

Global English in Theoretical Mathematics: Citation Analysis

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Abstract

The article presents the results of the analysis of English in Math as an academic discipline claiming that English is currently the undisputed language of science and technology replacing the vernacular in scientific journals in many countries. The research reports on the percentage of the cited resources in English and other European languages used in the articles published in the leading American and European journals in the field of Theoretical Mathematics throughout the decade 2000-2010. The data includes **3499** citations from **179** articles. Only papers written in the same language as the language of the country in which this journal is published were analyzed. The categories of the citations are books and articles in English, German, French, and Italian. The findings show the follows: among Americans there is a tendency of decrease of English cited resources during the period from 2000 till 2010 - the continuing use of foreign-language sources by American scholars in these fields have been noted. Among other nations such as Germans, French and Italians, English remains the dominant language, and the continuing increase of the number of the cited resources in English has been observed, and the low use of foreign-language resources has been noted.

Keywords: bibliometrics, language barrier, citation analysis, Theoretical Mathematics, Global English.

1. Introduction

1.1 The subject research and the background.

Pertaining to the problem of “the language barrier” in written communication among scientists speaking different languages, many researchers have devoted their papers to citation studies to determine the dominance of English as a language of Science and to answer the question how it effects on the scientific information flow and other languages (Chan, 1976; Sherwood, 1979; Smith, 1981; Bergeijk, 1984; Yitzhaki, 1987/1988; Regaunt, 1994; Yitzhaki, 1998; Egghe et al., 1999; Tsionit, 2000; Kellsey and Knievel, 2004). Undoubtedly, there was a necessity of “having a common language to serve as a vehicle for scientific communication and production” (Siguan, 2001, p. 59). This is the reason why English has extremely diffused for last forty years in all scientific fields, and we can compare its role with Latin in the Middle Ages, being a common language until the beginning of the Modern Era. For many centuries, Latin served as a lingua franca between educated elites in Europe. Global English may be the new global Latin but just as the use of Latin gradually faded away, so Global English may not prove to be a permanent phenomenon. It took centuries for Global English to develop and, like Latin, it may take centuries for its influence to decline.

The global linguistic future is already looking more complex. Language learners in some parts of the world are already queuing for classes in Chinese, Hindi and Arabic. Furthermore, comparing English with Medieval Latin, which was both a medium of scholarly exchange and a language of literature, science, law and administration, it should be noted that for some scholars English is the first language, whereas for others it is the second language, and not always it is on the Mother tongue level. Thus, becoming a language of international communication for Scientific Production, the following question arises - whether it affects the scientific knowledge itself? In the fifties the English language was not thought to be dominant. And it is proved by the fact that scholars did prefer to cite sources in their own language.

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This was true for all the nationalities selected for the research such as Germans, French, Italians and Russians. However, in the seventies the picture was changed - the English started "to gain momentum" among some nationalities such as the Germans and the Italians, whereas among the French and the Russians the number of the cited sources in their own language still exceeded the number of cited sources in the English language. The increasing dominance of the English language was noticed in the nineties almost among all the selected European nationalities, except for the Russians, who are still known to prefer publications from Russian journals, which are then translated from cover to cover into English.

Before I undertake to address the question why English get the special status in Europe, I'd like to set the scene *how a language from "an island on the corner" of the continent went global*. First of all, as well-known, the spread of English around the world was historically a colonial process. Then, in 1973, after Ireland and Britain admitted into the European Union, English became one of the nine official languages of the EU (Danish, Dutch, English, French, German, Greek, Italian, Portuguese and Spanish) (Robit, P & Z. Cooper, 2006). That fact made English developed a special status within the Europe – English and French are the only "official" languages of the European Council, whereas other languages are determined as "working" languages (Kaplan, 2001). Considering English as a language of Science, Ammon (1996) points out the following important items:

1. throughout fifty years till 1995, English made gains as a language of Science,
2. the sole working language of the European Science Foundation is English,
3. the leading European journals prefer English as a language of publication,
4. in the member countries of the EU, English is the most widely taught language,
5. the perceived shift toward using more English in business-oriented communication among the political

Bodies of the European Union and in the economic domain within European countries. The other important fact that the scientific infrastructure of the United States was not damaged by the War II let the USA assume leadership in Science and Technology. Thus, in the 1950-60s much of the science and technology researches were conducted in English. This can explain the fact why most of the information in the great information storage network was written in English. Thus, the WW II, the birth of the United Nations, the invention of the computer, the growth of Science and Technology, all these circumstances, occurring approximately at the same, established conditions for English to become the predominant language in Science and Technology (Kaplan, 2001, p. 11-12).

All this points to the fact that the language barrier, existing in the fifties with all scholars from the selected nationalities preferring to cite sources in their own language, in the seventies was replaced by a tendency to cite also sources published in other languages, and in the nineties the language barrier almost disappeared due to the special status of the English language in Science and Technology, except for the Russian scholars who do prefer resources originally published in Russian. This fact may be explained by the advent of the Cold War, which was resulted in heavy political restrictions on the use of Russian both from the USA and the Soviet Union sides: the Soviet Union showed reluctance to share scientific information, and the USA together with other Western States showed the equal reluctance to access materials written in the Russian language (Kaplan, 2001).

Undoubtedly, nowadays Global English in Science and Technology serves as a unique linguistic device allowing international cooperation which is supposed to solve possible scientific and technological problems. But on the other hand, due to the global distribution, it may be assumed that English is no more the property of English speakers – the notion of standard language gave birth to the development of many varieties of English such as Indian English, Nigerian English, Philippine English, Japanese English, Singapore English, Hong Kong English and etc.. So, while the linguistic diversity is being replaced by the linguistic unity, the phenomenon of the "common" language may cause death of small languages, and the extinction of the languages may be catastrophic due to the fact that the language extinction is actually the extinction of the linguistic, cultural means which are important for the nationality existence and development.

For example, in such countries as Sweden and Hungary, most of the material published in the scientific and technological journals is in English and not in their national languages (Medgyes and Kaplan, 1992; Baldauf, 1997, 2000; Kaplan, 2001). Furthermore, it is not a secret, that in order to move up the promotion ladder in the academy, the scientists are pressed to publish preferably in English. The scholars who don't publish their papers in English journals cannot get the conventional rewards available through the academy. Thus, good scientists, who's English does not meet the standards of journal editors are sure to be deprived of the opportunity to contribute their views and

assumptions to the global information networks. And as a result of this, their scientific contributions can be lost not only to the scientists themselves, but actually to the Science itself (Kaplan, 2001).

Consequently, it can be claimed that the spread of English in Science and Technology stills the voice of Science in languages other than English.

1.2. The questions of the article.

The article makes an attempt to answer the following questions:

1. What is the percentage of the usage of English and European language sources by American, German, French and Italian mathematicians in scholarly articles during the last ten years?
2. Has the pattern changed in decade 2000-2010?
3. Can it be assumed that a continuous use of foreign-language sources by scholars in Mathematics exists?
4. Do the English speaking scholars in Math continue to recognize the importance of other foreign languages to their research despite overall drops in language enrollment in the United States?
5. Whether the application of such measures as a research evaluation tool enhances research performance and scholarly progress in general?

1.3. Research limitation:

The study is limited to one field: Theoretical Mathematics as an academic discipline. Only academic and scholarly journals published in the USA, German, France and Italia have been analyzed.

1.4. Originality/Value.

This essay reports on the results of research into the patterns of use by scholars in the field of the theoretical Mathematics of English and European language sources throughout 2000-2010 among different nationalities. To provide **consistence** over time, this study focuses on *one journal in each language*:

1. American Journal of Math (US) [journal + ejournal]. Baltimore: Johns Hopkins University Press, 1878-.
2. Mathematische Zeitschrift [journal + ejournal]. Berlin: Springer, 1918-.
3. Mathematische Annalen [journal + ejournal]. Berlin: Springer, 1869-.
4. Bulletin des sciences mathématiques: serie II [journal + ejournal]. Paris: Gauthier-Villars, 1877-.
5. Annali di matematica pura ed applicata [journal + ejournal]. Bologna: Nicola Zanichellieditore, 1850-.

1.6. The findings.

The results of her research showed that the use of English resources has increased, except for the Russians, who are still known to prefer cite sources in their own language, which are then translated into English. The decrease of cited English sources among the Americans has been noted throughout last ten years (from 94% (2000) to 92% (2010)), though the dominance of the English language still exists. As for other nationalities such as Germans, French Italians, the dominant language is still the English language, and the number of cited sources in the English language continues increasing: among **Germans**- from 77% (1993) (Tsionit, 2000) to 92% (2010); among **French** – from 62%(1993) (Tsionit, 2000) to 83% (2010); among **Italians** – from 81% (1993) (Tsionit, 2000) to 93% (2010).

1.7. The hypotheses:

1. A continued use of foreign-language sources by American humanities scholars in the field of Theoretical Mathematics does exist;
2. the American mathematicians do continue to recognize the importance of language to their research despite overall drops in language enrollment in the United States (Kellsey, 2004);
3. There is a certain ration of language self-citation among the different nationalities, other than American and British.
4. The cited work is a symbolic of specific content, an indicator of document content, a document descriptor. However, it should be taken into consideration that some proportion of the references can be perfunctory.

1.8. Practical implications – This paper will be helpful for libraries to develop their collections and to make budget decisions regarding the European-language sources in the field of Theoretical Mathematics.

