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Abstract

Purpose – The purpose of this paper is to explore the differences and similarities between computer ethics, internet ethics and cyberethics as reflected in the contents of the published literature as well as the search trends on Google.

Design/methodology/approach – The paper opted for an informetrics approach, and more specifically content analysis, to investigate the inter-relationships between computer ethics, internet ethics and cyberethics. The data sources for this study included Google Trends, Google Scholar and the Web of Science citation indexes. Different search queries were used, depending on the structure of each data source, to extract the relevant data sets.

Findings – Using different methods and techniques to analyse the data, the paper provides an alternative means of investigating relationships among concepts. The findings indicate that there is still no clear distinction between the concepts in terms of subject and title terms used to describe the published literature on the three concepts, as well as the research areas where the three concepts are applied. Going by the current trend, the paper envisages that cyberethics may, in the future, become a broader term to include computer ethics and internet ethics.

Research limitations/implications – The data sources that were selected for the study might have not been comprehensive in the coverage of the published literature on the three concepts and therefore there is need for further research, which will expand the scope of the data sources.

Practical implications – The paper's findings may apply in the practice of indexing and abstracting as well as thesaurus construction as far as the three terms are concerned.

Originality/value – The paper offers an alternative technique that can be used to investigate relationships among concepts. The value of the paper could include curriculum development of programmes dealing with ethical issues that arise when developing and using computers and related technologies.

Keywords Information retrieval, Internet, Ethics, Computers, Data mining

Paper type Research paper

1. Introduction and background information

The emergence of computers and related technologies in the mid-1800s and early 1900s, when the early mechanical computers were designed (Chapman, 2010), ushered in a new development in the information era. The development of global information networks, which allow data, voice, video and location transmission through wired and wireless grids, has led to the development of an information-centred society that has come to be simply called "an information society". Moore (1997) believes that this society has the following characteristics: information is used as an economic resource; it is possible to identify the greater use of information among the general public; and the information sector is developed within the economy. Not only is plenty of

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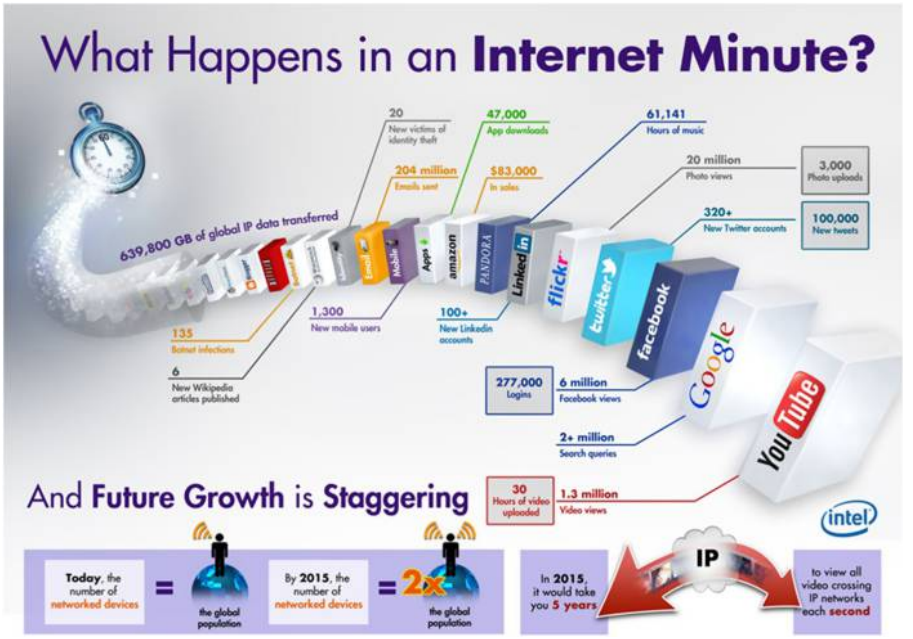
information used by the general public, but much of it is also being generated every second. According to a study conducted by Lyman *et al.* (2000):

> […] the world produces between 1 and 2 exabytes of unique information per year, which is roughly 250 megabytes for every man, woman, and child on earth. An exabyte is a billion gigabytes, or 10^{18} bytes. Printed documents of all kinds comprise only 0.003% of the total. Magnetic storage is by far the largest medium for storing information and is the most rapidly growing, with shipped hard drive capacity doubling every year. Magnetic storage is rapidly becoming the universal medium for information storage.

This scenario must have changed by now (2013), as more channels for generating, storing and sharing information have been introduced. Moreover, there are more people engaged not only in generating new information, but also in disseminating already-existing information. The internet and cloud computing are but two of the technologies that have had a profound effect on the manner in which information is handled by using ICTs of the twenty-first century. The internet's applications, such as social-networking sites, and supporting technologies, for example mobile phones, have greatly increased the amount of information that is generated as well as accessed and used. Figure 1 offers a summary of what happens on the internet in a minute.

One noteworthy prediction made in Figure 1 is that the number of networked devices will be two times the global population by 2015. In 2013, the International Telecommunication Union (ITU) estimated that, worldwide, there were: a total of 1,171 million fixed telephone subscriptions; 6,835 million mobile-cellular subscriptions; 2,096 million active mobile-broadband subscriptions; and 696 fixed-broadband



Source: www.intel.com/content/www/us/en/communications/internet-minute-infographic.html (accessed 28 August 2013)

Figure 1.
What happens in an internet minute?

(wired-broadband) subscriptions (International Telecommunication Union, 2013). Further, the ITU estimated that a total of 2,749 million people were using the internet in 2013, with 1,791 million of them being from developing countries.

The increased activity on the internet has had a profoundly negative impact on society. According to the survey conducted by Detica Limited (2011) in the UK, it was found that the cost of cyber crime was significant and growing, and that the impact was felt most by UK businesses. The Internet Crime Complaint Center (Internet Crime Complaint Center, 2012), too, reports that the number of complaints as well as the cost of crime on the internet have continued to grow. The Centre reports that it received a total of 289,894 complaints in 2012 alone. Of this number, 114,908 (39.64 per cent) reported financial loss. The total financial loss incurred in 2012 was US$525,441,110. The 2012 report of the Centre further indicated that the majority of the complaints were lodged by males (51.61 per cent), while females submitted 140,273 complaints, accounting for 48.39 per cent of the total number of complaints. The USA was the country with the highest number of complaints, having posted 91.2 per cent of the complaints, followed by Canada (1.4 per cent), the UK (0.9 per cent), Australia (0.7 per cent) and India with 0.6 per cent of the complaints. In Africa, most complaints originated from South Africa, which posted 0.18 per cent of complaints, followed by Nigeria with 0.08 per cent of the complaints. Egypt was ranked 46 in the list of complainants, with 0.04 per cent of the complaints registered in 2012.

