalization of competences to assess performance.

Group #8 called Linguistics is formed by 27 documents. Its degree of centrality is low as it only interrelates with the Education and educational research group. It is formed by three sub-categories: linguistics, language and literature. The relationship between education and linguistics is due tot research related to communicative and linguistic competence, its relevance in the psycholinguistic company and studies related to the translating competence and its second language acquisition theories.

Group #7 called Medicine is formed by 167 documents. And it covers 15 categories, from which there are 7 regarded as main categories, due to their node size and because they are cutting points. These are: Rehabilitation, Pharmacology, Gerontology, Medicine, Health Sciences, and Health Policies. Relationships with the Psychology group exist through the Neuroscience category, resulting from research related to brain activity and effect on performance, motivation and performance in learning of specific task competences. Relationships with the Education group results from research related to the identification of necessary competences in the medical profession, curricular design and assessment based on competences through simulation, observation, audits and objective tests. Relationships with the Social Sciences group is generated from research on the development of professional competences in the health sector in the practice of social work in activities such as geriatrics, the need for interpersonal competences such as cultural competence, needed and mandatory for work involving cultural and social sensitization contexts.

Group #4 called Administration and Businesses is formed by 282 documents. Its main relationships with the Engineering group take place through the categories: Operations research, as it has been previously mentioned. Its relationships with the group Psychology is through the Ethics category and this is due to publications which highlight the importance of moral competences in decisions which involved conflicts between ethical considerations and business imperatives. With the Informatics Sciences group relationships are maintained through the information sciences and librarianship category, in which the importance of information and communication technologies to generate competitive advantages in companies and technical competences for IT professionals requested by companies is stated. With the Social Sciences group relationships are conducted through categories: work relationships, planning and development, urban studies are a result of research related to human capital, management through competences in public administration and leadership competence models.

Group #5 called Informatics Sciences is formed by 258 documents and composed of two main

categories: Computer sciences and Information and librarianship sciences. Research generated in this group is related to professional development programs which aim at Education and at training of information professionals, at the need for integration of competences oriented towards optimizing industrial performance, Project efficacy and innovation through collaborative nets.

Group #2 called Social Sciences is formed by 98 documents and integrated by 5 main categories: public, social sciences, social problems, sociology, public administration. Research in this group is related to the understanding of the social and cultural dimension in professional competence training, where social intelligence and intercultural communicative competence are pointed out as necessary competences for the public sector, health sector, judicial sectors and social development project sector workers.

3.3. Analysis of term co-occurrence

The analysis of term co-occurrence was based on titles, summaries, keywords from registers extracted from the data bases.

Through visualization in a time line we have been able to identify the evolution of the most relevant terms in regards to professional competences.

From Fig. 3 we can approximate that the first documents published where the words professional competences are used date back to the 50's. The main topics in the 70's are related to ethics, teacher training, identifying competences, standards, methodologies, identifying competences, competence models which determine imitative behavior or which are related to work position, certification of specialty competencies in the field of medicine.

In the 80's the development and testing of professional competences for Education and the training of specialists in pedagogy is relevant; there are also the issues related to leadership and decision making. While in the 90's emphasis is given to research in learning processes, in training programs for Education and competence nucleus for organizations, at the same time publications related to the certification of labor competences (NVQs) created in Great Britain are emphasized (NVQs).
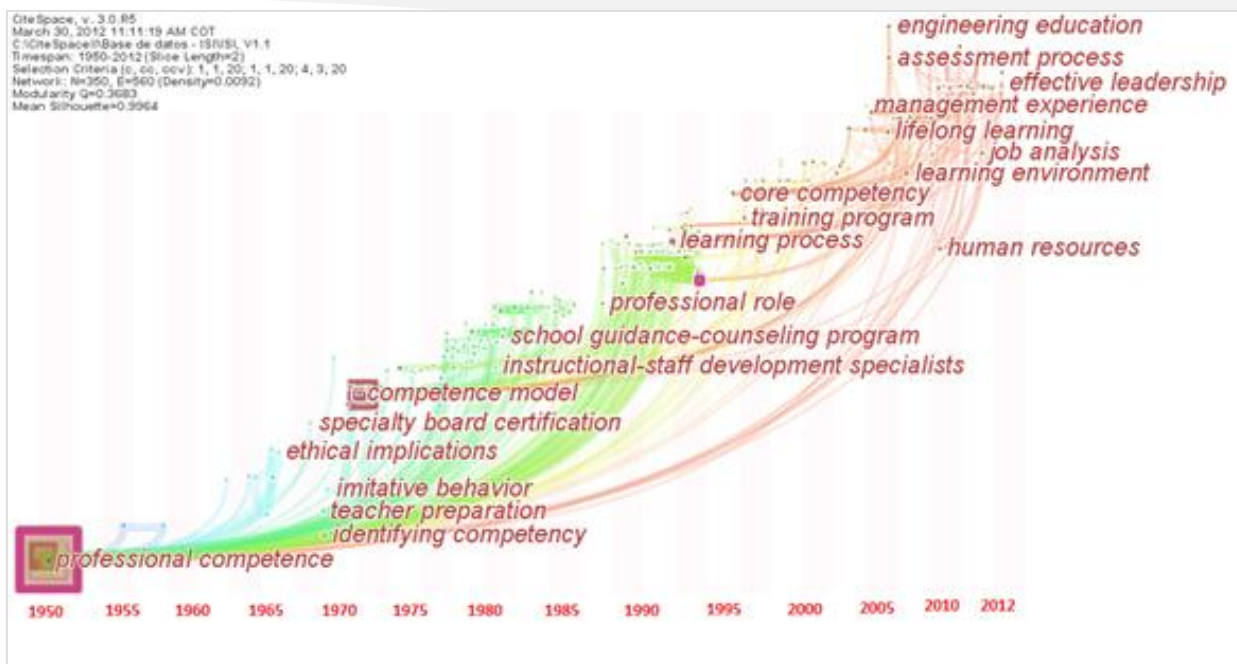
Fig. 3. Co-occurrence of terms

