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Current Science and Applied Ethics, Theories and Practice: Mapping the Field

Modern scientific knowledge is generated in a complex system that exhibits self-organizing properties. The produce of scientific knowledge is distributed in a process involving producers and consumers, as implemented, for example, in the nonlinear patterns of innovation. The paradigm of the „new production of knowledge" or the structures of the so-called Triple Helix involving the academic, the industrial and the governmental sphere shows the actors of generating knowledge heavily interdependent.

To deal with the issues of ethics and responsibility raised in this context, several specialised fields of professional or applied ethics have emerged. In this paper, I present a brief overview of the main dimensions along which the concept of science ethics can be evaluated, followed by a preliminary study on the disciplinary pattern that can be assigned to science-related professional ethics. The aim of this attempt is twofold: first, to characterize the nature of science ethics by identifying the most frequent framings of (meta-level) discussion on this topic; second, to take steps towards an empirical mapping of the organization of the fields in question.

1. Dimensions of the discourse on science and technology ethics

A general frame of reference: micro vs. macroethics

Maybe the most general frame of reference for the assessment of science ethics it that of the distinction between micro- and macroethics. As Allenby (2005) claims, „it seems necessary to reject the common approach of projecting individual ethical responsibility to the scale of these systems [of knowledge production]." The argument for this statement is an immediate continuation of the introductory propositions above: individual scientists and engineers, according to Allenby, cannot be made responsible for the behaviour of self-organizing, unpredictible systems, such as the phenomena of modern science, even if they contribute to their behaviour. The solution to handle or to control system responses lies in setting up the stage for two levels of description in applied ethics. The level of individual responsibility, then, is assigned to Microethics, while ethics at the group, or professional level is covered by Macroethics (ibid.)

Herkert (2001) formulates a more accurate distinction. Aside from the slightly different conceptualization of the framework (where the main categories are the individual, the social and the professional levels, each divided into their respective macro and micro dimensions), the distribution of well-known ethics-related issues of engineering practice and scientific research between these levels of description enlightens the intended conceptual system (Table 1).

Table 1.

	Engineering Practice	Scientific Research
Microethics	Health and safety, bribes and gifts	Integrity, Fair credit
Macroethics	Sustainable development, product liability	Human cloning, nanoscience

Herkert's concern, as reflected in this framework, can now be identified as the main issue raised by this perspective on science ethics: it is the problem of the gap between micro- and macroethics, i.e. the problem of whether individual responsibilities of professionals, or ethical questions regarding the internal affairs of scientific professions can be linked to macroethics. While they are different conceptually, clear causal connections exist between the two (e.g. the ethical questions of scientific fraud, a microethical issue, and the possible societal risks of such research activity, as a macroethical one). The goal, therefore, is an integrated approach towards a unified framework for applied micro- and macroethics.

A kind of ethics and a role for the empirical: paradigms for science ethics

The situation described above is primarily reflected in the debates on the scope as well as on the legacy of various codes of scientific conduct. Whether the scientific community and the science-consumer sector are to be concerned with different codes that jointly ensure the minimum societal risk of S&T; whether the the different academic fields require field-specific codes with equal weighting or whether there is room for a universal code of conduct is a matter of debate.

A distinguished issue concerning codes is the basis for the content thereof. One fundamental dichotomy is the normative vs. the empirical, which, in this case, roughly matches the other between the pure conceptual vs. the empirical. Ethical codes are a set of rules often said to be derived from partly normative arguments, discussions of theoretical concepts, analyses of particular cases. The appropriateness of such a treatment of science is often questioned, claimed to be in need of systematic empirical support. Responding to this (controversial) weakness is the movement called „the empirical turn in science ethics”, which, as the agenda of a recent conference states, uses the method of social scientists (Between Facts and Norms. Empirical Methods in Bioethics, 2003. March 7, Leuven).

The dimension of discourse at stake here is the problem of the nature of science and technology ethics with regard to its methodological character. Is it ethics as a discipline that is at play here or another special field-based expertise that has nothing to do with axiomatic, context-independent rules? Trends like „empirical bioethics" and its criticism are indicative of this paradigm of ethics applied to science (MUSSCHENGA 2005).