Although South Africa was ranked 11 in terms of the number of complaints, it was ranked 7 in terms of the amount of financial loss incurred through online fraud. The country reported a financial loss of US$2,692,682.45, compared with the USA's US$436,604,854.17. Nigeria, too, was highly ranked when it came to financial loss. The country was ranked 8 (one position behind South Africa) with a total of US$2,552,944.03. It should be noted, however, that these huge figures are not reflective of the true state of online crimes committed worldwide, as many of the crimes are not reported. In addition, IC3 is based in the USA and therefore there is a likelihood that the majority of the crimes committed in developing countries as well as other geographic regions outside the USA may go unreported.

2. Ethical considerations and dilemmas – brief discussion

It is now readily acknowledged that computers and the internet have become indispensable in our lives (Wong, 1995). Society is becoming increasingly dependent on the use of computers and the internet to carry out various activities ranging from simple communication between two people (e.g. through e-mails) to more complex and delicate life-saving endeavours such as medical operations (e.g. the use of computers for organ transplants and heart surgeries in human beings, etc.). As a result, society is becoming ever-more concerned about the increasing number of ethical issues/problems associated with computers and the internet. Wong (1995, p. 181) puts it thus: "Society is increasingly concerned about computer ethics and the difference between what is right, what is wrong, what is acceptable and what is criminal". Not only has the number of information technologies increased tremendously, but their use has also grown over time, as depicted in Figure 1. The trend is likely to continue as new technologies are discovered, thereby resulting in an additional increase in ethical problems. Moor (2005, p. 117) observes that, as the social impact of technological revolutions grows, ethical problems increase.

Ethical dilemmas associated with computers and their technologies emanate from, first, the determination of the scope of computer ethics *vis-à-vis* other related types of ethics. For instance, Wong (1995, p. 180) questions whether computer ethics are actually different from "any other kind of ethics". Lyu (2012, p. 395) puts it thus: "If the Internet has had a substantial impact on our moral, legal, and social systems, then are any of the resultant problems and concerns unique moral issues?" Citing other scholars such as Kaliman and Grillo (1993), Parker *et al.* (1990), Johnson (1984, 1985), Wong concludes that there is no distinct difference between computer ethics and other ethics, "but rather that the proliferation of use and the capabilities of computers often impart a unique character to problems of computer ethics" (Wong, 1995, p. 180). According to Lyu (2012), there are two schools of thought in this regard, namely: first, the internet-related concerns involving privacy, free speech and so forth should be understood as expressions of such long-standing moral notions as autonomy, responsibility and respect for persons; and second, the internet may not have introduced new problems, but the context is new and, therefore, "it becomes important to examine issues in this new context to determine if new answers are required". Although a closer analysis of what constitutes "computer ethics", "internet ethics" and/or "cyberethics" reveals that the terms used to describe what is ethical or unethical when using computers and/or the internet are basically similar to those used to describe the "other ethics", the second school of thought argues that the context has indeed changed and, therefore, there is a need for a new social consensus.

The second dilemma (which is closely linked to the first one above) which society faces revolves round distinguishing between computer ethics, internet ethics and cyberethics. Are the three concepts describing the same or different things? Whereas the ethics associated with the use of the computer and its technologies (computer ethics) were introduced between 1940 and 1950 (Bynum, 2011; Stamatellos, 2007), the ethics associated with the use of the internet (internet ethics) and cyberspace technologies (cyberethics) are relatively new. It is, however, noted by various authors such as Stamatellos (2007, p. 3) that the term "computer ethics" was first introduced by Walter Maner in the mid-1970s. Then, the term was used to refer to the "field of philosophical inquiry that deals with ethical problems, aggravated, transformed or created by computer technology" (Stamatellos, 2007, p. 3). Moor (1985, p. 266) sees computer ethics as the "analysis of the nature and social impact of computer technology and the corresponding formulation and justification of policies for the ethical use of such technology", where "computer technology" is broadly used by Moor to include computers and associated technologies. We will merely compare this definition with the rest that compare the concepts of computer ethics, internet ethics and cyberethics. Akbulut *et al.* (2008, p. 464), while acknowledging that computer ethics has been defined extensively in the literature, attempt to define internet ethics by arguing that, "if computer ethics is one of the issues that emerged with computer technology, internet ethics might be considered as either a sub-component of computer ethics or a new area of ethics that emerged with the advance of [the] Internet". Torum, in Kavuk *et al.* (2011, p. 1044), define internet ethics as a concept that expresses how people should behave while they are using the internet. As regards cyberethics, Froehlich (2005) is of the opinion that cyberethics is a "particular branch of computer ethics". In citing Sullivan, Froehlich notes that cyberethics may replace computer ethics, since, he argues, cyberethics is concerned in particular with ethical issues related to the internet or cyberspace. He states that possible topics in this area include expert systems, artificial intelligence and the

ability of robots to reason. It is Spinello and Tavani (2004, p. 1), however, who have provided broad operational definitions and have indicated the relationship between the three concepts. The authors observe thus:

> Cyberethics can be defined as the field of applied ethics that examines moral, legal, and social issues in the development and use of cybertechnology. Cybertechnology, in turn, refers to a broad spectrum of technologies that range from stand-alone computers to the cluster of networked computing, information, and communication technologies. Until recently, many have used the expression "computer ethics" to refer to the field that we call cyberethics. Note, however, that "computer ethics" can easily suggest the study of ethical issues that are associated primarily with computing machines or with the computing profession. Because the readings in this volume examine a much wider range of ethical issues, we believe that the term "cyberethics" better captures these issues. Other expressions that also have been used to refer to this relatively new field of applied ethics are "internet ethics" and "information ethics". The cyberethics issues that we examine in this text are broader in scope than the set of issues likely to be considered under the heading "internet ethics". And because cyberethics issues are concerned with ethical aspects of information as they relate specifically to networked computing and communications devices, "information ethics" is too general a heading. Hence, our preference for using the term cyberethics to describe the range of issues we examine in this book of readings. At times, however, the expression "computer ethics" and the term "cyberethics" are used interchangeably in this chapter as well as in other sections of this book (Spinello and Tavani, 2004, p. 1).

It is apparent, therefore, that the meaning of, and distinction between, computer ethics, internet ethics and cyberethics is not clear. In his study of the problems related to computer ethics, Kuzu (2009) underscores this observation and reiterates that:

> ICT professionals were not sure of a working definition of computer ethics, and described the concept through providing unethical computer using behavior examples. They all agreed on a consensus regarding the importance of the issue, but considered computer ethics primarily as a component of Internet ethics.

