

The Matrix Method of Literature Review

Rembrandt Klopper

Sam Lubbe

Hemduth Rugbeer

Abstract

In this contribution we document the concept matrix method of literature review that could be used as conceptual scaffolding at the beginning of a problem-based research project when the researcher's knowledge about the subject is finite and her/ his ignorance about it is more or less infinite. The concept matrix provides a means to systematise the process of literature review, thereby ensuring that a literature review does not become a subjective process stitching a patchwork quilt of references, or the unilateral cherry picking of references that supports one's point of view, while ignoring references that present contrary points of view.

Key Concepts

Concept, concept matrix, epistemology, knowledge, literature review, matrix analysis, problem-based research

Introductory Remarks

Matrix analysis of one sort or another has for the past century been used in a variety of disciplines to summarise complex aspects of knowledge

generation and to provide an eagle's eye perspective of them. Examples are formal probability theory (Popper 1959), linguistics (Chomsky & Halle, 1968; Quirk *et al.*, 1974; Chen & Wang, 1975, Lass, 1984), psychology (Fox *et al.*, 2001) and in communication science (Rugbeer (Y), 2004, Reddy 2004). The focus of this article, *the matrix method of literature review*, was popularised as a research tool in the health sciences by Garrard 1999, later reprinted as Garrard 2004. We have adapted Garrard's method somewhat to extent it to other disciplines and to make it more flexible from an epistemological point of view.

The matrix method of literary review protects the reviewer against ignorant assumptions about the research theme at a stage that s/he is the most vulnerable due to lack of knowledge about the topic under investigation. This of course relates to the conceptual domain of knowledge known as epistemology.

From an epistemological vantage point it is self evident that research mostly begins at a stage of total ignorance about the topic under investigation, progressing to a realisation of the extent of one's ignorance, to a stage of limited knowledge about it, and if one persists, to a stage of expert knowledge of the topic. All problem-based research therefore begins with ignorance, because conducting research about known subjects would be like reinventing the wheel. We propose the following four-phase knowledge competency continuum:

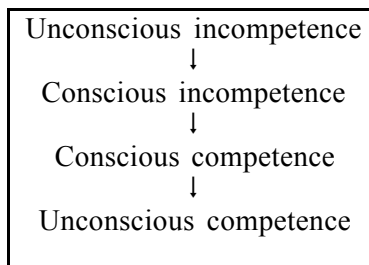


Figure 1: *Levels of competency when completing a conceptual task*

- *Unconscious incompetence*: being unaware of something, its relationship to other things, and how it can be used in conjunction with other things.

- *Conscious incompetence*: becoming aware that one does not know what can be known.
- *Conscious competence*: beginning to surmise, envisage and hypothesise the nature of something, its relationship to other things, how it can be used, but not yet being able to use it as intended.
- *Unconscious competence*: achieving an expert level of knowledge of something and its relationship to other things, how it can be used, and having achieved such a level of command of using it, that one can conceptualise it as forming part of newly understood events, and being able to utilise it without consciously focussing one's attention on it, so that one can focus one's attention on the general interrelationship and interaction potentials between that thing and other things.

The matrix method of literature review is a powerful and practical research tool that forms the initial scaffolding to help researchers sharpen the focus of their research and to enable them to rapidly progress from the initial state of conscious incompetence to the stage of conscious competence as outlined above.

Forms of Matrix Analysis

Taking *Encyclopaedia Britannica* (2004) as point of departure the prototypical matrix can be characterised as a kind of a conceptual framework in table or grid format, consisting of a rectangular array of symbols that are arranged in rows and columns to form a symbolic set which, when used together as a set, enables a researcher to make conclusions about non-obvious relationships that exist between entries on the table. Where a row and column intersect in a matrix, one has a cell that contains a particular datum that contributes to the overall interpretive potential of the matrix. Matrices contain verbal information, quotes, summarised text, extracts from notes, memos, standardised responses and, in general, data integrated around a point or research theme that makes sense. In the main, matrices contain information about and explain aspects of research, and allow the researcher to get a quick overview of data related to a certain point. In this very sense they serve a similar purpose to that of tables employed in quantitative research (Sarantakos 1998:359). Because matrices are

powerful interpretive tools, they are currently being used in a wide variety of disciplines such as physics, engineering, economics, statistics, mathematics, logic, cryptography, linguistics, communication science, health science and information science.