The other side of this coin is the structure of science ethics as a profession. This question constitutes the next dimension of our field under investigation.

A kind of ethicist: science ethics as a profession

The general problem of the disciplinary structure of ethics for science often comes in the form of polemies about the required competencies for doing science ethics. From metaethical frameworks through applied ethics to the domain-specific, practical knowledge of the scientist (down to, e.g., medical practices), a wide range of candidates (and their combinations) are defended as the true basis for science ethics. Translated into competencies, at least three main (not independent, best viewed as complementary) tendencies can be identified: (1) ethical expertise is gained in addition to the scientific one, mainly in a postgraduate scheme. This scientist-ethician approach emphasises the role of education of ethics; (2) science ethics is an inter-, or, at least, multidisciplinary cooperation between ethicians (philosophers) and field experts and (3) science ethics is to be implemented through research-specific empirical studies that explore, uncover and predict the potential risks and side effects of the particular activities (technology assessment, risk management etc.). A way of fulfilling the need for an empirical turn, as expressed in this latter approach, is multidisciplinary interaction again, but, in this case, between the social and the natural, i.e., empirical sciences.

A case study

The structure of science ethics, formulated in terms of the interrelated dimensions of methodology and profession, is well illuminated by a recent debate on bioethics that appeared in 2004 in the journal Studies in History and Philosophy of Biological & Biomedical Sciences. The polemy is centered around the proper role of bioethics in its primary applications, and is connected to a criticism of the field's nature and legacy.

The core of the debate is the questioning of 1) the nature of bioethics as a discipline or as a research field, additionally challenging the type of expertise in this field, 2) the usefulness of practising it, and 3) the kind of corruption associated with bioethics as a profession outside the academic sphere.

The first two issues are, to a high degree, interrelated, as the main questions the debaters have in mind is what kind of ethics bioethics is (if any), and how it is related to scientific activiy. These questions in turn imply the one of how bioethical expertise is distributed among scientists and philosophers.

The keywords conservatism and particularism help to highlight the main opposingpositions. According to the former, „bioethics fails as philosophy because it takes for granted some of the institutions or practices of particular cultures or times, such as hospital-based medicine or advanced biotechnologies, and fails to consider alternatives” (O'NEILL 2002, cited by LEWENS 2004, 121). Furthermore, „[A]t the limit, criticisms of conservatism shade into outright claims of incompetence. In its strongest form one hears (one does not see it written down) that what is wrong with bioethics is simply that most bioethicists have a limited grip on 'serious' philosophy” (LEWENS 2004, ibid.). On the other hand, champions of the latter position, particularists claim that „a lack of deep philosophical knowledge is no great hindrance in areas where bioethicists often work, for in these applied areas it is practical knowledge, and maybe a cultivated set of moral intuitions, that are of value in decision-making” (ibid.). That is to say, it is scientific expertise, predicting and managing risks that matters, i.e. particular, case-sensitive knowledge, without need for philosophically grounded general and normative rules, or deontic logic.

This latter position can be reformulated in terms of disciplinary structure. Criticising the lack of a proper philosophical basis is most compatible with the statement that bioethics is a branch of applied ethics supported by philosophers' work. Commitment to particularism is compatible with the broader standpoint that bioethics must be integrated into the process of research, being at best the output of interdisciplinary research conducted by experts in medicine, law, sociology, etc. On this account, bioethics is primarily an empirical analysis of the implications of a particular research on society, the individuals etc. In the latter case, pure empirical findings constitute the body of this knowledge, without any, or, at least, with minimal, normative components.