The confusion surrounding the exact meaning of computer ethics, internet ethics and cyberethics, as well as their related "ethics" does not only pose problems for the indexers of the published literature, but may also pose big challenges for educators who teach the subject/s. This paper therefore explores the differences and similarities between the three concepts, namely, computer ethics, internet ethics and cyberethics using informetrics techniques and, more specifically, content analysis so as to provide an understanding of the three concepts as they are reflected in the published literature.

3. Methods and materials

As mentioned above, an informetrics approach was adopted in order to conduct the current study. Wormell (2000) describes informetrics as the "combination of advanced information retrieval" while Diodato (1994, p. ix) observes that informetrics are methodologies that examine "patterns that show up not only in publications but also in many aspects of life, as long as the patterns deal with information". According to Egghe and Rousseau (1990, p. 1), informetrics deals with the measurement, mathematical theory and modelling of all aspects of information. This conglomeration of methods has been widely applied in many fields/disciplines, including library management, the sociology of science, the history of science, information retrieval, biometrics, econometrics, chemometrics, sociometrics and quantitative linguistics. There are several methods that constitute informetrics, but these can be broadly grouped into two categories, namely,

descriptive methods and evaluative methods. One of the descriptive methods or analytic techniques that has become increasingly common in informetrics circles, and which was used to conduct this study, is content analysis. Content analysis is defined as a methodology in the social sciences for studying the content of communication. Babbie (2010, p. 333) defines it as "the study of recorded human communications, such as books, web sites, paintings and laws", while Bryman (2012, p. 289) describes content analysis as an "approach to the analysis of documents and texts (which may be printed or visual) that seeks to quantify content in terms of predetermined categories and in a systematic and replicable manner". For her part, Palmquist (nd) sees content analysis as a research technique for the objective, systematic and quantitative description of the manifest content of communications. The technique has been associated with, and applied in, the analysis of printed texts, but has become increasingly appropriate for evaluating electronic manifestations of information. Hence, the method has been extensively used in informetrics studies on different topics such as HIV/AIDS (e.g. Onyancha and Ocholla, 2009), the Web (Bar-Ilan and Echerman, 2005; Vaughan and You, 2008), archives (Fujigaki, 2006) and nursing (e.g. Graneheim and Lundman, 2004), to name but a few.

The data sources for this study included Google Trends, Google Scholar and the Web of Science (WoS) citation databases. The WoS databases used to obtain relevant data for the study are the Thomson Reuters citation indexes, namely, the Social Sciences Citation Index, the Arts and Humanities Citation Index and the Science Citation Index. Table I summarises the type of data that was extracted from each source.

In order to obtain the type of data shown in column 2 in Table I, different search queries were used, depending on the structure of each data source. Whereas the concepts were used as search terms (i.e. "computer ethics", "cyberethics" and "internet ethics") in Google Scholar and Google Trends, the search strategy in respect of Thomson Reuters search platform was slightly different, that is, the terms "internet", "computer" and "cyber" were searched separately and the results combined with those generated from a search for "ethics" in order to yield the desired results for "computer ethics", "internet ethics" and "cyberethics". The search for "cyberethics" was further refined by combining the previous search of "Cyber Ethics" and "cyberethics" using the Boolean operator OR (i.e. (Cyber AND Ethics) OR Cyberethics). The search in Google Trends yielded immediate results, which were plotted on line graphs in Figures 2-4, while the data collected from Google Scholar and Thomson Reuters was subjected to further analysis. In the case of Google Scholar, the Publish or Perish software was used to extract data, which was then saved in text format (i.e. .txt) and later on analysed

Source	Type of data	Purpose
Google Trends	Volume of searches on each concept over time	To find out the most popular concept among the searchers To reveal the trend of searches on each concept
Google Scholar	Title words	To determine the most common title words used to describe the concepts To map the core terms used to describe the concepts under investigation
Thomson Reuters citation indexes	Research areas	To identify the research areas in which the concepts are most applied
	Subject categories	To find out the disciplines in which the concepts are applied