2. Literature Review

2.1. The language barrier.

It can be argued that English has become the Lingua Franca of International Science. Consequently, if the native language of the scholar is not English, he faces a problem. Unless a scientist can read English, he won't know most of what is reported in the literature; and unless he can write and publishing English, your own research may be overlooked by the world scientific community. S. Ellen (1979) used a questionnaire survey to find out whether the language barrier was an important hindrance to researchers. She point out the two main problems: 1. the linguistic ability of users of the literature appeared to vary with age, being more proficient in the in the upper age groups; and 2. the linguistic ability of social scientists appeared to be appreciably lower than that of scientists and technologists. Coming across papers in foreign languages, the researchers would like to have read, but often no action to obtain a translation was taken. S. Ellen claims that who tried to locate existing translations were dissatisfied with the lack of information about existing services. She estimates such a situation unsatisfactory, emphasizing the need in good translation services to overcome the problem of language barrier.

Stankus et al. (1981) points out the declines in the use of the foreign language sources among American scholars, claiming that the Americans avoid reading articles in Science published in foreign languages. Such a trend was noted after the Second World War Two, whereas before the war the American scientists attributed more importance to German and French studies. This was the reason why the publishers of German basic science journals progressively increased the proportion of articles in English.

J. A. Large (1983) examined the language problem from the perspective of scientists whose native language is English. He suggested that researchers in Britain and in the United States had been under no pressure to acquire and maintain proficiency in some foreign language due to the fact that English had become the dominant language of Science for decades. Thus, those scientists who speak and read only English ignore significant results reported in foreign language publications. The researcher claims that although the percentage of the world's scientific publications that are published in foreign (non-English languages) is relatively small, the absolute number is growing. Particularly, the science materials in the Japanese, Chinese and Russian languages are still increasing. And how much of them are not covered by the leading abstracting services, that are to be comprehensive, turned out to be unclear (Garfield, 1989). This fact leads us to the assumption that most of the foreign researches may be buried in the mass of the non-English publication, remaining unknown for Western scientists. Though Large's detailed survey is concentrated on the languages of published articles, it says nothing about the nationalities of the authors: it is pointed out that English-language articles cite other English-language publications, and only a small proportion of the references are cited foreign language materials. However, the researcher does not specify what percentage of the cited English-language items is written by French, German, Japanese, Chinese and Russian authors? On the other hand, a large proportion of references in non-English language articles are from English language publication, but it is not determined how many of those English language articles were written by scientists from the citing author's country.

R. D. Thorp et al (1988) made a general survey of attitudes amongst a group of research workers in the UK pharmaceutical industry towards non-English material, and their various ways of dealing with it. The investigators mane to the following conclusion: there is indeed a 'language barrier', which leads to the two main problems: 1. the underuse of this material, and 2. the overall lack of appreciation of the value of information lost as a result. They point out that Japanese material, for instance, is particularly important, and poses especial difficulties. They claim that the same situation make happen to the Chinese scientific material I future. E. Garfield (1991) challenges the language problem in world scientific communication called a "barrier "supporting that by the following possible situation: "if scientists in country A cite research conducted in many different nations and reported in English", whereas "scientists in country B only cite papers by their own nation's authors reported in several languages", thus we come across the following question: who of them are less aware of the international literature? Thus, according to E. Garfield (1991), before talking about the "language-based crisis in Science" as a result of the "language barrier" (Large, 1983), there is a need in a comparative bibliometric method, which is supposed to take into account both interlingual and international links in the Science literature. Anat Tzionit (2000) made an attempt to determine the extent and the dimensions of the language barrier in the field of Theoretical Mathematics throughout 40 years from 1953 till 1993 among different

nationalities: the Americans, the British, the Germans, the Italians, the French and the Russians. She selected two leading journals from each of the countries respectively. In each article the researcher checked the list of references and determined the percentage of each language cited.

The findings of the study bear witness to the constantly increasing of the use of English among all the above-mentioned nationalities throughout the checked period. If in the fifties the English language was not dominant, the own language was preferred by any scholar to site sources, in the seventies the pattern was changed by English becoming dominant among the German and the Italians. In the nineties, the dominance of the English language spread almost among all the nationalities except for the Russians. Thus, A. Tsionit came to the conclusion that in the nineties it may be claimed that the language barrier almost disappeared with the English language becoming the dominant language. However, it can be said about all the nationalities: the Russians still prefer to cite sources in their own language, more than in any other language.

To my mind, the main problem today that poses the biggest obstacle to Scientific Communication is not the language problem (language barrier) but rather Information Overload. The solution for this problem can be information services and review journals, which are to identify core material in foreign journals, and only the best should be added to the communication channels. Furthermore, for a better identification of important information, it should be also supported by personal contacts between the scientists. And to increase personal contacts the cultural and political value of linguistic training, which is indeed vital for a good science, should be stressed on.

2.2. Library use and circulation studies.

To analyze use of foreign materials by scholars and come to certain conclusions, “*the place of foreign language materials in the research activity of an academic community*” should be measured (W. J. Hutchins, L. J. Pargeter, and W. L. Saunders, 1971). To determine that, W. J. Hutchins, L. J. Pargeter, and W. L. Saunders used the University of Sheffield in England as a case study. They not only sampled the book collection and articles in the journal collection, but also counted a year’s circulation of materials by department of the borrower, items on loan on one particular date, and items requested on interlibrary loan. Furthermore, they conducted a survey of in-house use of journal articles. For example, as for the humanities faculty, items borrowed in English were found to be 81.5% in English, 4.3% in French, 4.2% in German, 5.6% in Latin and Greek, and under 1% in other languages. Thus, observing fifty-one publications including 5,017 citations, their findings showed that 61.7% were to English publications. The foreign-language citations, including books, articles, and theses, was 18.8% per publication. The investigators pointed out that the most-cited languages except English were German (11.4%), French (5.35%), Spanish (0.75%), and Italian (0.4%). Kent Pittsburgh’s study (Metz, 1900, p. 147) claims that *English*-language material represented 91.2 percent of circulation from 1969 to 1973.

Library of Congress study (1977) showed that 87.7% of monographs and 92.5% of serials used were in English (Metz, 1900, p. 148). Observing seventy-two Association of Research Libraries (ARL) members², Anna H. Perrault (1995) discovered that *in 1985* English and non-English imprints had a nearly *equal share of titles purchased*. However, *by 1989* non-English imprints had declined to 39% of the total.

To crown all, what all these studies reinforce is that the academic library circulation is actually concentrated on the books, withdrawn primarily by undergraduates and beginning graduate students. Thus, such circulation studies tell us nothing about research use of a research library. Consequently, the above-mentioned findings can contribute little to the knowledge of collection development and of what the limits of resources for universities with heavy commitments to research are sharing.

2.3. Citation analysis.

The main method of the research is “citation analysis”, a well-known technique in the field of Bibliometrics. Generally, citation analysis involves the construction and application of the serious of indicators of the “impact”,

²ARL is a nonprofit organization of 126 research libraries at comprehensive, research-extensive institutions in the US and Canada that share similar research missions, aspirations, and achievements.

“influence” or “quality” of scholarly work, derived from citation data – data on references cited in footnotes or bibliographies of scholarly research publications (Moed, 2005). According to Henk F. Moed, such indicators are supposed to be applied in the study of scholarly communication and in the assessment of the research performance.

Thus, it can be concluded that Citation Analysis is to shed light on the contribution of scholarly work to the advancement of scholarly knowledge.

2.3.1. Bibliometrics.

Having its origins in the West, “bibliometrics” arose from the statistical studies of bibliographies (Egghe & Rousseau, 1990, p. 2). This term ‘bibliometrics’ is fairly recent (Pritchard, 1969), but its usage and practice can be traced back to the 1890's (Campbell, 1896). The earliest attempt at bibliometric studies was Campbell's (1896) work, in which statistical methods for studying subject scattering in publications were used (Sengupta, 1992, p. 75). In 1917, Cole & Eales studied statistically the growth of literature in Comparative Anatomy during 1550-1860, through bibliographical citations. Following them, Huhne (1923), by using the term statistical bibliography, made an attempt to describe how the process of the history of science and technology can be made more understandable by counting documents (Garfield, 1977, p. 137). Likewise, in 1948 Ranganathan, a mathematician, believing that statistical and mathematical analysis are the key tools for all developmental and forecasting studies, suggested the term “librametry”, arguing that since the application of statistics and mathematics had caused some viable new specialties such as Biometry, Econometry, Psychometry etc., librarians should use appropriate mathematical and statistical techniques to develop Librametry (Sengupta, 1992, p. 87). In 1969, the researcher clearly demonstrated the application of librametric techniques by a series of examples (Ranganathan, 1969, p. 286). In 1969, Pritchard (Pritchard, 1969, p. 349) replaced the term statistical bibliography with bibliometrics, while Nalimov & Mulchenko (1969) used the term Scientometrics. Pritchard's reason for replacing the term statistical bibliography with bibliometrics was the ambiguity of the phrase statistical bibliography - it could mean a statistical analysis of bibliographies or bibliographies on statistics. Numerous authors such as Fairthorne (1969, p. 319), Lawani (1980, p. 1), Hertz (1987, p. 144), Brookes (1988, p. 29), White & McCain (1989, p. 122) and Soper et al. (1990, p. 25) supported Pritchard's choice of terminology and agree with the term “bibliometrics”. “Bibliometrics” has two roots: “biblio” and “metrics”. The word “biblio” is derived from the combination of a Latin and Greek word “biblion” meaning book. The term “metrics”, which indicates the science of meter, (i.e. measurement), is derived either from the Latin or Greek word “metricus” or “metrikos” respectively, each meaning measurement (Sengupta, 1992, p. 76). Pritchard (1969, p. 349) claims that bibliometrics deals with “the application of mathematics and statistical methods to books and other media of communication”. Fairthorne (1969, p. 319), paraphrasing Pritchard, defines it as “the quantitative treatment of the properties of recorded discourse and behavior appertaining to it”. In 1976, The British Standards Institution describes “bibliometrics” as the application of mathematical and statistical methods in the study of the use of documents and publication patterns.