Matrix Analysis in Physics

The term ‘matrix’ entered scientific discourse early the 20th century when Werner Heisenberg formulated his theory of Matrix Mechanics, which postulated infinite matrices to represent the position and momentum of an electron inside an atom. According to this theory one would only be able to probabilistically calculate either the position or velocity of an electron in orbit around the atomic nucleus because at any given instant it could occupy any position on the matrix. This meant that it was impossible to mathematically calculate the precise location of an electron on its set wavelength orbit around the atomic nucleus. This insight was formalised in 1927 as the uncertainty principle, which stated that it is impossible to simultaneously specify the precise position and the momentum of any sub-atomic particle in its orbit around an atomic nucleus because the orbit exists as an array consisting of an infinite number of rows, each row consisting of an infinite number of quantities. Popper (1980 [1959]: 326-348) demonstrates how matrix analysis has been used since early in the 20th century in formal probability theory.

Matrix Analysis in Linguistics

Chomsky and Halle (1968) and Lass (1984) extensively use matrix analysis to demonstrate that arrays of phonemes can be ordered and analysed in terms of shared and differing articulatory features. Quirk *et al.* (1974: 447) use semantic matrices to analyse shared semantic features in English maximisers like ‘fully, thoroughly, totally’ and ‘absolutely,’ and on pp. 982-1004 use matrix analysis to analyse the distribution of semantically negative English prefixes and suffixes. Chen and Wang (1975) use matrices to demonstrate how phonological changes have diffused throughout the lexicons of different Chinese dialects over the course of several millennia.

Matrix Analysis in Communication Science

Under the entry ‘cryptography’ Encyclopaedia Britannica (2004) shows how matrices are used during the encoding and decoding of ciphers for the purpose of covert communications. Rugbeer (2004) uses concept matrix analysis to determine which semantic features English deception words share, and why clusters of particular words are used during particular forms of deception. Govender (2004) uses concept matrix analysis during the analysis of the subjective perceptions of arbitration officials regarding the root causes of conflict between aggrieved educators in KwaZulu-Natal, South Africa, and their employer, the KwaZulu-Natal Department of Education, as well as to analyse the subjective recommendations of the arbitration officials to improve arbitration procedures.

Matrix Literature Review in Health Science

Garrard (1999 [2004]) presents a coherent and easy to follow methodology for medical professionals to assist them to regularly and systematically review current medical scientific literature as part of medical best practice. Garrard’s review procedure is designed to help medical researchers, clinicians and health care professionals to identify relevant literature, to organise and critically evaluate it, and to synthesise and incorporate major new research findings and the results of clinical trials as the basis for medical research design, and to help them to make decisions about the most efficacious treatment and care of their patients.

After defining the basic principles of literature review, Garrard explains how an information management plan ought to be designed prior to actual research so that facts abstracted from sources can be properly organised and analysed. Garrard finally explains how the review matrix ought to be used to synthesise and thematically index the contents of various sources in relation to the problem under review.

Using the method popularised by Garrard (1999) in the health sciences, and acknowledging Garrard (1999) in their list of references, Pongjaturawit and Harrigan (2003: 189-194) use a six-page matrix to review literature on parent participation in the care of hospitalised children, under the concept matrix headings, *Author, Purpose, Design/sample, Measurement and Results/ country*. Similarly, Jintrawat and Harrigan (2003: 86) use a brief matrix to review literature regarding the beliefs of Thai mothers about the causes of acute respiratory illness

among their children, under the concept matrix headings *Author*, *Type of illness*, *Categories of beliefs of illness causation* and *Causes of illness*.