Table I.
Data sources, type and purpose

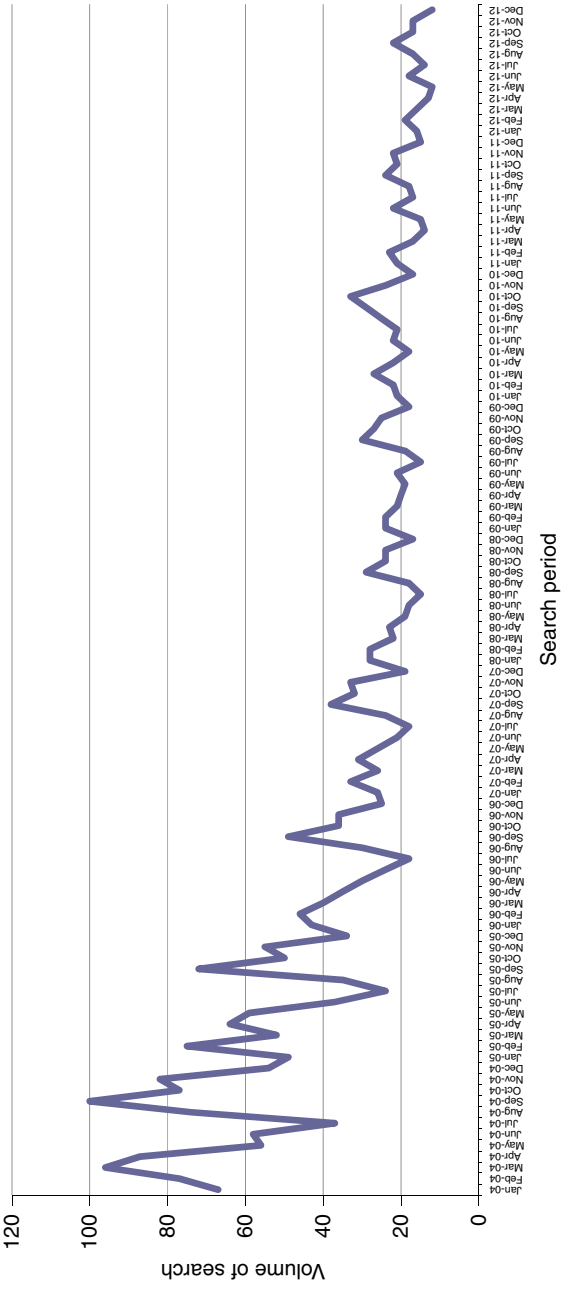


Figure 2.
Trend and volume of searches on computer ethics

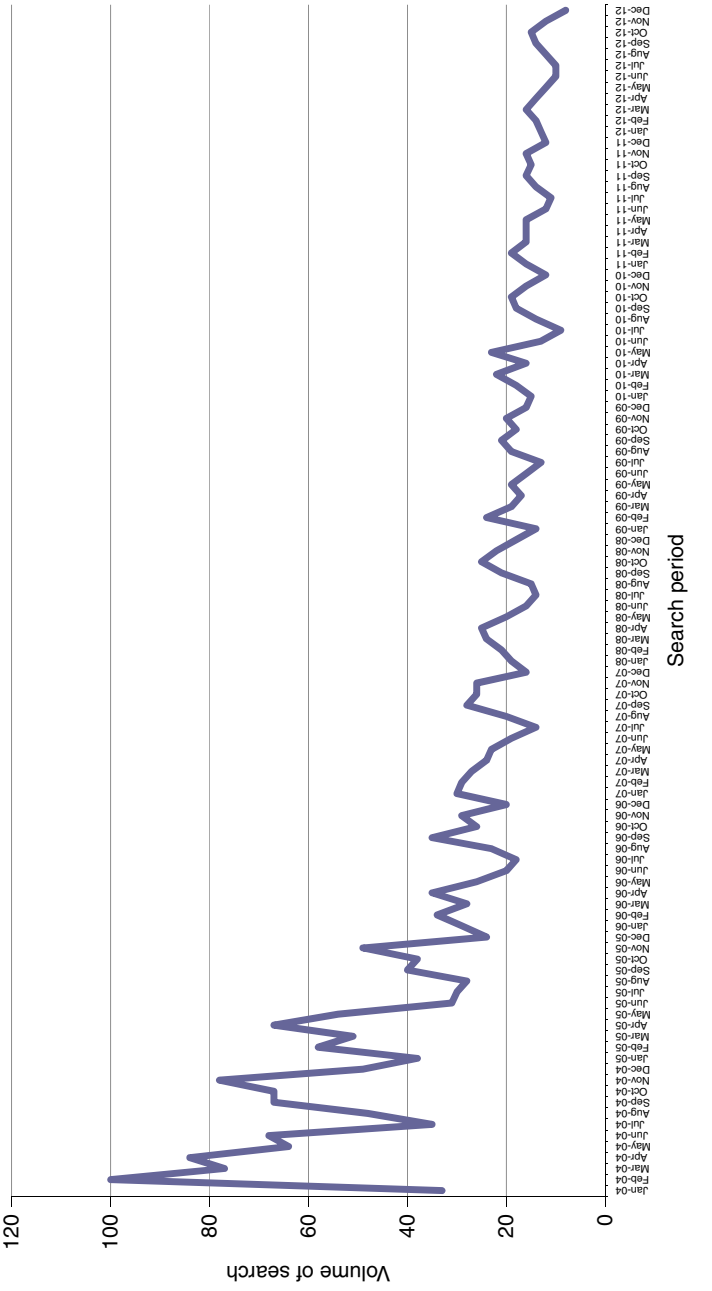


Figure 3.
Trend and volume of searches on internet ethics

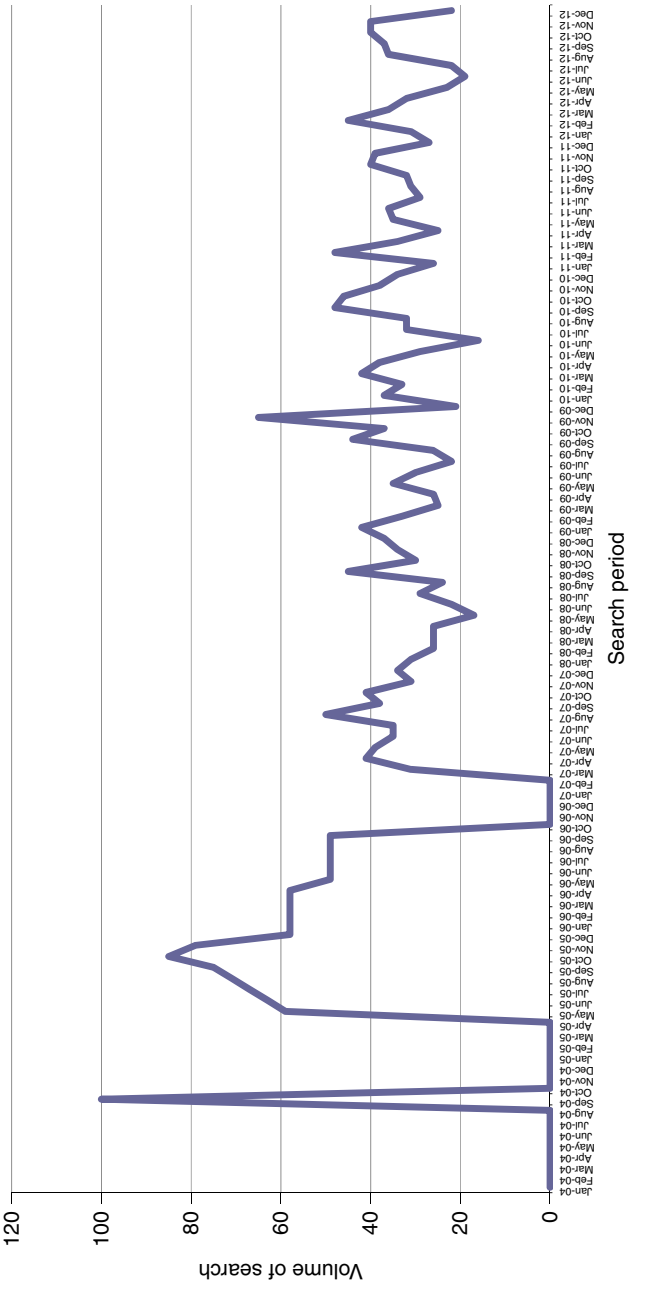


Figure 4.
Trend and volume of searches on cyberethics

using TextStat to generate the most common words in the titles of each concept. The words that produced the highest frequencies, herein referred to as "core terms/words", were then mapped to produce the social networks in Figures 4 and 5. In the case of Thomson Reuters, data was analysed using the inbuilt tool (within the database) which analyses the data according to various variables, including author, year of publication, research areas, subject categories, source/journals, etc.

4. Results and discussion

The findings are presented and discussed under the trend and volume of the searches, the most common title words, the disciplines in which the concepts are researched and the subject categories in which the concepts are applied.

4.1 Trend and volume of searches

Figures 2-4 demonstrate the trend and volume of the searches conducted on the three concepts between 2004 and 2012 through Google.