Finally, a somewhat independent issue is the case of corruption. If bioethics is proved to be autonomous as a field and useful in application, a serious question remains (among others not addressed in the cited debate): when this application is, as is usual, outside the academic boundaries, and appears in the layers of application (medicine, industry etc.), a subject matter of science ethics, namely, conflict of interest, may come to apply to bioethics itself. It tends to be a commonplace to emphasise that contemporary research does and should transgress the academic boundaries. Bioethics as a field can be a paradigm example, since its primary locus is not the university department, but the scenes of its application in advising medical, biotechnological and other industrial activities. The question is whether the consuption of bioethics biases the area, and whether it is ethical to get finance or to receive payment from patients for advice on decision-making concerning ethical issues. As Lewens poses the question, „[I]f it is, is that because the bioethicist is more likely to encounter an intolerable conflict of interest, or is it instead because of something else about ethics that makes it an inappropriate discipline for charging consulting fees?”

Disciplinary landscape and field-specificity

A universal ethical approach or code to, at least, the natural sciences and technology, is problematic primarily due to the developments of S&T itself. Contemporary issues of science, ethics and responsibility seem to organise into seemengly established research fields. The rapid changes and new trends in the disciplinary-technological landscape have been followed by the professionalisation of science-related ethics into several interrelated specialised fields such as bioethics, environmental ethics, information and computer ethics, or the specific issues of nanoscience and -technology, etc. It can be expected that these fashionable concepts refer to more or less autonomous specialised fields with interrelated, still distinctive, problems/characteristics. On the other hand, the question often arises whether the issues raised by particular new fields of research are uniqe with respect to that field, nanoscience and nanotechnology (NST) being an example.

Emerging technologies: emerging ethics?

The case of NST best indicates further complications. NST, the subject of which is fundamentally a level of material organizaton, actually and potentially overlaps with a multitude of disciplines and technologies. Biotechnology and nanotechnology are, in particular cases (as is protein engineering research), just two different systems of reference. Special issues of environmental ethics (e.g. the production of new qualities of matter) or information ethics (e.g. the emerging possibilities of new kinds and sizes of databases) are reducible to ethical implications of nanotechnology. The non-uniform distribution of ethical fields among the new technologies is further illustrated by the case of biotechnology, which is equally addressed by environmental ethics (e.g. GMOs), and the various kinds of bioethics usually undrestood as covering human applications.

Table 2.

Specialised field of Ethics / Emerging technologies	Bioethics (research ethics)	Information and computer ethics	Environmental etchics
Biotechnology	Human applications, …	Biological (genomical etc.) databases, …	GMOs, …
ICT		Data security, societal implications, …	
Nanotechnology	Biotechnological applications of nanotechnology, …	ICT-applications of nanotech, …	New qualities of matter, …

What underlies this mapping of ethics to disciplines is the recurring urge to enable scientific production to be in accord with the precautionary principle, or, as is often stated, to enable science-related ethical knowledge to keep up with science. The question, however, concerning the best disciplinary approach, still remains open.

2. A brief study: disciplinary organization in science and technology ethics

In order to get an empirically informed view concerning the organization of scientific ethics as a cluster of specialised fields, the qualitative methods of scientometrics might be utilized. Some intitial steps in this line of analysis can reveal the disciplinary patterns that emerge in the development of ethical subfields to that extent, which enables us to state at least some hypotheses on this issue. In particular, one might be able to form some preliminary answers to the question of whether the professionalization of ethics related to science can be confirmed empirically. Further insights could be gained on the relationship between the subfields of scientific ethics as well as on the weight of the various specialized fields within the whole system of scientific ethical inquiry.

Method: citation analysis

The initial steps referred to above consist of the application of citation analysis. This bibiliometric method is a now-canonical tool in the toolkit of scientometrics, designed to assess the organization and dynamics of the scientific landscape. Usually traced back to the seminal paper of De La Solla Price, a systematic analysis of citation links between publications, authors (or scientific journals on the aggregate level) is considered to show the social and, indirectly, the cognitive structure of the selected fields. Most common is the method of co-citation analysis, where certain similarity measures between publications are invented based on how often they are co-cited in a set of publications. The similarity measure then can be used iteratively to generate a hierarchical clustering of those publications, the resulting hierarchy of clusters being a reflection on the thematic structure of the field at various levels of generality.