Hawkins (1977, p. 13) defines bibliometrics similarly, but in a simpler language as, the application of *quantitative analysis* in the bibliographical references of the body of literature.

Lancaster (1977, p. 353) describes it as the study of patterns of authorship, publication and literature use by applying various statistical analyses. White & McCain (1989, p. 119) state that bibliometrics is “the quantitative study of literatures as they are reflected in bibliographies”. Nevertheless, agreeing with the definition of Scientometrics by Nalimov & Mulchenko (1969), Braun et al. (1985, p. 5) states that those quantitative methods, viewed as an Information process, which deal with the analysis of science, should be referred to Scientometrics only. Thus, they emphasize the importance of distinguishing between Bibliometrics and Scientometrics according to the subject and purpose of the topic in spite of the fact that their methods are very similar and sometimes identical:

1. ***Bibliometrics*** - its major purpose of is to improve scientific documentation, Information and communication activities by quantitative analysis of library collections and Services;
2. ***Scientometrics*** - a quantitative analysis of the generation, propagation and utilization of scientific Information aspects. Its major purpose is *to contribute to a better understanding of the mechanism of scientific research as a social activity*, is valuable through ***scientometric techniques***.

2.3.2. The scope of Bibliometrics.

Trying to determine the scope of Bibliometrics, Ravichandra Rao (1993, p. i) points to *Informetrics* as a popularly known subject since the mid 1980s, claiming that the scope of Informetrics does cover both bibliometrics and scientometrics and other quantitative studies related to Information science: “Informetrics connotes the use and

development of a variety of measures to study and analyse several properties of Information in general and documents in particular" (Ravichandra Rao, 1993, p. i).

For Pritchard (1969, p. 348; 1972, p. 38-39), the scope of Bibliometrics is implied by the purpose of bibliometrics "to shed light on the processes of written communication and of the nature and course of development of a discipline, by means of counting and analysing the various facets of written communication". Borgman (1989, p. 587) indicates the scope of bibliometrics claiming that scholarly communication can be studied by bibliometric methods using one or more of three theoretical variables such as: 1. producers of the communication, 2. artifacts of communication, 3. communication concepts.

2.3.3. The areas of Bibliometric studies.

Nicholas & Ritchie (1978, p. 9-10) divided bibliometric studies into two broad groups: 1. **descriptive studies** including *Bibliometrics, Citation Analysis and Co-Citation Analysis* with characteristics or features of a body of literature), and 2. **behavioural studies**, sometimes referred to as citation studies, but not restricted to them (dealing with the relationships formed between components of the literature). Stevens (1953, p. 10) divided "bibliometric" studies into two basic areas and several sub-areas as follows below:

1. Productivity count or descriptive area:
 - a. Countries (Geographic locations)
 - b. Different periods of time
 - c. Different disciplines (Subject fields)
2. Literature usage count or evaluative area:
 - a. Reference
 - b. Citation Similarly.

According to Potter (1988), bibliometric studies should be divided into two categories: 1. descriptive category - attempts to study the body of a literature by counting its contributing countries, authors, Journals, year of publications, and disciplines:

E. g.: a researcher may count and rank a body of literature according to the frequencies of documents produced by each author, country, Journal, year of publication and/or discipline.

2. evaluative category - attempts to study the use of a body of literature by using citation analysis:

E. g.: it can be concluded that in a specific field and period of time the most cited papers are the most useful or important papers, and also the most co-cited papers are the most related papers.

Diodato (1994, p. 14) points out three major areas in bibliometric research:

1. Bibliometric laws or distributions: E. g.: Bradford's law³, Lotka's law⁴, and Zipf's⁵ law;

³**Bradford's law** is a pattern first described by Samuel C. Bradford in 1934 that estimates the exponentially diminishing returns of extending a search for references in science journals. Bradford's Law serves as a general guideline to librarians in determining the number of core journals in any given field. It states that journals in a single field can be divided into three parts, each containing the same number of articles: 1) a core of journals on the subject, relatively few in number, that produces approximately one-third of all the articles, 2) a second zone, containing the same number of articles as the first, but a greater number of journals, and 3) a third zone, containing the same number of articles as the second, but a still greater number of journals. The mathematical relationship of the number of journals in the core to the first zone is a constant n and to the second zone the relationship is n^2 . One formulation is that if journals in a field are sorted by number of articles into three groups, each with about one-third of all articles, then the number of journals in each group will be proportional to 1:n:n² (Black, 2004).

⁴**Lotka's Law** describes the frequency of publication by authors in a given field. It states that "... the number (of authors) making n contributions is about $1/n^2$ of those making one; and the proportion of all contributors, that make a single contribution, is about 60 percent" (Lotka 1926, cited in Potter 1988). This means that out of all the authors in a given field, 60 percent will have just one publication, and 15 percent will have two publications ($1/2^2$ times .60). 7 percent of authors will have three publications ($1/3^2$ times .60), and so on. According to Lotka's Law of scientific productivity, only six percent of the authors in a field will produce more than 10 articles. Lotka's Law, when applied to large bodies of literature over a fairly long period of time, can be

2. Citation analysis;
3. Indicators of research performance.

Hertzal (1987, p. 156) points out that although all the descriptive studies are not evaluations, all the evaluative analysis are first descriptive, with the evaluative aspect taking the data one step further, providing "data on the condition or character of the literature as a whole" (Nicholas & Ritchie, 1978, p.10). Furthermore, Nicholas & Ritchie (1978, p. 11) believe that both major areas of bibliometric studies complement each other. Borgman (1989, p. 586) describes scholarly communication more explicitly as the use and dissemination of Information through *formal* (the written part) and *informal* (usually oral part) channels by scholars in any field. On the other hand, Tomajko & Drake (1985 / 1986, p. 290), Bellardo (1980-1981, p. 232) believe that Journal publishing represents the heart of scientific and technical communication, claiming that Journal literature is the major formal channel of communication among scientists. Importantly, bibliometric studies rely on written literature (Pritchard, 1969:348; Potter, 1981:5). Likewise, Borgman (1989, p. 586) states that bibliometric studies are only applicable to the formal part of scholarly communication which is the written part of the scholars' productions. But the researcher claims that in combination with data gleaned from other methods, bibliometrics can provide a large and rich characterization of communication processes that cannot be achieved by traditional methods such as surveys and case studies. In addition, Diodato (1994, p. ix) asserts that bibliometric analysis does not cover only documents which appeared in papers, it covers electronic Journals, voice mail, and video images as well.

2.3.4. Citation analysis.

One of the major methods used in Bibliometricsto establish relationships between authors or their work is citation analysis. So, when one author cites another author, a relationship is established. Citation analysis uses citations in scholarly works to establish links. Many different links can be ascertained, such as links between authors, between scholarly works, between journals, between fields, or even between countries. Citations both from and to a certain document may be studied. One very common use of citation analysis is to determine the impact of a single author on a given field by counting the number of times the author has been cited by others. One possible drawback of this approach is that authors may be citing the single author in a negative context (saying that the author doesn't know what s/he's talking about, for instance) (Osareh, 1996).

Soper et al. (1990, p. 25) clearly described bibliometric techniques, stating that bibliometric techniques often use citation analysis in a variety of collection evaluation and use studies: ranking publications according to their importance, identifying core literature, tracing the diffusion of ideas, measuring the impact of publications, studying subject interrelationships, investigating the structure of knowledge and improving bibliographic control. Lancaster (1991, p. 1) gives a comprehensive definition of bibliometric applications in saying that, in general, the word bibliometrics is applicable to any form of quantitative analysis relating to the production, distribution and use of the published or semi-published literature. Bibliometric studies include studies of: the growth of the literature in some subject; how much literature is contributed by various languages; how the literature on some subjects is scattered (e.g. over documentary types, languages, Journals); and how quickly the literature on some subjects becomes out-of-date (studies of obsolescence).

Ravichandra Rao (1993, p. i) identifies the more important applications of informetrics in areas such as collection management and library and information Services. He asserts that how well a country is performing relative to others in various fields also can be evaluated by using informetric techniques.

accurate in general, but not statistically exact. It is often used to estimate the frequency with which authors will appear in an online catalog (Potter, 1988).

⁵**Zipf's Law** is often used to predict the frequency of words within a text. The Law states that in a relatively lengthy text, if you "list the words occurring within that text in order of decreasing frequency, the rank of a word on that list multiplied by its frequency will equal a constant. The equation for this relationship is: $r \times f = k$ where r is the rank of the word, f is the frequency, and k is the constant (Potter, 1988). Zipf illustrated his law with an analysis of James Joyce's *Ulysses*. "He showed that the tenth most frequent word occurred 2,653 times, the hundredth most frequent word occurred 265 times, the two hundredth word occurred 133 times, and so on. Zipf found, then that the rank of the word multiplied by the frequency of the word equals a constant that is approximately 26,500" (Potter, 1988). Zipf's Law is considered not statistically perfect, but it is very useful for indexers.