The data obtained from Google Trends does not reflect the total number of searches on each concept but the normalised number of searches. Google Trends analyses a percentage of Google Web searches to determine how many searches have been done for the terms one enters compared with the total number of Google searches done during a particular time (Google Inc., 2014). Therefore, the numbers reflected in Figures 2-4 do not represent absolute search volume numbers, because the data is normalised and presented on a scale from 0 to 100. Each point on the graph is divided by the highest point, or 100. When Google does not access enough data on any given search term, a zero (0) is returned, indicating a low search volume (Google Inc., 2014).

A comparative analysis of the three concepts indicates that, whereas they were all popular among Google searchers in the early 2000s, the volume of searches has continued to decrease relative to other searches being conducted through the Google search engine. "Computer ethics" compared relatively well in March 2004 and September 2004, in that it posted a relative and normalised search volume of 96 and 100, respectively, implying that the searches relating to computer ethics during the said periods were the same as the queries that were the most searched. This pattern was witnessed in March 2004 (in the case of "internet ethics") and September 2004, when "cyberethics" peaked at 100 normalised score of the search volume. Whereas the search volume for "computer ethics" and "internet ethics" has remained below 40 since October 2006 and December 2005, and dropped to below the 20 mark in November 2011 and June 2010, respectively, the search volume for "cyberethics" largely remained above 20 throughout the entire

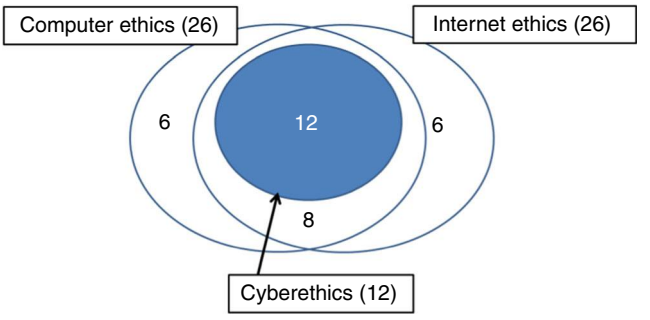


Figure 5.
Overlap of research areas in which computer ethics, internet ethics and cyberethics are applied

period of investigation. In fact, "cyberethics" has continued to attract more interest from Google searchers since May 2005 than "internet ethics" and "computer ethics". This can be attributed to the fact that cyberethics is a relatively recent concept when compared with computer ethics and internet ethics. Spinello and Tavani (2004, p. 1) also explain that cyberethics encompasses computer ethics and internet ethics, a situation that may explain why most Google searchers may prefer a search on "cyberethics" as opposed to the other two, as the search on "cyberethics" may yield documents discussing computer ethics and internet ethics.

In terms of the relationships among the concepts, a Spearman correlation yielded the results in Table II. The results indicate that there was a high correlation between computer ethics and internet ethics in terms of the volume of searches conducted on the two concepts. This pattern may be attributed to the fact that both concepts have been in existence for a longer period of time than cyberethics.

Table II shows that whereas there was a significant relationship between the search volumes in computer ethics and internet ethics, the relationship between computer ethics and cyberethics, on the one hand, and internet ethics and cyberethics, on the other hand, were not significant. In fact, there was a very highly correlated relationship between computer ethics and internet ethics, which produced a correlation coefficient of 0.888. This implies that that the search patterns in computer ethics and internet ethics followed similar trends during the period under investigation while the searches conducted on cyberethics have followed a different trend. This is exemplified by the negative correlation coefficient generated in the relationship between internet ethics and cyberethics (i.e. −0.058).

4.2 Research areas in respect of computer ethics, internet ethics and cyberethics

The Thomson Reuters WoS was used to obtain data in order to compare the three concepts of computer ethics, internet ethics and cyberethics in terms of the research areas that not only contribute to shape their scope, but also utilise the theories associated with the concepts. The research areas also provided the scope of research for each of the concepts. The most researched area depicted the discipline or sphere in which the concept is either applied or wherein the concept is most popular, or the discipline that contributed

			Spearman correlations		
			Computer ethics	Internet ethics	Cyberethics
Spearman's rho	Computer ethics	Correlation coefficient	1.000	0.888**	0.020
		Sig. (2-tailed)		0.000	0.838
		n	108	108	108
	Internet ethics	Correlation coefficient	0.888**	1.000	−0.058
		Sig. (2-tailed)	0.000		0.554
		n	108	108	108
	Cyberethics	Correlation coefficient	0.020	−0.058	1.000
		Sig. (2-tailed)	0.838	0.554	
		n	108	108	108

Note: **Correlation is significant at the 0.01 level (two-tailed)

Table II.
Spearman correlation of search volumes in computer ethics, internet ethics and cyberethics

the most towards shaping a given concept; in this case, computer ethics, internet ethics or cyberethics. Table III provides the research areas for each concept.

A close examination of the total number of research areas in which each concept was researched, as shown in Table III, reveals that research on computer ethics was conducted in a total of 26 research areas, depicting the disciplines in which computer ethics is either popular or can be situated. Internet ethics research, too, spanned 26 research areas in Thomson Reuters citation indexes, while cyberethics/cyber ethics research was covered in 12 research areas.

Out of the total of 104 records retrieved from the Thomson Reuters citation indexes on computer literacy, 39 (40.63 per cent) addressed issues relating to computer science, while the other top five disciplines shared the records as follows: social sciences and other related topics (23 or 23.96 per cent), information science and library science (20 or 20.83 per cent), philosophy (13 or 13.54 per cent) and engineering (12 or 12.50 per cent). As regards internet ethics, out of a total of 62 records, 21 (33.87 per cent) focused on the broad field of social sciences and other related topics, followed by business economics (14 or 22.52 per cent), computer science (11 or 17.74 per cent), information science and library science (9 or 14.52 per cent), government law (5 or 8.07 per cent) and psychology (5 or 8.07 per cent). The core disciplines or research areas that contributed to cyberethics research included, in descending order of productivity: information science and library science, which posted nine out of the total of 16 records, accounting for 56.25 per cent; computer science (6 or 37.50 per cent); and with communication, engineering, psychology and social sciences and related topics contributing a total of two records each, which accounted for 6.25 per cent each.

It was also noted that there were research areas which were common to computer ethics, internet ethics and cyberethics researches. In fact, all the research areas listed in the cyberethics/cyber ethics research column (column 7 in Table III) were common to both internet ethics and computer ethics research. Figure 5 demonstrates the overlap of research areas with regard to the three concepts. Figure 5 illustrates that, out of the 26 research areas in which internet ethics research was situated, eight were shared with computer ethics, while six uniquely belonged to computer ethics research only. The unique research areas for computer ethics research include agriculture, construction building technology, imaging science photographic technology, public environmental occupational health, research experimental medicine and rheumatology. The subject areas that were unique to internet ethics are: general internal medicine, cultural studies, family studies, nutrition dietetics, social work and substance abuse. There were eight research areas that were common to computer ethics and internet ethics but which did not appear in cyberethics research. These are: education educational research, business economics, health-care sciences services, medical ethics, biomedical social sciences, psychiatry and sociology.