***Matrix Literature Review in Informatics*¹**

Alavi *et al.* (1989) provide a twenty-year status review of Management Information Systems (MIS) research, based on the systematic comparative analysis of 792 articles from seven core journals for specific IS themes. From these comparisons they developed a classification framework that subdivided articles into non-empirical and empirical ones, and that encompassed sub-sub-classifications for non-empirical and empirical articles. By way of example, their sub-classifications of empirical articles distinguished articles that focused on objects such as types of systems, products and installations, and articles that focussed on events and processes such as laboratory experiments, field experiments, field studies, case studies, surveys, etc. Alavi *et al.* (1989) show that in two-year periods stretching from 1968 to 1988 there was a steady rise in articles with an empirical as well as a non-empirical research focus, with slightly more non-empirical articles than empirical ones having been published in each two year period, with the exception of the last two year period, 1986 to 1988, when the trend was reversed.

Webster and Watson (2002: xiii) state that since the 1970s the study of Information Systems (IS) has progressed from developing classification systems, of which Alavi *et al.* (1989) is a good example, to the development of conceptual frameworks. Webster and Watson (2002) further note a paucity of literature review articles in IS, which they ascribe to the youth of the field and 'the complexity of assembling a review in an interdisciplinary field.' Webster and Watson (2002: xvii) show that literature reviews traditionally are either concept-centric or author-centric, and propose the use of a concept matrix in which the presence and absence of particular research themes are traced throughout groups of articles. In this approach the articles are listed below one another in the leftmost column of the matrix, with concepts A, B, C, D

¹ We are using *Informatics* as cover term for Information Systems & Technology (IS&T), Information Systems (IS), Management Information Systems (MIS), Information Communication Technology (ICT) and Computer Science (CS).

... being listed at the head of subsequent columns so that for each article the presence of a particular concept can be marked with a right tick (✓) in the appropriate cell of the matrix. The use of such a concept matrix enables the researcher to directly establish at a glance, which articles deal with a particular research theme, enabling the researcher to explicitly identify, classify and assess facts thematically, rather than infer them indirectly from memory of articles read in isolation of one another.

Three Cases of Problematic Literature Reviews that Could Have Benefited from Matrix Analysis

The cases presented below are examples of misappropriating literature that the authors experienced as supervisors. It is a small sample that demonstrates that students, if not advised properly, can lose track of what they need to do.

Case One

The student was a doctoral candidate and could not determine when to stop his literature review and ended with a literature review of 180 pages. When the supervisor requested that the student cut this down, the response was 'You tell me what to cut out.' The student belonged to the conscious incompetence branch of the competency quadrant. This student should never have been accepted for a doctoral study.

Case Two

The student was another doctoral candidate who argued that he was using grounded theory to inductively generate a new theoretical framework from collected data because he could not find enough literature to review on his topic. The supervisor agreed that the grounded theory approach could be appropriate if the research theme falls within an emerging field of knowledge generation. However, to the surprise of the supervisor he soon thereafter received a literature review of 100 pages of theory from the candidate. The supervisor then pointed out that the grounded theory approach would be inappropriate because the student had found more than enough theoretical literature to review. The student clearly was not aware of the appropriate conditions for using grounded theory, which

placed him in the unconscious incompetence stage of conceptual competency. The supervisor argued that the student should not use grounded theory and that he should reduce the theory to at least 45 pages.

Case Three

The business student started a proposal and was advised to use headings. He used some headings and when advised to list specific headings, argued that he would slot it into the introduction. The student's supervisor eventually could not make out head or tail of the unsystematic literature review that was presented.

Building a Concept Matrix to Organize and Constrain a Literature Review

How a matrix is to be constructed is a process that relates more to the personal creativity, proficiency and originality of the researcher than to rules and principles. Miles and Huberman 1994: 240-241 state that there are no *correct* matrices, only *functional* matrices. Researchers should keep in mind that they will have to modify earlier versions of literature survey matrices as their understanding of their research topic grows.