Diodato (1994, p. vii) points to the wide application of bibliometrics even in a daily newspaper for instance: The New York Times with the headline, "Ranking Law Schools by Faculty Publishing Rate".

Thus, citation analysis as one of the bibliometric techniques as descriptive and evaluative tools of publications has found its way through a wide range of applications in different areas.

2.3.5. References and citations.

Generally, "a scientific paper does not stand alone; it is embedded in the 'literature' of the subject" (Ziman, 1968, p. 58). Weinstock (1971, p. 19) confirms Garfield's idea that in a review article almost every sentence is supported by a citation besides, the list of references pointing to prior publications, particularly in the sciences, is a major part of research papers (Smith, 1981, p. 83). It is true that most authors are not so exact in their usage of terms "reference" and "citation", and they use them interchangeably. Egghe & Rousseau (1990, p. 204) agree with Price's (1970, p. 7) point of view that it is "...a great pity to waste a good technical term by using the words citation and reference interchangeably".

Narin et al. (1976, pp. 334,337) state that **a reference** is *the confirmation that one document gives to another*, however, the *acknowledgment that one document receives from another* is called **a citation**:

E. g.: **A citation**:

When document (A) appears in the list of references of document (B), it means that document (A) has been cited by document (B) in support of an idea or a fact, etc. In this case, not only document (A) is a reference of document (B) but also, it has received a citation from document (B) (Garfield, 1991, p. 9). In other words, document (B) is a citing document and document (A) is at cited document (Diodato, 1994:32-33).

According to Sandison (1989, p. 60), a citation is not just a set of bibliographic data at the end of a paper as end notes, footnotes, etc., or extracted from a citation index. In fact, a citation is the representation of a decision made by an author who wants to show the relation between the document he is writing and the work of another at a particular point.

Similarly, Shaw (1979, p. 32) states that "citation establishes a relation among authors which is a measure of the extent to which they communicate indirectly through the literature". Smith (1981, p. 84) claims that the relationship between cited and citing documents is represented by a citation. Making an attempt to characterize the nature of this relationship, Smith (1981, p. 84) points to the following reasons for citing a document, which are identified by Garfield (1972):

1. Paying homage to pioneers;
2. Giving credit for related work (homage to peers);
3. Identifying methodology, equipment, etc.;
4. Providing background reading;
5. Correcting one's own work;
6. Correcting the work of others;
7. Criticizing previous work;
8. Substantiating claims;
9. Alerting to forthcoming work;
10. Providing leads to poorly disseminated, poorly indexed, or uncited work;
11. Identifying original publications in which an idea or concept was discussed;
13. Identifying original publications or other work describing an eponymic concept or term;
14. Disclaiming work or ideas of others (negative claims);
15. Disputing priority claims of others (negative homage).

Summing up, the existence of a cited document in a reference list indicates the facts that there is a relationship (for instance, similarity in the subject, topic or methodology, etc.) between the cited and citing documents from the author's point of view.

2.3.6. Co-citation analysis or co-citation coupling.

Co-citation coupling is a method used to establish a subject similarity between two documents. If papers A and B are both cited by paper C, they may be said to be related to one another, even though they don't directly cite each other. If papers A and B are both cited by many other papers, they have a stronger relationship. The more papers they are cited by, the stronger their relationship is. That is why, many authors such as Small (1973), Cawkell (1976), Bellardo (1980/1981) define co-citation method as a subject similarity indicator. Stating that cited documents are linked together through the process of co-citation, and this process is similar to the similarity measures of the co-occurrence of words, Small (1973, p. 265) describes it as "the frequency with which two documents are cited together". Cawkell (1976, p. 3) presents a similar definition of co-citation as a subject similarity indicator, and demonstrates co-citation and bibliographic coupling clearly through a citation matrix. Bellardo (1980/1981; p. 231) defines co-citation as a process whereby an author cites two earlier documents in a new work. According to Egghe & Rousseau (1999, p. 239), two documents are co-cited if both appear in the reference list of a third document. Diodato (1994, p. 42) believes that co-citation happens when two or more authors, documents or journals are cited by another document simultaneously. To conclude, citation analysis as a type of bibliometric research methods, which is used in library and information science, utilizes quantitative analysis and statistics to describe patterns of publication within a given field or body of literature. This bibliometric method of evaluation can be used by researchers to determine the influence of a single writer, for example, or to describe the relationship between two or more writers or works.

3. Methodology

3.1. The journals selected for the analysis.

As has been already mentioned above, this research is a quantitative study, most of the questions of which begin with "why" and compare groups (for example: is the number of cited English sources in scholar articles has increased in 2010 in comparison with the results of 2000 of the same journal) or relations between variables (for example: does variable 'x' (the phenomenon of Global English) explains variable 'y' (the decline of foreign citations over time as a percentage of total citations)). The method chosen for this study to determine the extent and the dimensions of the global distribution of the English language in the field of Theoretical Mathematics is "citation analysis". One or two leading journals, publishing original research, were selected, from each of the following countries: the United States, Germany, France and Italy. From each journal only articles written by scholars, who are citizens of the same country, were selected, from each of the following target years: 2000 and 2010. The data were collected at the Library of Mathematics and Computer Science of the Hebrew University of Jerusalem. In each article the list of references was checked, and the percentage of each language cited was determined.

3.2. Citation counting criterion.

All citations for the complete volume from each of the following years (2000 and 2010) were counted. Numbers of issues per volume ranged among the journals between four and eight, and the number of articles per volume varied from 32 to 53. The total number of articles per entire journal written by scholars, citizens of the same country, varies from 2 to 51. A total of 3499 citations in 179 articles were included for analysis in this study. Citations were counted and entered into spreadsheets, which were used to calculate totals and percentage of all data. Most of the journals' issues were available in full text online via Springer, JSTOR, Elsevier or a similar aggregator. Categories of included citations are books and journals in English, German, French, Russian, Spanish, Italian, Scandinavian languages. All other language materials are grouped into "Others".

Unlike articles in the humanities, journal articles in the Sciences usually do not include their citations in discursive footnotes or within the text itself, which makes citation-counting much easier. In most journal articles in the field of Theoretical Mathematics the citations are separated into a bibliography at the end of the article. If citations were incomplete, abbreviated, which makes determining the source very difficult, every effort was made to determine the language of the source based on the available information.

5. Results

The data collected for this study is focused on the usage of language-foreign sources. Proving my expectations, the data show a consistent trend of increasing usage of English sources. However, though the dominance of the English language still exists among the Americans, my findings show the decrease of cited English

	p-adic group $GSp(4)$	Bighash, R									
ISSUE 6											
43	On automorphisms of the Toeplitz algebra	Muhly, P & Xia, J	8 (100%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	8 (100%)
44	Generalized Tate curve and integral	Ichikawa, T	27 (90%)	2 (7%)	1 (3%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	30 (100%)
45	On uniqueness of meromorphic functions	Fujimoto, H	8 (89%)	1 (11%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	9 (100%)
46	On- and off-diagonal heat kernel	Bendikov, A & Saloff-Coste, L.	31 (91%)	0 (0%)	3 (9%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	34 (100%)
47	On Ribet's level-raising theorem for $U(3)$	Clozel, L	14 (67%)	0 (0%)	7 (33%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	21 (100%)
48	A classification of two-dimensional tube domains	Shimizu, S	10 (91%)	0 (0%)	1 (9%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	11 (100%)
MEAN			18.7 (94%)	0.2 (1%)	1.3 (5%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	20.2 (100%)
MEDIAN			16 (95%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	18 (100%)
SD			11.4 (8%)	0.5 (3%)	2.6 (8%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	13 (0%)