It is worth noting, however, that the ranking of the common research areas was not similar in the three cases, that is, in respect of computer ethics, internet ethics and cyberethics research. Table IV provides the rankings of the 12 common research areas. The different rankings of the research areas in which the concepts under investigation in this study are situated may render credence to the view that the three concepts are somehow different, although they overlap in their scope, as depicted in Figure 5 and Tables III and IV. Specifically, Table IV may be indicative of the intensity of the application of the concepts in the different research disciplines. As expected, computer ethics was largely applied or situated in computer science and information science library science disciplines, as was the case with cyberethics. Internet ethics was most common in social sciences other sciences and business economics. The latter was not

Computer ethics ($n = 104$)			Internet ethics ($n = 62$)			Cyberethics/Cyber ethics ($n = 16$)		
Research area	No.	%	Research area	No.	%	Research area	No.	%
Computer science	39	40.625	Social sciences other topics	21	33.871	Information science library science	9	56.25
Social sciences other topics	23	23.958	Business economics	14	22.581	Computer science	6	37.5
Information science library science	20	20.833	Computer science	11	17.742	Communication	2	12.5
Philosophy	13	13.542	Information science library science	9	14.516	Engineering	2	12.5
Engineering	12	12.5	Government law	5	8.065	Psychology	2	12.5
Education educational research	10	10.417	Psychology	5	8.065	Social sciences other topics	2	12.5
Business economics	8	8.333	General internal medicine	4	6.452	Government law	1	6.25
Science technology other topics	8	8.333	Science technology other topics	4	6.452	History philosophy of science	1	6.25
History philosophy of science	7	7.292	Biomedical social sciences	3	4.839	Nursing	1	6.25
Psychology	5	5.208	Psychiatry	3	4.839	Philosophy	1	6.25
Social issues	3	3.125	Social issues	3	4.839	Science technology other topics	1	6.25
Health-care sciences services	2	2.083	Sociology	3	4.839	Social issues	1	6.25
Medical ethics	2	2.083	Education educational research	2	3.226			
Agriculture	1	1.042	Engineering	2	3.226			
Biomedical social sciences	1	1.042	Health-care sciences services	2	3.226			
Communication	1	1.042	History philosophy of science	2	3.226			
Construction building technology	1	1.042	Medical ethics	2	3.226			
Government law	1	1.042	Philosophy	2	3.226			
Imaging science photographic technology	1	1.042	Communication	1	1.613			
Nursing	1	1.042	Cultural studies	1	1.613			
Psychiatry	1	1.042	Family studies	1	1.613			
Public environmental occupational health	1	1.042	Nursing	1	1.613			
Research experimental medicine	1	1.042	Nutrition dietetics	1	1.613			
Rheumatology	1	1.042	Social work	1	1.613			
Sociology	1	1.042	Substance abuse	1	1.613			
Telecommunications	1	1.042	Telecommunications	1	1.613			

Table III.
Research areas in respect of computer ethics, internet ethics and cyberethics literature

Table IV.
Rank of research areas in respect of computer ethics, internet ethics and cyberethics research

Research area	Rank in: Computer ethics	Internet ethics	Cyberethics
Communication	14	19	3
Computer science	1	3	2
Engineering	5	13	3
Government law	14	5	4
History philosophy of science	9	13	4
Information science library science	3	4	1
Nursing	14	19	4
Philosophy	4	13	4
Psychology	10	5	3
Science technology other topics	7	7	4
Social issues	11	9	4
Social sciences other topics	2	1	3

common in the literature on the three concepts. Nevertheless, the third-most common research area in internet ethics was computer science, indicating some similarities among the three concepts.

4.3 Subject categories in computer ethics, internet ethics and cyberethics

The WoS subject categories were obtained using the citation indexes in order to compare the scope of the three concepts, which were the subject of this study's investigation. The analysis was also meant to determine the disciplines in which the three concepts can be situated.

The following can be deduced from Figure 6:

(1) The number of subject categories that were common among the three concepts was $A \cap B \cap C = \{8\}$.

(2) The number of subject categories common to computer ethics and internet ethics but not to cyberethics totalled $(A \cap B) - (A \cap B \cap C) = \{20\}$.

(3) The number of subject categories that co-appeared in computer ethics and cyberethics but did not appear in internet ethics was $(A \cap C) - (A \cap B \cap C) = \{2\}$.

(4) The number of subject categories that were common to internet ethics and cyberethics but did not appear in computer ethics was $(B \cap C) - (A \cap B \cap C) = \{3\}$.

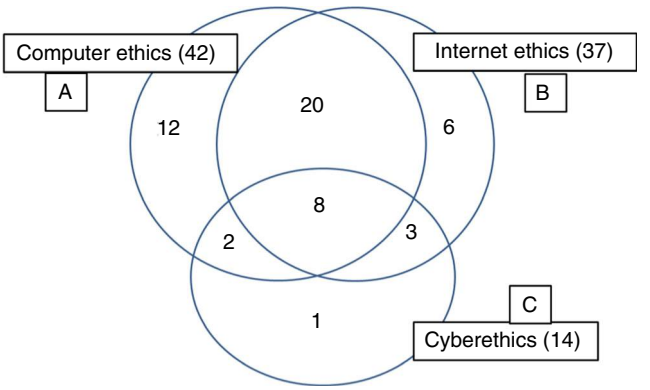


Figure 6.
Overlap of subject categories (disciplines) in which computer ethics, internet ethics and cyberethics are applied

(5) The number of subject terms that were unique to each concept was as follows: computer ethics (12), internet ethics (6) and cyberethics (1). It follows, therefore, that over 70 per cent of the subject categories in computer ethics were shared with either internet ethics or cyberethics. Likewise, more than 80 per cent of the subject categories in cyberethics and/or internet ethics were shared with computer ethics.

Table V provides 25 subject categories that recorded high frequencies of occurrence in the literature of computer ethics and internet ethics, while presenting all the subject categories in which cyberethics appeared. An examination of the top five subject categories in each case may reflect a close link that exists between computer ethics, internet ethics and cyberethics. Three subject categories, including information science library science, ethics and computer science information systems appeared in the literature on the concepts investigated in this study. There were variations in the topics discussed in the literature on computer ethics, cyberethics and internet ethics. For example, it was noted that, whereas the highest-ranking topics in computer ethics were, in descending order, ethics, information science library science and computer science software engineering, the ranking order of subject categories for internet ethics differed slightly with ethics topping the list, followed by business, information science library science and computer science information systems. These differences in the ranking of subject categories, although minor, may point to the fact that the three concepts are different in some sense.