In the 20th century research is diversified and related to the new context, where topics such as the new learning context, lifelong learning, competence assessment processes in the educational system and in organizations, competences in engineering, effective leadership, human resources and competence administration, competences in project administration, development of organizational culture, competences in innovative organizations and in social work; are emphasized.

3.4. Hybrid analysis of keywords and documents

The graph obtained is more complete when organizing and showing the research documents per group thus allowing for a better understanding of the intellectual structure of professional competences; thus visualizing intellectual structure and trends.

In Fig. 4 we identify 8 groups, 5 of these groups related to the approaches of professional competences described by Guerrero, De los Ríos and Díaz-Puente (2008): #1 the psychological of competences, #2 competences in the work position, #3 cognitive and motivational competences, #4 integration of competences under a holistic approach and #5 the nucleus of competences in the organizations.

Figure 4: Co-occurrence of keywords and documents

Group #6 is related to the competences in higher Education, where we identify some authors such as: Barnett, who states that the notions of competences were totally inadequate for higher education; Eraut describes the types of knowledge which are assessed in higher education; and Cheetham who poses an integrative model of competences based on Schon's model for the elaboration of education programs.

Group #7 related to competences from the perspective of industrial and organization psychology, in which are mostly highlighted the works of Kristof and his perspective of person-organization competences, of Schmidt with his assessment of procedures for predicting performance in the work place, and of Schippmann with his analysis of competence models through 10 scale levels which are being used by doctors and researchers in the evaluation of work, in new competence models by fields of specialty and in establishing norms for practice.

In group #8 competences are studied from the perspective of Engineering and Technology. Some worth mentioning are: Hakkarainen, who presents the concept of innovative communities generating competences, Draganidis, who concludes that technology plays an important role in the evolution of management through competences systems and Jansma, who elaborates a list of competences for systems engineers and who is working on fostering these competences in members of the systems engineers community.

4. Conclusions

Sciencegraphy of scientific domains based on social nets is quite useful for the representation, analysis and evolutionary study of professional competences. Nonetheless it should be regarded as a complement not as a substitute to traditional methods for the study of bibliographies.

By going beyond the traditional methods for the study of bibliographies, a more acute answer is given to those who wish to analyze or identify the convergence of works in terms of professional competences.

Emphasis is not only made on the most outstanding works in terms of professional competences, but the relationship of some topics to others is also shown, finding 8 groups formed from common characteristics and research topics.

From the relationship of terms and categories, we can see the main lines of research, specializations and trends, adjusted to the legality of scientific production stored in these data bases, which could help in the orientation o future research.

Among the limitations of the study lays the fact that no all research necessarily leads to a publication and not all documents name authors and co-authors participating in the research process.

Finally, it is important to highlight that the visualization of domains is making a new science or discipline in the last decade, so it will continue to experiment a strong tendency in the application if new science fields, and it will be reflected on the wide spreading of software specialized in the visualization of domains, so it is therefore regarded as necessary to have clear criteria when selecting software. It does not necessarily have to be a single program, the important issue is to cover the appropriate analysis tools for the study, compatibility to work with origin data, and feasibility in the use of users' program.

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