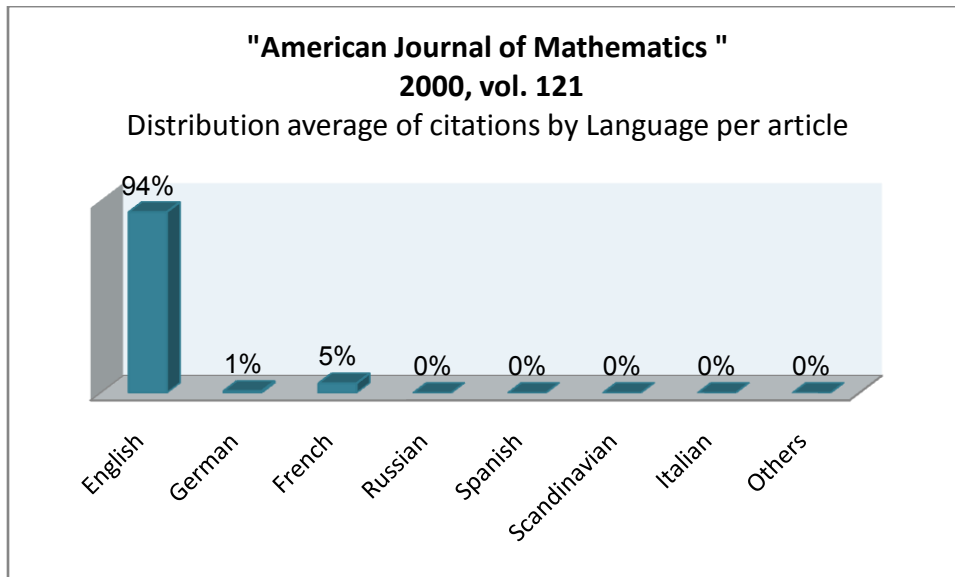


Figure 1

33	On the connected components	NAOKI IMAI	2 (67%)	0 (0%)	1 (33%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	3 (100%)
34	A vanishing theorem for log	TOMMASO DE FERNEZ et al	17 (94%)	0 (0%)	1 (6%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	18 (100%)
35	Semigroups of valuations on local	STEVEN DALE CUTKOSKY et al	15 (94%)	0 (0%)	1 (6%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	16 (100%)
36	Minimal surfaces and harmonic diffeomorphisms	JOSÉ A. GALVEZ et al	12 (100%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	12 (100%)
37	An arithmetic intersection formula	TONGHAI YANG	33 (94%)	0 (0%)	1 (6%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	34 (100%)
38	Two asymptotic problems for	NADER MASMOUDI et al	9 (100%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	9 (100%)
39	Does Khovanov homology detect the unknot?	MATTHEW HEDDEN et al	20 (83%)	3 (13%)	1 (4%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	24 (100%)
40	Nonexistence of holomorphic submersions between	VINCENT KOZIARZ et al	20 (100%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	20 (100%)
41	SUR LE DUAL UNITAIRE DE $GL_r(D)$	A. I. BADULESCU	20 (57%)	0 (0%)	15 (43%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	35 (100%)
42	Harmonic mappings of an annulus	TADEUSZ IWANIEC et al	14 (93%)	1 (7%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	15 (100%)
ISSUE 6											
43	The Nichols algebra of a semisimple Yetter-Drinfeld module	NICOLA S ANDRUSKIEWITSCH et al.	43 (98%)	0 (0%)	1 (2%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	44 (100%)
44	PROPERLY EMBEDDED SURFACES	ANTONIO ROS and HAROLD ROSENBERG	17 (94%)	0 (0%)	1 (6%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	18 (100%)
45	OPTIMAL DESIGN PROBLEMS IN ROUGH	EDUARDO V. TEIXEIRA	31 (100%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	31 (100%)
46	Chiral equivariant cohomology III	BONG H. LIAN et al.	16 (80%)	0 (0%)	4 (20%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	20 (100%)
47	On the equation $R(f) = Q(g)$,	Pakovich F.	29 (94%)	0 (0%)	2 (6%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	31 (100%)
48	p -adic elliptic polylogarithm,	Kennichi Bannai et al	22 (81%)	0 (0%)	5 (19%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	27 (100%)
49	The dynamical Mordell-Lang problem	Bell J. P. et al	28 (85%)	1 (3%)	4 (12%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	33 (100%)
50	Torsion anomalous points and families	Masser D. et al.	22 (92%)	0 (0%)	2 (8%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	24 (100%)
51	Regularity of one-phase Stefan	Sunhi Choi et al	19 (100%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	19 (100%)
MEAN			25.6 (92%)	0.3 (1%)	1.6 (6%)	0.13 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	27.76 (100%)
MEDIAN			22 (94%)	0 (0%)	1 (3%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	25 (100%)
SD			13.8 (11%)	0.86 (3%)	2.5 (10%)	0.98 (2%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	14.6 (0%)

	differential equations	Momm										(100%)
2000, VOL. 233, ISSUE 3												
10	The ring structure on the cohomology	Mark de Longueville	18 (100%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	18 (100%)
11	On the Morse indices of sign changing solutions	T. Bartsch et al	20 (100%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	20 (100%)
12	Quasi-projective reduction of toric varieties	A. A'Campo-Neuen et al	10 (91%)	0 (0%)	1 (10%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	11 (100%)
13	Riemann-Roch for tensor powers	B. K'ock	17 (81%)	0 (0%)	4 (19%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	21 (100%)
14	The local contribution of zeros of curvature to lattice	M. Peter	7(64%)	3 (27%)	1 (9%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	11 (100%)
15	Hypersurfaces of prescribed Weingarten curvature	C. Gerhardt	1 (100%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	1 (100%)
16	The point and line space	Linus Kramer	22 (88%)	2 (8%)	1 (4%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	25 (100%)
17	Sampling expansions	M.H. Annaby et al	47 (78%)	13 (22%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	60 (100%)
2000, VOL. 235, ISSUE 1												
18	L-functions on $GSp_2 \times GL_2$	S. B'ocherer et al	27 (84%)	4 (13%)	1 (3%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	32 (%)
19	Hypersurfaces of prescribed mean curvature	Claus Gerhardt	11 (100%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	11 (100%)
20	Decompositions of simplicial balls and spheres	G'unter M. Ziegler et al	22 (92%)	2 (8%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	24 (100%)
2000, VOL. 235, ISSUE 3												
21	Anderson model with decaying randomness	W. Kirsch et al	26 (100%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	26 (100%)
Mean			19 (91%)	1 (5%)	0.8 (4%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	21 (100%)
Median			18 (92%)	0 (0%)	1 (3%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	20 (100%)
SD			11.13 (9%)	2.9 (8%)	0.98 (5%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	13 (0%)

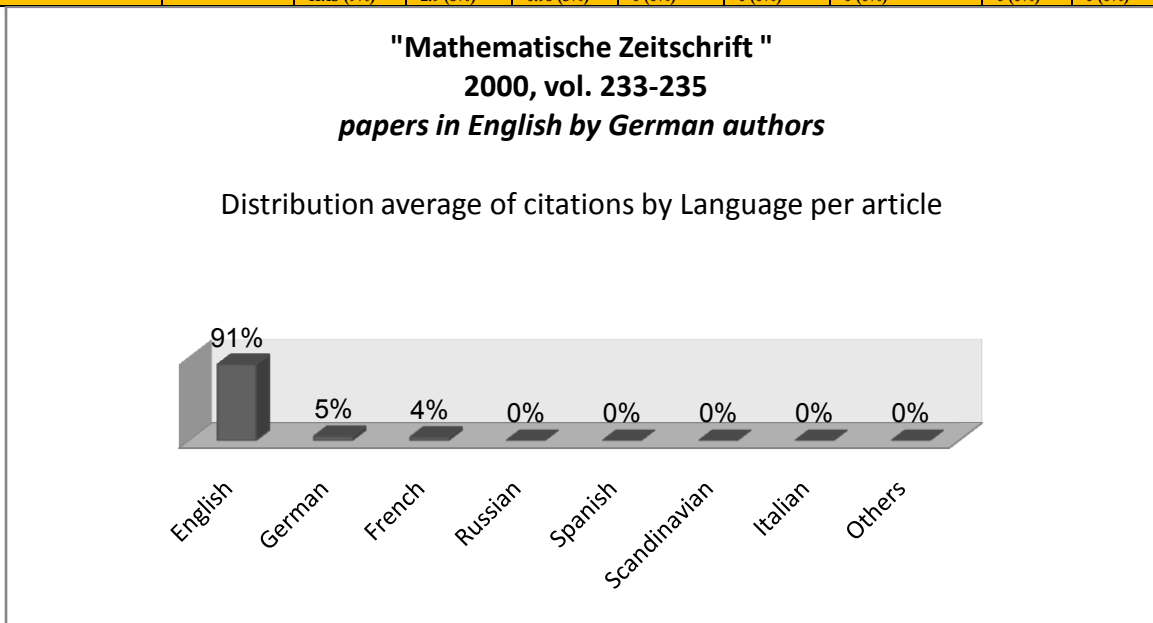


Figure 3

2000, VOL. 317, ISSUE 2											
6	Rigidity of group actions on solvable	Burkhard Wilking	22 (92%)	1 (4%)	1 (4%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	24 (100%)
2000, VOL. 317, ISSUE 4											
7	Integrality of L2-Betti numbers	Thomas Schick	25 (89%)	3 (11%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	28 (100%)
2000, VOL. 318, ISSUE 1											
8	Mean values of Dirichlet L-series	Manfred Peter	18 (86%)	3 (14%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	21 (100%)
MEAN			15 (85%)	1.55 (8%)	0.88 (7%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	18 (100%)
MEDIAN			13 (87%)	1 (8%)	1 (4%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	15 (100%)
SD			6.6 (11%)	1 (5%)	1.05 (9%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	6.79 (0%)