4.4 Network map of computer ethics, internet ethics and cyberethics

As a way of triangulation, the titles of the literature on computer ethics, internet ethics and cyberethics, downloaded from Google Scholar, were subjected to a content analysis and thereafter subjected to social network analysis to determine the relationship between the three concepts. The network maps in Figures 7 and 8(a)-(b) provide a synopsis of the most common terms appearing in the literature. The most common single words are provided in Table VI. Table VI reveals that, as was the case with the analysis of subject categories and research areas, there are differences and similarities in the representation of computer ethics, internet ethics and cyberethics in the literature's titles. The similarities are reflected in the common occurrence of words such as ethics, internet, students, information, teaching, education, study and university in the top-ranking list of words. The similarity reflects a common theme in the literature on the three concepts, namely, the teaching or study (education) of computer ethics, internet ethics or cyberethics (or information ethics) at the university level. Differences among the most common words in the titles for computer ethics, internet ethics and cyberethics were also discerned. Although some of the single-title words reflected in Table VI are not self-explanatory, they can nevertheless be used to inform curriculum development in computer ethics, internet ethics and cyberethics.

With the minimum number of occurrences of terms set at four, of the 1,505 title words/terms, 131 met the threshold requirement. For each of the 131 terms, a relevance score was calculated and, based on this score, 78 of the most relevant terms were selected for network mapping. Some of the 78 items were not connected to each other and therefore we chose to show only the connected items, consisting of 70 items.

The presentation of the title words through visual maps, as illustrated in Figure 7, revealed 12 clusters, some of which consisted of as few as three words. The words that belong to the same cluster are represented in the illustration using the same colour. The following are some of the clusters and their respective title words. The list of words has been edited to remove the meaningless single words: first – computer ethics course,

Computer ethics			Internet ethics			Cyberethics/Cyber ethics		
WoS subject categories	No.	%	WoS subject categories	No.	%	WoS subject categories	No.	%
Ethics	21	21.875	Ethics	18	29.032	Information science library science	9	56.25
Information science library science	20	20.833	Business	13	20.968	Computer science information systems	5	31.25
Computer science software engineering	18	18.75	Information science library science	9	14.516	Communication	2	12.5
Computer science theory methods	18	18.75	Computer science information systems	5	8.065	Engineering multidisciplinary	2	12.5
Computer science information systems	13	13.542	Law	5	8.065	Ethics	2	12.5
Philosophy	13	13.542	Computer science hardware architecture	4	6.452	Computer science cybernetics	1	6.25
Computer science hardware architecture	11	11.458	Medicine general internal	4	6.452	History philosophy of science	1	6.25
Engineering multidisciplinary	8	8.333	Multidisciplinary sciences	4	6.452	Law	1	6.25
Multidisciplinary sciences	8	8.333	Psychiatry	3	4.839	Multidisciplinary sciences	1	6.25
History philosophy of science	7	7.292	Psychology multidisciplinary	3	4.839	Nursing	1	6.25
Business	6	6.25	Social issues	3	4.839	Philosophy	1	6.25
Computer science interdisciplinary applications	5	5.208	Social sciences biomedical	3	4.839	Psychology applied	1	6.25
Education educational research	5	5.208	Social sciences interdisciplinary	3	4.839	Psychology multidisciplinary	1	6.25
Education scientific disciplines	5	5.208	Sociology	3	4.839	Social issues	1	6.25
Computer science artificial intelligence	3	3.125	Computer science interdisciplinary applications	2	3.226			
Engineering electrical electronic	3	3.125	Education educational research	2	3.226			
Social issues	3	3.125	Health policy services	2	3.226			
Health-care sciences services	2	2.083	History philosophy of science	2	3.226			
Management	2	2.083	Medical ethics	2	3.226			
Medical ethics	2	2.083	Philosophy	2	3.226			
Psychology multidisciplinary	2	2.083	Communication	1	1.613			
Social sciences interdisciplinary	2	2.083	Computer science artificial intelligence	1	1.613			
Agriculture multidisciplinary	1	1.042	Computer science software engineering	1	1.613			
Communication	1	1.042	Computer science theory methods	1	1.613			
Computer science cybernetics	1	1.042	Cultural studies	1	1.613			

Table V.
Subject categories in the literature on computer ethics, internet ethics and cyberethics

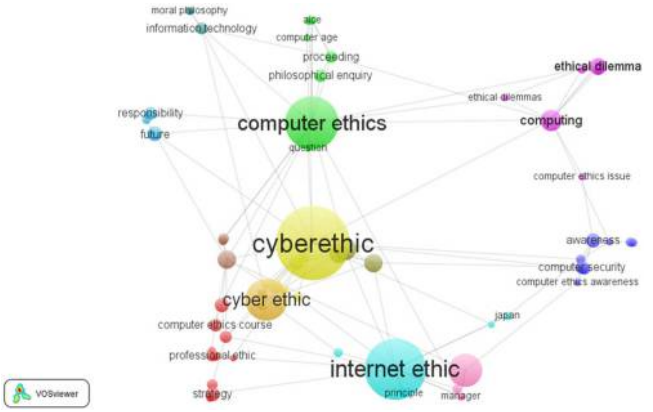


Figure 7.
A map of the literature on computer ethics, internet ethics and cyberethics

No.	Computer ethics Title word	*F*	Internet ethics Title word	*F*	Cyberethics Title word	*F*
1.	Computer	784	Ethics	145	Cyberethics	121
2.	Ethics	757	Internet	145	Ethics	61
3.	Teaching	75	Research	12	Cyber	50
4.	Information	63	Issues	8	Googling	20
5.	Science	58	Teaching	8	Character	13
6.	Students	36	Education	7	Cyberspace	13
7.	Ethical	34	Ethical	7	Information	13
8.	Curriculum	32	Students	7	Internet	12
9.	Study	28	Study	7	Cyberethics	11
10.	Education	26	Business	6	Teaching	11
11.	Issues	26	Age	5	Age-school-oriented	10
12.	Computing	25	Case	5	Education	10
13.	Security	25	Japan	5	Morality	10
14.	Course	24	Law	5	Students	9
15.	Technology	22	Online	5	Study	8
16.	Conference	21	University	5	Computer	7
17.	Professional	21	College	4	Law	7
18.	Philosophical	20	Computer	4	Social	7
19.	Integrating	19	Construction	4	Moral	6
20.	Moral	18	Information	4	Network	6
21.	Social	17	Children	3	Readings	6
22.	University	17	Constructing	3	School	6
23.	Dilemmas	16	Consumers	3	Security	6
24.	Internet	16	Crisis	3	Technology	6
25.	Teach	16	Electronic	3	Case	5
26.	Using	16	Field	3	Cybersafety	5
27.	Approach	15	International	3	Cybersecurity	5
28.	Awareness	15	Medical	3	Issues	5
29.	Case	15	Perceptions	3	Theory	5
30.	Tales	15	Relationship	3	Challenges	4

Table VI.
Most common single words in the literature on computer ethics, internet ethics and cyberethics

computer ethics education, conceptual framework, professional ethic, teaching; second – AICE, computer age, computer ethics, computer ethics conference, philosophical enquiry; third – awareness, computer ethics awareness, computer security, influence, information security, information system, social responsibility; fourth – character education, classroom, cyberethic, cyberethics, cybersafety, googling age school; fifth – computer ethics cautionary tale, computer ethics issue, computing, ethical dilemma, ethical dilemmas; and sixth – cyberspace, law, morality, new frontier.