Figure 2 below provides a sample concept matrix:

Theme: Using Information Communication Technology to deliver e-Education

References	e-Learning	e-Run	Digital Divide	e-Healthcare	Online/Remote	Technology adoption	TM	Digital Inclusion/Exclusion	Multiplatform Community Centers	ICT for Development	E-Education	Smart phones	evaluation
Averweg (2005)						✓	✓						
Bayler et al. (2002)													
Boss (2002)					✓								
Bridges,Org (2005)			✓	✓									
Buthelzet et al. (2003)								✓					
Chasa (2003)			✓										
Chen et al. (2006 a/c)													✓
Cradler (2003)	✓	✓											
Demetriadis et al. (2003)					✓								
Dumas (2004)													✓
Easton et al. (2000)			✓										
Federal Comm. Commission Economist Intelligence Unit (2002)		✓		✓									
GCIS (2001)								✓					
Gusman (2003)			✓					✓					
Hall et al. (2004)													✓
Harris (2002)	✓												
Hargittai (2002)			✓										
Hoffman et al. (1996)			✓										
Hu et al. (2005)							✓						

Figure 2: Section of a concept matrix

As can be seen above, the layout of the concept matrix is straightforward. In the leftmost column the references to be reviewed are listed in abbreviated Harvard style. The head of each column displays concepts that have been derived from the problem statement of the research project. If a concept is discussed in a particular reference a tick is placed in the appropriate cell. This approach enables the researcher to conduct a critical comparative literature review of all references listed under each concept. This approach emancipates the reviewer from the tyranny of being trapped within a particular reference, and from merely providing general paraphrases of references. It also enables supervisors to establish at a glance that only relevant literature is being reviewed and captured in the bibliography because *references that do not appear on the concept matrix may not form part of the literature review and may therefore not be included in the bibliography.*

Discussion and Conclusion

The literature review involves a qualitative content analysis of available information already published in some form. It can be a study of the research object alone, with the aim of collecting information about its structure, process and relationships, increasing the familiarity of the researcher with the research object and establishing the credibility of the project. In addition, it can consider previous research, attempting to link it with the study currently planned. It may also be geared towards a historical or comparative analysis of the issue in question so the current study can be placed in a historical context. Finally, it may review a theory of methods and techniques most suitable for the study, simply by looking at the ways other researchers have approached the topic, and by evaluating their suitability and effectiveness (Sarantakos 1998: 129).

Punch (1994: 93) writes that without adequate training and supervision, the neophyte researcher can unwittingly become an unguarded projectile bringing turbulence to the field, fostering personal trauma (for researcher and researched), and even causing damage to the disciple.

There are many cases where students have attempted to conduct a literature review (see some previous section) but many failed and their studies therefore failed as well. O'Neill in Wellington *et al.* (2005: 89) states that conducting a literature review is a bit like climbing your way up a pyramid, where the total area at any particular point in the climb represents the search area for the review at that particular moment in time. You start in the largest area at the bottom and slowly move upwards, all the time refining and narrowing your searches, as you move from incompetence to competence.

Wellington *et al.* (2005: 87) state that reviewing the literature involves searching, collecting, prioritising, reading with a purpose and seeking out key issues and themes, and then presenting and discussing these critically. The aims of a literature review are:

- To establish which of the problems identified for solution by means of empirical research have been solved by other researchers so that they can be removed from the research equation
- To give readers a clear idea of the nature context of one's research

- To convince the reader of one's knowledge of the field
- To build a case for the empirical part of one's study

If one looks at the way novice researchers attempt to survey literature, it seems that the supervisor has failed to acquaint the student with the different phases for conducting a proper literature review. The first phase is where many students get stuck and remain – they cast about collecting data with no defined problem statement from which they extract keywords to serve as filter for the identification of relevant literature. They read each reference in detail rather than using abstracts and summaries to establish relevance, and they start summarising the literature with no plan in mind, and end up with a document without a proper layout, showing no coherence and progression, and in many cases ending up perpetrating intentional or unintentional plagiarism because they have not kept track of the sources of the ideas that they jotted down so that, even if they wanted to, they cannot properly acknowledge their sources. This is the first and probably the worst case scenario. In our view it reflects a mindstate of unconscious incompetence.