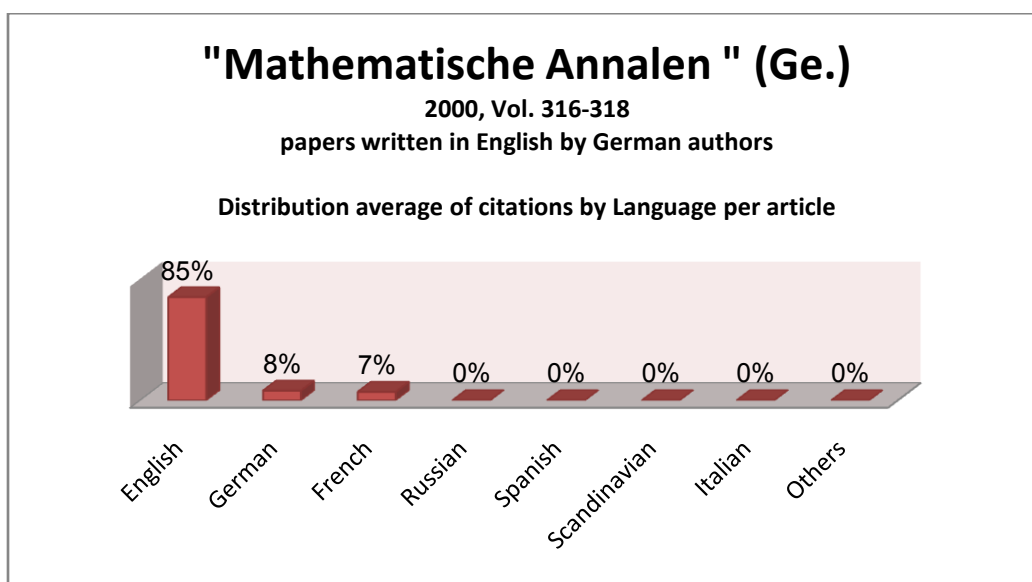


Figure 5

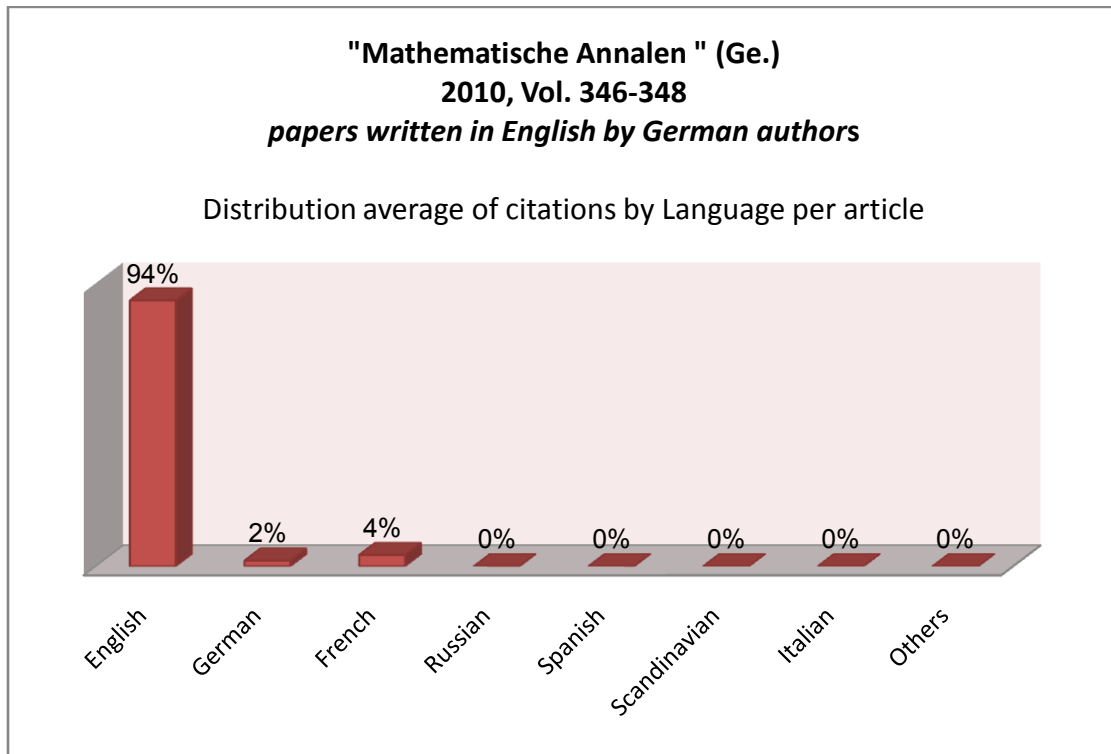


Figure 6

In Figures 5 - 6, the data show that there is a noticeable jump in the use of English sources per article: from 85.00% (2000) to 94.18% (2010), whereas the number of citations in German and French declined dramatically over the ten-year time period: the number of German citations per article decreased from 8.36% to 1.59%, and the number of French citations per article dropped from 6.64% to 4.23%. Thus, taking into consideration the findings of both journals, we get the following results: the number of English citations per article went up from 88.16% (2000) to 92.44% (2010), and the number of French citations per article increased from 5.51% to 5.67% (2010), but the number of German citations noticeably declined from 6.6% (2000) to 1.9% (2010).

Tables 7 and 8 contain data for the French journal "Bulletin des Sciences Mathematiques":

Table 7 "Bulletin des Sciences Mathematiques", 2000, vol. 124, issues 1-8											
Paper no.	Title	Authors	English citations	German citations	French citations	Russian citations	Spanish citations	Scandinavian citations	Italian	Other languages	Total no. of citations
2000, VOL. 124, ISSUE 1											
1	EQUATIONS NON LINEAIRES AVEC LE p-LAPLACIEN	THIERRY AUBIN et al	8 (67%)	0 (0%)	4 (33%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	12 (100%)
2	ENSEMBLES DE SOUS-NIVEAU ET IMAGES	CHRISTER O. KISELMAN	8 (57%)	0 (0%)	5 (36%)	1 (7%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	13 (100%)
2000, VOL. 124, ISSUE 2											
3	LIEU DES POINTS EXCEPTIONNELS	MONGI BLEL	5 (42%)	1 (8%)	6 (50%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	12 (100%)
4	STABILISATEURS CYCLIQUES POUR LA REPRESENTATION	LAURENT GUIEU	9 (60%)	0 (0%)	6 (40%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	15 (100%)
2000, VOL. 124, ISSUE 3											
5	DISTORSION DES DISTANCES DANS LES GROUPEs	SAMI MUSTAPHA	14 (88%)	0 (0%)	2 (13%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	16 (100%)
6	VARIÉTÉS CAUCHY-RIEMANN HOMOGENES	KARL OELJEKLAUS et al	13 (76%)	0 (0%)	4 (24%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	17 (100%)
2000, VOL. 124, ISSUE 4											

7	SUR LA SYMPLECTISATION DE STRUCTURES	FANI PETALIDOU	44 (90%)	0 (0%)	5 (10%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	49 (100%)
8	DIMENSION RÉDUITE ET VALEURS PROPRES MULTIPLES	HÉLÈNE DELQUIÉ et al	4 (67%)	0 (0%)	2 (33%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	6 (100%)
2000, VOL. 124, ISSUE 5											
9	ESTIMATIONS DU NOYAU DE LA CHALEUR SUR LES	HONG-QUAN LI	9 (82%)	0 (0%)	2 (18%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	11 (100%)
10	INFLUENCE DE LA MASSE SUR LES SOLUTIONS	DAVID HOLCMAN	15 (60%)	0 (0%)	10 (40%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	25 (100%)
2000, VOL. 124, ISSUE 6											
11	UNE DESCRIPTION DE LA COHOMOLOGIE DU	DAVID LUBICZ	9 (82%)	0 (0%)	2 (18%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	11 (100%)
12	LOCALISATION DES COURBES ANORMALES ET COUPLES	PATRICK CABAU et al	15 (60%)	0 (0%)	10 (40%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
2000, VOL. 124, ISSUE 7											
no papers written in French by French authors											
2000, VOL 124, ISSUE 8											
13	CONNEXION DE GAUSS-MANIN DES POLYNÔMES		19 (68%)	1 (4%)	7 (25%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	27 (100%)
Mean			14 (70%)	0.15 (1%)	4.85 (28%)	0.77 (1%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	19 (100%)
MEDIAN			12 (60%)	0 (0%)	5 (33%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	16 (100%)
SD			10 (0.14%)	0.38 (0.024%)	2.27 (0.122)	0.27 (0.02%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	11.18 (0%)