Despite the above grouping of title words into different clusters, thereby reflecting distinct differences among the three concepts under investigation in this study, Figure 7 reveals that computer ethics, internet ethics and cyberethics are interrelated in a way. This is partly reflected by the lines that link the nodes, which represent the concepts. Another revelation in Figure 7 that is worth mentioning is the size of the font and circle, which reflect the weight of the title words. According to Van Eck and Waltman (2013), "the font size of the item's label and the size of the item's circle depend on the weight of the item". As regards the weight of an item (i.e. of the title words in the current study), this can be determined as follows:

> The weight of an item is determined by the weight or normalized weight column in a map file. When a new map is created without providing a map file with a weight or normalized weight column, the weight of an item is set equal to the total strength of all links of the item. When an existing map is opened without providing a map file with a weight or normalized weight column, all items in the map are given the same weight (Van Eck and Waltman, 2013, p. 5).

In view of the above explanation, cyberethics posted a relatively higher normalised and relevance value than computer ethics and internet ethics. This may be attributed to the fact that the term "cyberethics" appeared as a compact single term in all the titles that contained the term, as opposed to the other two concepts which contained two terms each. For instance, there may have been a distance between the two words that form computer ethics (i.e. computer + ethics) in some of the titles in which they appeared, meaning that the two words may not have appeared as a phrase but as single words in some of the titles. It was also noted that the concept of cyberethics is variously expressed in the literature. In some instances, the concept is expressed using one single word, while, in other circumstances, it is expressed using two terms, namely, "cyber" and "ethics"; hence the two clusters of the concept in Figure 7. This knowledge is important, especially when one is dealing with not only knowledge organisation but also information searching and retrieval.

5. Conclusions and recommendations

Based on this study's findings, it can be concluded that the scope and breadth of the three concepts were not clearly discernible through the use of informetrics techniques. This may partly be attributed to, on the one hand, the fact that cybermetrics is a relatively recent concept and therefore the literature that addresses the concept is still in its early stages of growth. On the other hand, there seems to be confusion among scholars as to what exactly constitutes computer ethics, internet ethics and cyberethics. The confusion that reigns among scholars is also reflected in the absence of the three concepts as indexing terms in some of the major thesauri, including the EBSCOHost thesaurus. While conducting preliminary work on the terms that can be used to search and retrieve documents on the three concepts, we noted that the term "computer ethics" is not among the indexing subject terms in the EBSCOHost thesaurus. Instead, such terms as computer crimes, computer fraud, computer hackers and computers – law and legislation are the closest indexing terms that computer ethics can be associated with. The same applies to internet ethics,

which, instead, can be explained through such indexing terms as internet – law and legislation, internet censorship, internet fraud, internet piracy and internet publishing – law and legislation. As far as cyberethics is concerned, such indexing terms as cyberterrorism were the closest that we encountered in the EBSCOHost thesaurus.

Although the search volume of computer ethics and internet ethics yielded a very high correlation coefficient, as well as demonstrating a significant relationship, it was observed that the search volume for the two concepts was on the decline while that of cyberethics was on the rise.

The current status, in terms of the distinction between the three concepts, seems to suggest that there are overlaps among all the concepts. Figure 5 and 6 show that, although the four concepts are not entirely different, there are some aspects of each of the concepts that may not necessarily belong to the other concepts. In fact, the illustrations in Figure 5 and 6 shows that there are more common terms that describe the three concepts than there are differences. We believe that, as cyberethics develops into a distinct concept, the distinction among the concepts under investigation in this study will become clearer. The likely future overlaps among the three concepts are provided in Figure 8(a)-(b). We predict that cyberethics will develop to cover

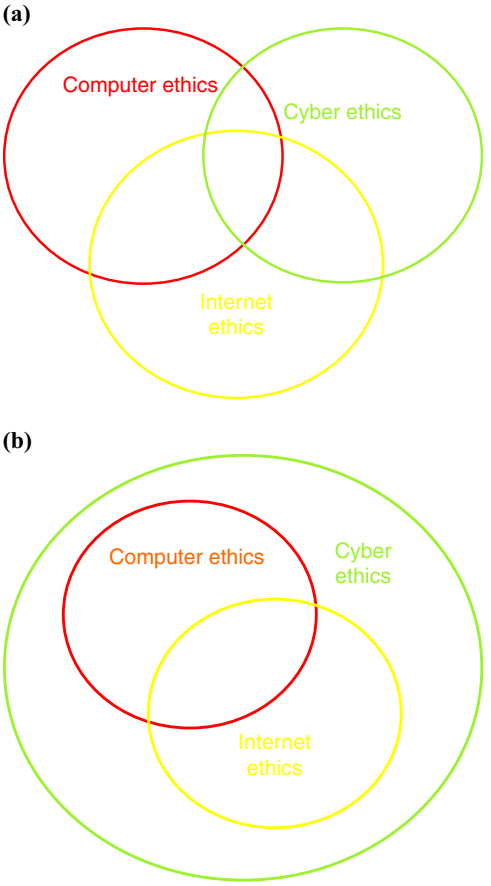


Figure 8.
(a) Current overlaps among the three concepts; (b) future overlaps among the three concepts

all aspects related to computer ethics and internet ethics. Cyberethics has shown signs of growth and has received more attention from searchers, unlike computer ethics and internet ethics, which registered a decline in the search volume as illustrated in Figures 2-4.

Nevertheless, we hasten to recommend a longitudinal study that will monitor not only the growth of literature on the three concepts, but also of the literature on information ethics. Perhaps a longer period of study will yield more accurate results in order to test the aforementioned predictions. A study to investigate the perceptions of experts in the area of computer ethics, cyberethics, internet ethics and information ethics could also be conducted using such research methods as Delphi to ascertain the relationships between the concepts.

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