The next phase is when students begin to appreciate how little they do know of the topic, but they set out without a plan and write unsystematically without knowing where they must stop creating pages upon pages of copious notes. They rely on the supervisor to tell them what they must leave out. We call this phase conscious incompetence. The next phase is conscious competence. In this phase the student becomes aware of the fact that s/he is coming to grips with the major references that relate to the problems under investigation. Due to the student's newfound confidence is sometimes difficult for the supervisor to properly advise the student what to, leading to disagreements about what should be included in the literature review and what should be left out and often leading to unfounded mistrust on the side of the student.

The final phase is where the student has become a true researcher. This stage we refer to as *unconscious competence*. The student creates a proper problem statement and extracts key concepts from it that s/he then uses to search for refereed literature to be used in the literature review. By using key concepts derived from the problem statement, the *problem statement itself becomes the filter* that ensures that only literature relevant to the problems under investigation forms part of the review. This method also enables the researcher to determine to what extent problems that s/he has identified have been solved by other researchers, enabling the researcher to remove solved problems and

reformulate the original problem statement, the research objectives and the research questions, the latter which forms the basis of particular more detailed questions posed to respondents in research instruments like questionnaires and interview schedules.

The researcher generates content for the concept matrix by surveying *only the abstracts and summaries of references*. Once the appropriate literature to review has been identified the researcher commences with the literature survey proper, which entails a critical analysis of each reference to identify potential solutions to the problems under investigation. The critical analysis of individual references should be followed by a critical comparative analysis of all references that are listed under a particular concept, to establish differences of opinion, converging opinions and consensus among experts under review.

In this approach to literature review the researcher systematically reads each article, considers the validity of what is being read, and thereafter classifies the reference thematically. The importance of using this method is that the student must realise that s/he cannot use everything in an article but should instead concentrate on those aspects that relate to the problems under investigation.

The key concepts on the matrix therefore become the key concepts embedded in the headings in the literature review. The concept matrix enables the researcher to subject all literature to critical comparative analysis. The references that have been ticked on a particular column of the concept matrix are subjected to critical comparative analysis in the thesis. The concept matrix also enables the researcher to establish at a glance whether s/he has identified enough references under each concept.

The researcher can order each column of the matrix in different ways to foreground different aspects of the knowledge contained in it. The matrix can be reorganised according to:

- Publication date, demonstrating longitudinal aspects of the topic (*time-ordered matrix*)
- Table rows containing verbal information about the view of role occupants on a specific issue of the project (*role-ordered matrix*)
- Integrated data on a summative index or scale, thus organising several components of a single, coherent variable (checklist matrix)
- A central theme (*conceptually clustered matrix*)

- Outcomes and dependent variables (*effects matrix*)
- Present forces that are at work in particular contexts showing processes and outcomes (*site dynamics matrix*)
- A series of events displayed in any possible order (*event listing*)
- A field of interrelationships between dependent and independent variables, describing causal connections between them (*causal network*) (Sarantakos 1998: 360)

Wellington *et al.* (2005: 83) state that in writing about the literature, you are adding to it, by creating links, drawing attention to particular issues and contributing your construction of the ‘story’ to be found in existing research.

It is a long and ‘rigorous’ road for a researcher to progress from unconscious incompetence to unconscious competence. The supervisor will have to be patient and has to ensure that the student keeps a proper record (the matrix) of the process. The matrix should be added as an appendix into the dissertation. The student cannot move directly from unconscious incompetence to unconscious competence but has to follow each stage the sequence of understanding shown in Figure 1.

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Rembrandt Klopper, Sam Lubbe and Hemduth Rugbeer

Department of Communication Science. The University of Zululand, South Africa.

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Rembrandt Klopper
School of Information Systems & Technology
University of KwaZulu-Natal, South Africa

Sam Lubbe
School of Computing
University of South Africa (UNISA), South Africa

Hemduth Rugbeer
Department of Communication Science
University of Zululand, South Africa