Co-citation analysis, however, is not the sole method to retrieve information from citation data. To get an overall view on the tentative field of science ethics, we attemt to use a heuristic called mutual citation analysis, that is, to draw conclusions on a matrix of mutual citations between publications (or, in our case, journals) representing the field. The result is meant to further reflect the potential establisment of subfields within science ethics.

Finally, the most straightforward way to utilize citation information is the extraction of citation patterns with respect to ethical journals. For the present purposes, the citation pattern w.r.t. a particular journal J translates into a frequency distribution of academic journals citing J for a selected timespan. A comparative analysis of citation patterns may refer to the relative position of a journal in a set of similar journals (of professional ethics), as well as contribute to the delineation of the field in terms of publication activity.

To sum up, the preliminary study below will include the following three types of analyses (or at least some initial steps of them sufficient for setting up some hypotheses) of a selected set of journals on professional ethics:

· Citation pattern of journals on professsional ethics (mapping the academic field of professional ethics, delineating science ethics in terms of academic journals, etc.).
· Co-citation analysis of journals on professional ethics, so as to reveal the intellectual structure of the field. In fact, in this line only the initial steps are taken (see below).
· Mutual citation analysis of journals on professional ethics, in an attempt to enlighten some patterns the network of ethical sub-fields exhibits.

The Sample and Analyses

For the analysis a set of journals linked explicitly to professional ethics was extracted from the database ISI Web of Science©. The result set consisted of all titles in the database containing ethics (or bioethics). As a refinement of this collection, the titles apparently not closely related to the ethics of knowledge production (as journals on religion and ethics or philosophy) have been singled out from the sample. Parallel to this, the collection was also complemented with the Journal of Medicine and Philosophy from a result set containing entries with the word philosophy, as it is apparently relevant to the field under analysis. The final list of journals can be seen in Figure 1.

In the next step, the citation pattern for each journal was retrieved from the database. As a result, the citing journals, and the distribution of citations among the citing journals were depicted for a selected timespan, namely the year 2005 (which means that for each journal J in the sample the set of journals citing J in 2005 has been idenitified). From the same dataset two citation matrices were created: a co-citation matrix and a mutual citation matrix, both for the salient ethical literature only, i.e. for the selected ethical journals.