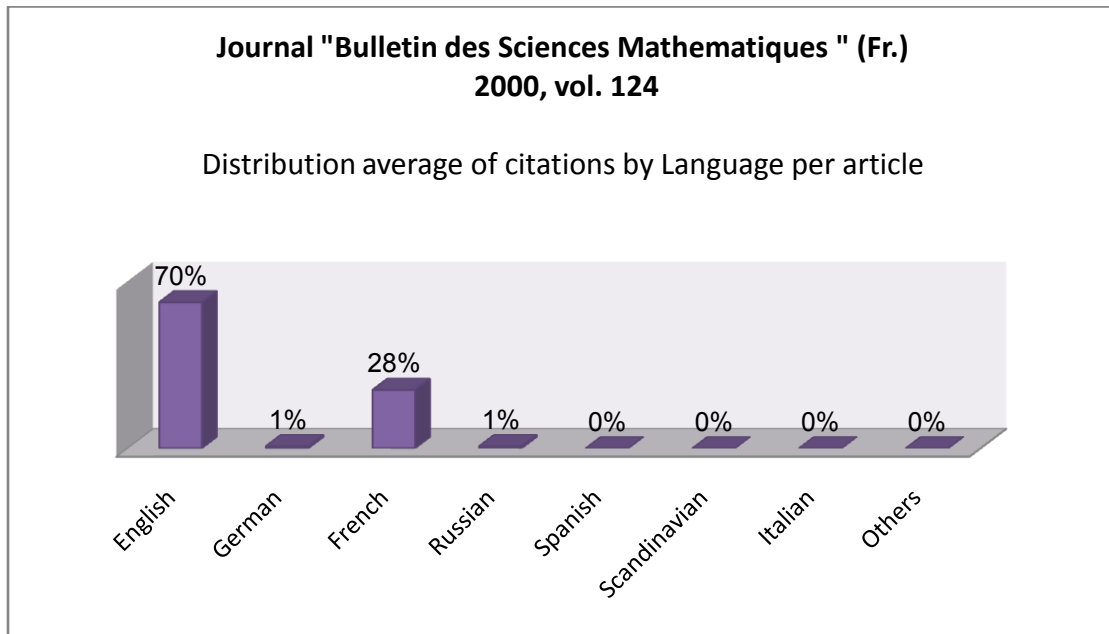


Figure 7

Table 8 "Bulletin des Sciences Mathématiques", 2010, vol. 134, issues 1-8											
Paper no.	Title	Authors	English citations	German citations	French citations	Russian citations	Spanish citations	Scandinavian citations	Italian	Other languages	Total no. of citations
issue 1 no papers written in French by French authors											
issue 2											
1.	Inverse asymptotique des matrices de Toeplitz	Philippe Rambour et al	15 (88%)	0 (0%)	2 (12%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	17 (100%)
Issues 3-4 no papers written in French by French authors											
Issue 5											
2	Invariants du tore quantique	Julie Baudry	9 (100%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	9 (100%)
Issue 6											
3	Idéaux fermés d'algèbres de Beurling	B. Bouya et al	13 (87%)	0 (0%)	2 (13%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	15 (100%)
4	Le cône diamant symplectique	Didier Arnal et al	10 (91%)	0 (0%)	1 (9%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	11 (100%)
Issue 7 no papers written in French by French authors											
Issue 8											
5	Cohomologie Lp et formes harmoniques	Noël Lohoué	3 (50%)	0 (0%)	3 (50%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	6 (100%)
MEAN			10 (83%)	0 (0%)	1.6 (17%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	12 (100%)
MEDIAN			10 (87%)	0 (0%)	1.8 (13%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	11 (100%)
SD			4.58 (19%)	0 (0%)	1.14 (19%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	4.45 (100%)

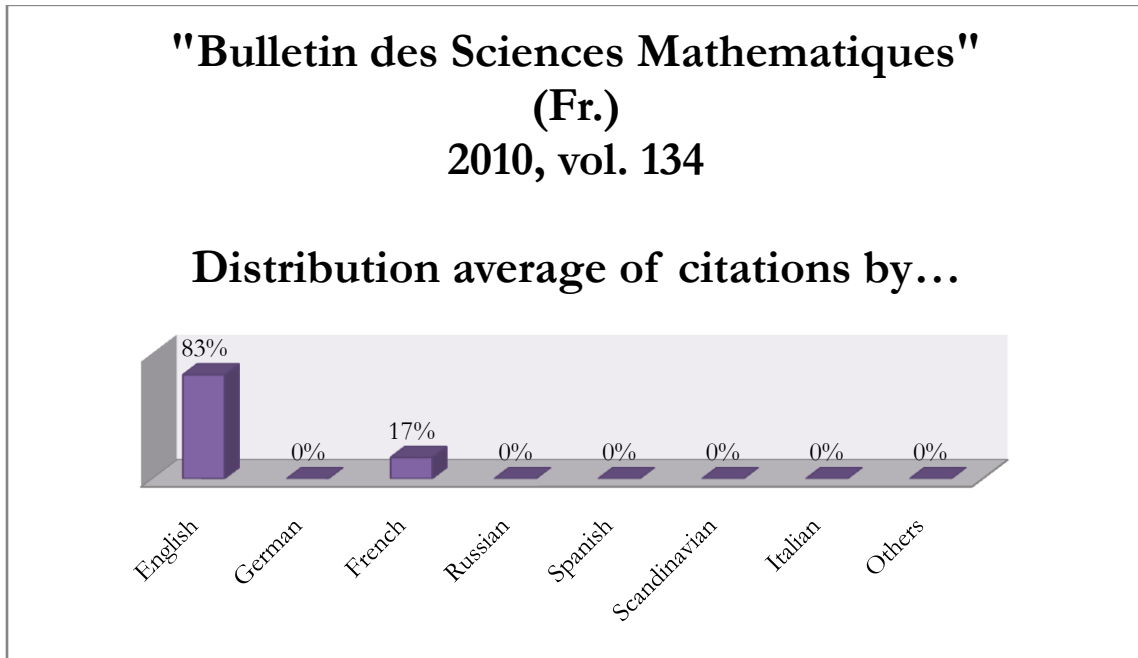


Figure 8

The finding demonstrated in Figures 7-8 show the rise in the use of English sources: the number of English citations per article jumped from 69.88% to 83.16%. However, there is a decrease in the use of foreign sources: the number of German citations declined from 0.92% to 0.00%, and the number of French citations dramatically went down from 28.38% to 16.84%. The results for the Italian journal “Annali di Matematica Pura ed Applicata” are demonstrated in Tables 9 and 10:

Table 9 "Annali di Matematica Pura ed Applicata" (It.) 2000, vol. 178 PAPERS WRITTEN IN ENGLISH BY ITALIAN AUTHORS											
Paper no.	Title	Authors	English citations	German citations	French citations	Russian citations	Spanish citations	Scandinavian citations	Italian	Other languages	Total no. of citations
1	Branched covers of the sphere	Maria Antonietta Pascali et al	22 (88%)	1 (4%)	2 (8%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	25 (100%)
2	Increasing variational solutions for a nonlinear	Simone Secchi	13 (93%)	0 (0%)	1 (7%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	14 (100%)
MEAN			18 (90%)	0.5 (2%)	1.5 (8%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	20 (100%)
MEDIAN			18 (90%)	0.5 (2%)	1.5 (8%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	20 (100%)
SD			6.36 (0.034%)	0.707 (0.28%)	0.707 (0.006%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)		7.78 (0%)

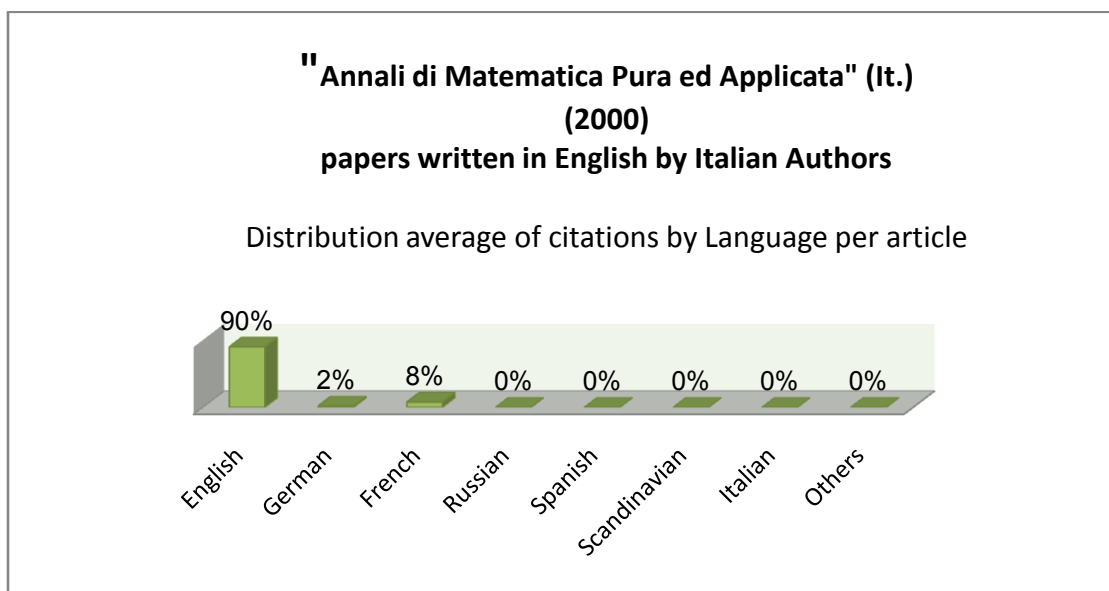


Figure 9

Table 10 "Annali di Matematica Pura ed Applicata" (It.) 2010, vol. 189 PAPERS WRITTEN IN ENGLISH BY ITALIAN AUTHORS											
Paper no.	Title	Authors	English citations	German citations	French citations	Russian citations	Spanish citations	Scandinavian citations	Italian	Other languages	Total no. of citations
1	Local-global divisibility by 4	Laura Paladino	9 (75%)	2 (17%)	1 (8%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	12 (100%)
2	Local solvability for partial differential	Alessandro Oliaro	30 (91%)	0 (0%)	3 (9%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	33 (100%)
3	Frames and oversampling formulas	Vincenza Del Prete	17 (100%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	17 (100%)
4	Optimal Sobolev and Hardy-Rellich constants	Filippo Gazzola et al	21 (100%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	21 (100%)
5	A generalisation of the Hopf construction	S. Montaldo et al	7 (100%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	7 (100%)
6	An example of chaotic behaviour in presence	Flaviano Battelli et al	38 (100%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	38 (100%)
7	Locality of the perimeter in Carnot	Luigi Ambrosio et al	12 (86%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	2 (14%)	0 (0%)	14 (100%)
MEAN			19 (93%)	0.3 (2%)	0.6	0 (0%)	0 (0%)	0 (0%)	0.3 (2%)	0 (0%)	20 (100%)
MEDIAN			17 (100%)	0 (0%)	0	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	17 (100%)
SD			11 (10%)	0.76 (6%)	0.13	0 (0%)	0 (0%)	0 (0%)	0.75 (5%)	0 (0%)	11 (0%)