Results

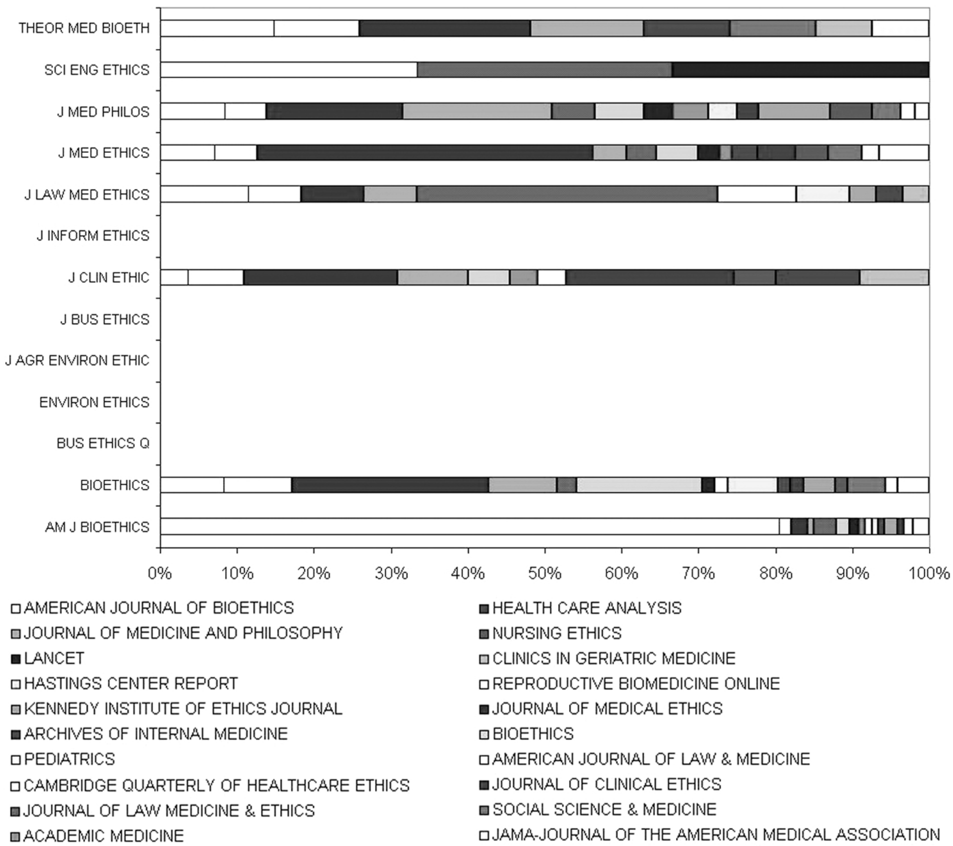
1. Citation patterns

Figure 1. presents the individual citation patterns for the selected journals. The collection of citing journals is restricted to those appearing in more than one citation pattern, for – beyond constraints on visibility – these intersections point towards sources that are more characteristic of the field.

The most apparent feature of the distributions is that bioethics-related topics have the highest frequency both among the cited and the citing items. In the colletion of cited items (the sample set) medical and clinical ethics amounts to 5, general bioethics to 3, environmental ethics to 2, business ethics to 2 of 13 journals. The remaining single series, Science and Engineering Ethics is supposed to be general in scope.

The share of bio- and medical ethics is also outstanding among the common citing sources. Only two of twenty items are not explicitly linked to either bio- or medical ethics (Lancet and Kennedy Institute of Ethics Journal). Neither the journals representing information ethics, nor those standing for environmental ethics appear in the common set, which is indicative of the subsequent findings regarding the relationship and distinctness of the ethical subfields. As for the individual sample items, there is a striking match between the citation patterns of the journals on bio- and medical ethics in qualitative terms, the set of citing journals constituting a strong „family resemblance” category. More variable is the frequency distribution for the citing journals. A salient feature is, for example, the high ratio of self-citations in some elements of the sample set, the American Journal of Bioethics (AJOB) being at the head of this list. Among other things (e.g. sociological factors of science), some self-dependence, or autonomy of the subfield represented by the journal (if there is one) could be hypothesized from this sign (whatever its relation to other subfields might be): in our case, beyond general bioethics, medical ethics (J MED ETHICS), the intersection of law and medical ethics (J LAW MED ETHICS) seems to be such an autonomous (sub)field.

Figure 1. *Comparative analysis of citation patterns*



The sole exception in out graph, again, is Science and Engineering Ethics. Given the suggestion the title carries, viz. a journal covering all topics of science ethics, it is worth focusing on this item as to the relative position it can be assigned to in the ethical landscape under study.

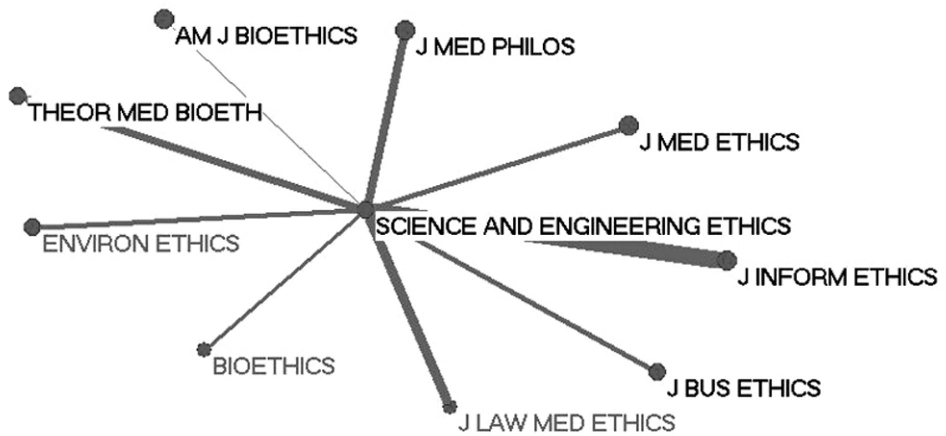
2. Co-citation analysis

Science and Engineering Ethics (SCI EN ETHICS) is somewhat similar to AJOB with respect to the shape of the citation pattern: the ratio of self-citations is much higher than it is in any other sources. The question then arises, which subfields of science ethics this journal is associated with. The underlying idea is the assumption that the links between the associated journals and a „core journal", a comprehensive platform supposedly covering the various issues of science ethics indicate the current weight of the ingredients of the latter field, and somehow mirror its thematic structure.

To this end, a co-citation analysis has been carried out for SCI EN ETHICS, which was „selective" in at least two respects: (1) only those occurences were counted where SCI EN ETHICS was one of the components of the co-cited pair, and (2) only the ethical journals were taken into account as the co-cited sources. The similarity index between the core journal i and the co-cited journal j has been identified with the number of co-occurences (in the year 2005) being normalized with the amount of references to both i and j in order to filter out the effect of their respective „popularity". The results are shown in Figure 2 (where the width of the edges is tantamount to the similarity value, or the tightness of the relatioship between the items).

Figure 2. *Selective Co-citation pattern for SCI ENG ETHICS Similarity measure:*

$$S_{ij}=\frac{c_{ij}}{c_i c_j}$$



The figure shows a somewhat more balanced landscape than the joint citation patterns above. Surprisingly, the tightest is the core journal's relationship with information ethics, and the loosest is its relation with the journal AJOB. This is partly because the relative citation weight (i.e. the share from the total number of citations) is with an order of magnitude higher in the case of AJOB – it is much more frequently cited than J INFORM ETHICS; in fact, the latter is cited only a few times, and, in these cases, always with SCI ENG ETHICS. The remaining subfields – in particular, environmental ethics, medical ethics and business ethics – are quite equally well associated with the core journal. It seems, however, that more inter- or multidisciplinary subfields – represented by J MED PHILOS, and J LAW MED ETHICS have a higher correlation with with SCI ENG ETHICS.

3. Mutual citation analysis

The final part of our preliminary analysis is the mutual citation analysis, i.e. the mapping of the actual network of the ethical journals in terms of their references to each other during the year 2005. The visualization of the mutual citation matrix resulted in Figures 3. and 4. In Figure 4. it is the structure of the network that is highlighted, while in Figure 3. the emphasis is on the mutual citation frequencies (taking into account both directions, the relation being an asymmetric one).