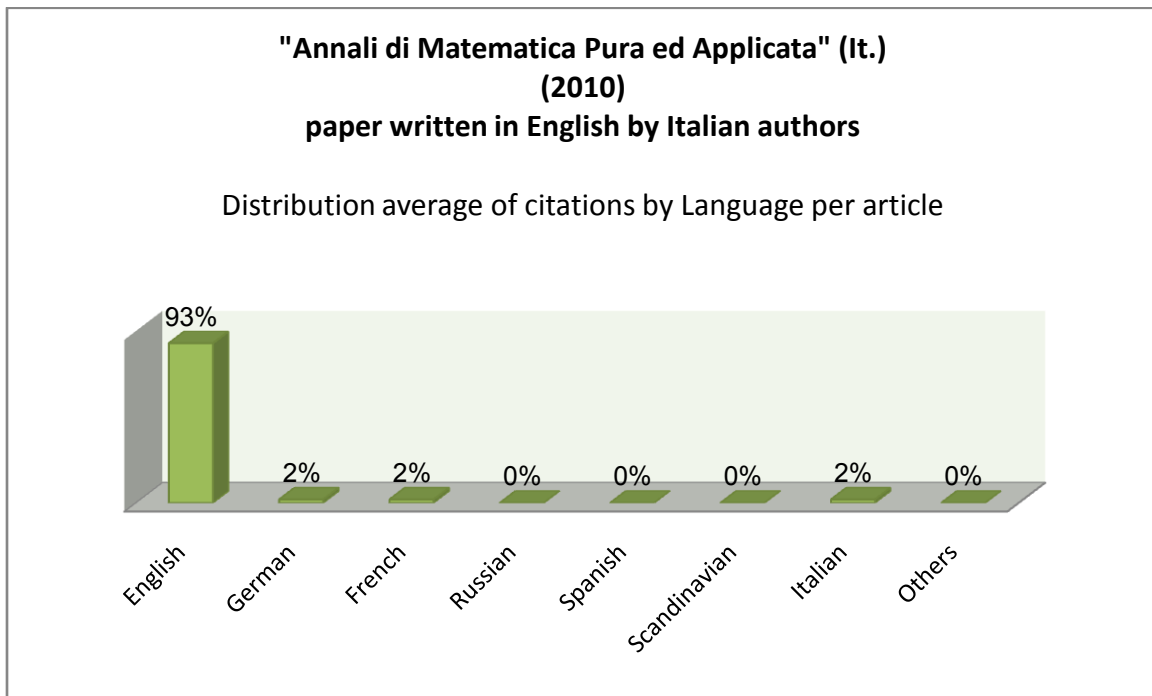


Figure 10

Thus, the received results for the Italian journals presented in Figures 9-10 are the follows: there is an increase in the number of English citations per article jumping from 90.43% (2000) to 93.09% (2010); there is also a small increase in the use of sources in the German language: the number of German citations per article went up from 2.00% (2000) to 2.38% (2010). The findings regarding the citations in French show the surprising decrease dropping from 7.57% (2000) to 2.49% (2010). So, proving my expectations upon beginning this study, the data show the consistent trend of increasing usage of English sources among all the checked nationalities except for the Americans. To see the full picture of the use of English and foreign resources by scholars in the field of Theoretical Mathematics in order to arrive at some conclusions, I compared my findings with the results of the former study (Anat Tsionit, 2000), which are demonstrated below in tables 12-14:

Table 11 Percentage of citations by Language per article in the three periods <i>American scholars</i>			
Language	1993 (A. Tsionit, 2000)	2000	2010
English	88.39%	93.78%	92.38%
German	2.84%	1.33%	1.18%
French	7.82%	4.89%	5.88%
Russian	0.57%	0.00%	0.33%
Spanish	0.00%	0.00%	0.00%
Scandinavian	0.00%	0.00%	0.00%
Italian	0.06%	0.00%	0.00%
Others	0.00%	0.00%	0.00%

Table 12 Percentage of citations by Language per article in the three periods <i>German scholars</i>			
Language	1993 (B. Tsionit, 2000)	2000	2010
English	76.81%	88.16%	92.44%
German	11.23%	6.6%	1.9%
French	10.41%	5.51%	5.67%
Russian	0.96%	0.00%	0.00%
Spanish	0.44%	0.00%	0.00%
Scandinavian	0.00%	0.00%	0.00%
Italian	0.15%	0.00%	0.00%
Others	0.00%	0.00%	0.00%

Table 13 Percentage of citations by Language per article in the three periods <i>French scholars</i>			
Language	1993 (C. Tsionit, 2000)	2000	2010
English	62.28%	69.88%	83.16%
German	2.22%	0.92%	0.00%
French	34.02%	28.38%	16.84%
Russian	0.52%	0.00%	0.00%
Spanish	0.00%	0.00%	0.00%
Scandinavian	0.00%	0.00%	0.00%
Italian	0.00%	0.00%	0.00%
Others	0.00%	0.00%	0.00%

Table 14 Percentage of citations by Language per article in the three periods Italian scholars			
Language	1993 (D. Tsionit, 2000)	2000	2010
English	81.13%	90.43%	93.09%
German	2.57%	2.00%	2.38%
French	8.15%	7.57%	2.49%
Russian	0.23%	0.00%	0.00%
Spanish	0.00%	0.00%	0.00%
Scandinavian	0.00%	0.00%	0.00%
Italian	6.87%	0.00%	0.00%
Others	0.00%	0.00%	0.00%

As demonstrated below in Table 12, 13 and 14, among the Germans, the French and the Italians there is a dramatic increase in the percentage of English citations. Among the Germans (Table 12), in 1993 the number of English citations totals up to 76.81% (Tsionit, 2000), in 2000 it is 88.16%, and in 2010 the percentage of English sources is 92.44%. Among the French (Table 13) and the Italians (Table 14), the noticeable jump in the number of English citations has been also noted: among the French scholars, in 1993, the English citations average out at 62.28% (Tsionit, 2000), in 2000 it is 69.88%, and in 2010 the number of English citation per article jumped up to 83.16%; among the Italians, in 1993, the distribution average of English citations per article sums 81.13% (Tsionit, 2000), in 2000 – 90.43%, and in 2010 the percentage of English citations per article increased up to 93.09%. However, as for articles written by American scholars, contrary to my expectation, in 2010 we witness the decrease in the usage of English sources: in 1993 – 88.39% (Tsionit, 2000), in 2000 – 93.78%, and in 2010 the number of English citations per article among the Americans dropped to 92.38%.

5. Discussion

The results of this study reveal several important implications. First of all, the average number of English citations per article in the American journal is lower in 2010 than in 2000. Contrary to my expectations, American scholars appear to continue using foreign-language sources due to the fact that there is a noticeable increase in the number of French citations per article, and there is neither increase nor decrease in the number of German citation per article over the examined time period, which reflects the consistency in the use of sources in the German language.

Consequently, such a trend can be said to presuppose a continued use of foreign-language materials (non-English sources) in the discipline of Theoretical Mathematics. To support this trend, there is a need in continued collecting of non-English materials by research libraries in the English-speaking countries.

Secondly, in spite of the fact that the number of English citations per article has not declined over last ten years among all other examined nationalities, but, on contrary, it continues to increase, the percentage of foreign citation over total citations has gone up in several cases: based on the collected data we witness the small increase in the use of French sources by German scholars (the jump from 5.51% (2000) to 5.67% (2010) of the number of French citations per article), and a surprising jump in the number of German citations in the articles written by Italian scholar going up from 2.09% (2000) to 2.38% (2000). Nevertheless, despite this fact, it can be argued that use of non-English citation is not keeping pace with the increase in use of English citations. One of the possible explanations for this phenomenon could be that the number of resources in English, which are being published, has increased dramatically over last time. Such factors as the history and culture of Theoretical Mathematics as a discipline also would contribute to a clearer picture of scholarship in this field.

Another possibility could be explained by the fact that fewer non-English sources are available in research libraries in the English-speaking countries, and most of the research books in the European academic libraries are in English rather than in the local language. Another interesting result of this research is the finding that German and French remain the most important non-English languages of scholarship for mathematicians. This study shows that French was more often cited than German. The other point is that some implications of this study results are worrisome, especially because of the existing trend among the German scholars, who prefer English to German for writing their scholar articles. Such a tendency “support” American scholars to avoid reading articles in Science journals published in foreign languages. And by way of response, in order not to lose their readers, some publishers of

such journals have progressively increased the proportion of article in English. Thus, the purpose of the trends tables presented in this paper is to serve librarians in their future decisions about storage and purchase.

6. Conclusion

The purpose of this study was to discover whether scholars in the field of Theoretical Mathematics continue to use either foreign-language sources (the Americans) or sources in their own language (the Germans, the French and the Italians) in their published work. The answer to this question may have important implications for collection development and budget decisions in libraries supporting Science scholarship. The fact that the decline in the number of non-English citations per article among the Americans in 2000, “replaced” by the surprising increase, recorded in 2010, and the continued use of non-English sources by the Germans, French and the Italians, indicates that mathematicians do recognize the importance of language to their research: the importance for non-English speaking scholars to write their research papers in their native language, and the research importance of other foreign language to English-speaking scholars, despite overall drops in language enrollment in English-speaking countries (Kellsey et al., 2004). Thus, observing the journals in such an individual field as Theoretical Mathematics, the attempt has been made to provide more practically applicable information to libraries for collection development in this discipline, taking into considerations historical, cultural, linguistic and statistical factors.

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