Figure 3. *Citation network of ethical journals indicating frequencies for 2005*

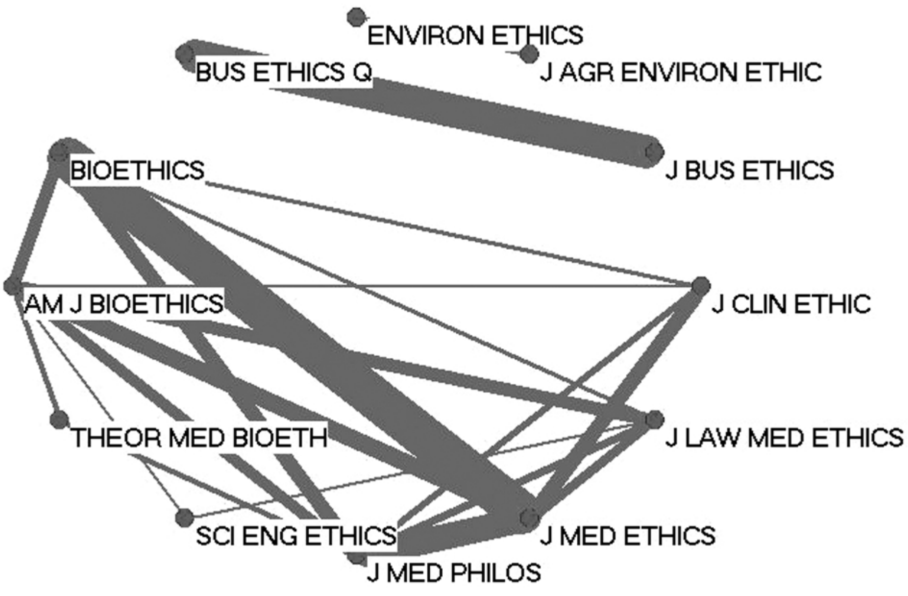
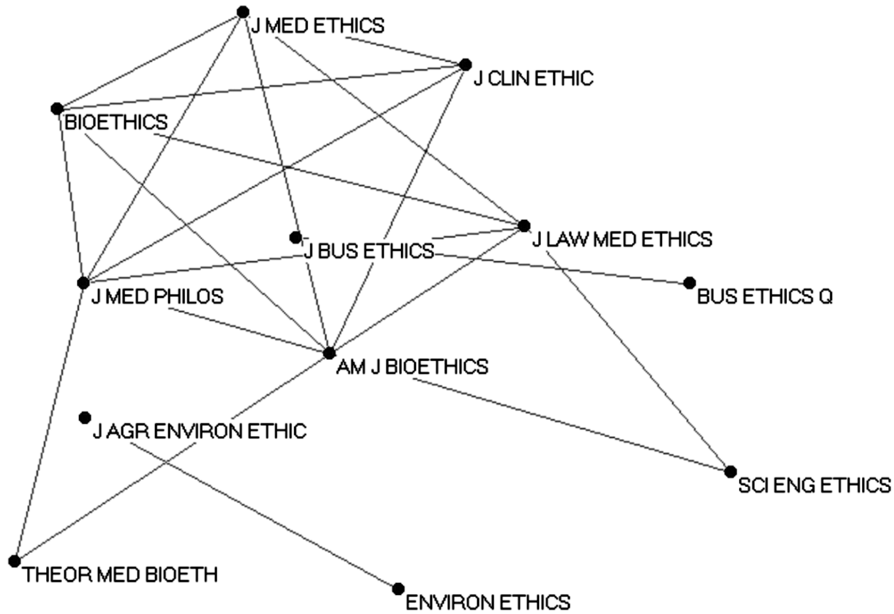


Figure 4. *Citation network of ethical journals indicating structure for 2005*



The pattern gained in this way seems to be rather unambigous: one can distinguish three isolated parts (islands) in the network: (1) one containing all the bioethical and medical ethical journals either being application-oriented or more theoretical, (2) the other containing journals of environmental ethics, and (3) the third comprising the two journals on business ethics. These three sets can therefore be viewed (at least based on this preliminary analysis) as segregated communities of scientific communication or „socio-disciplines". The degree of cohesion for these subfields can be approximated by the frequencies of mutual citation indicated by the width of the edges between nodes. In this light, business ethics, and a certain subnetwork of the bioethics cluster is the most cohesive of all. As for the latter, the structure of this subnetwork as depicted in Figure 4. reveals some further characteristics, namely, that an almost maximal set of the bio- and medical ethical sample items constitute a „maximally connected" part of the network: in this set, each is immediately related to all the others. The exceptions are SCI ENG ETHICS (as usual) and THEOR MED BIOETHICS, attached to this set through two nodes, respectively.

Some preliminary indications

Although the approach stressed so far is clearly not enough to draw far-reaching conclusions, an empirically informed preliminary map on the field of science ethics unfolds from these investigations, pointing towards a certain set of plausible features of it. Based upon the above results we might claim that professionalisation in science ethics is a real phenomenon. On the most general (but already informative) level, the field seems to be organised by two, differently structured and unified poles. Citation patterns and the network-structure both confirm the existence of a cohesive pole of bio- and medical ethics, with multiple layers. Co-citation analysis reinforces a kind of (rather) general science, with technology ethics showing a sturcture that differs markedly from that of the bioethics cluster: it seems to be more distributed within ethical issues in relation with technology and knowledge production. In fact, in the sense described above, we may speak of bio-/medical ethics and ethics of science and technology. It is worth noting in addition that although the commercialization of science and its consequences, or, more generally, the interactions between academia and the industrial sphere is a typical issue of science ethics, business ethics and „science ethics” (i.e., the rest) appear to be distinct, according to the network of formal communication between ethical journals.

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