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Novel Advanced Scoping Meta-Review Methodology for Defining a Graduate Level Textbook in an Emerging Subject Area

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Abstract

This paper describes a library-based project involving the library staff at the Institute of Technology Carlow (ITC), in a collaboration led by the European Cooperation in Science and Technology (COST), Action MP1302 Nanospectroscopy. The project uses a comprehensive scoping methodology, an Advanced Scoping Meta-Review (ASMR), to identify significant topics in an emergent subject area; Optical Nanospectroscopy. An agreed

mapping of the subject is derived in order to deliver a pedagogically coherent structure for a three-volume textbook set intended primarily for Early Stage Researchers (ESR). The review process is based on some earlier scoping methodologies, but is devised for a project involving a large number of individuals collaborating in authorship of the textbooks. A description of the scoping process is given, noting both the specific work in searching for and retrieving the appropriate literature, the qualitative and quantitative analysis and ordering of the search results, and placing the meta-review in the wider context of the editorial process to develop the Nanospectroscopy textbooks. The meta-review is employed in a special way in order to map an emergent subject area for the purpose of textbook development, rather than the more traditional use of such reviews to answer specific research questions. The importance of the library-led searching which underpinned this activity is emphasised. The successful outcome of this process resulting in agreement on the detailed content of three volumes is discussed. The paper ends with a critical evaluation of the lessons that can be drawn from this project.

Key Words: meta-review; library; research; nanospectroscopy

1. Introduction

A requirement for a deliverable under the auspices of the European Union COST Action MP1302 (COST, 2013) was for the production of a textbook in Optical Nanospectroscopy. The subject area of the proposed book is an emergent one (from the wider and established area of optical spectroscopy). In optical spectroscopy, the energy-dependence of the radiation intensity of a given system is evaluated, and typically plotted over the wavelength, frequency, energy, or wavenumber. Nanospectroscopy refers to spectroscopy on the nanoscale, i.e. looking at individual nano-objects or using techniques with nanoscale resolution. It offers powerful analytical tools for the investigation of light interacting with matter. Relevant application areas can be found in biomedicine, sensing, safety and security, health, material science or data processing. Brief overviews are given in Editorials by Çulha (2015) and by Meixner (2011). In order to identify and evaluate appropriate topics for inclusion it was essential to undertake a comprehensive review of extant literature within this emerging subject field. This would enable a pedagogically-coherent structure to be established for the textbook – this structure would then be

used in the editorial control and development of what would be a work with multiple authorship. The project may thus be seen as a best-practice example for preparation of multiple-authored works in emerging science fields. Ultimately it is intended that the coherent structure will be an important aid to student assimilation of the material and ensure the greater durability of the work.

The employment of a new scoping review methodology was an essential tool to achieve this. The task of undertaking such a rigorous survey of literature and other material in a relatively newly-developed area of science provided a unique opportunity for collaboration between academic and library staff. This work illustrates both a model for future collaborations and a template for scoping subject content for a variety of academic purposes, not the least of which is course development.

The development of methodologies for meta-analysis and scoping reviews has occurred primarily within the areas of medical, social and behavioural sciences. A search of a web discovery service, undertaken in January 2015, at the Institute of Technology Carlow, for the keyword phrase "scoping review" retrieved a total of 1,457 peer-reviewed journal articles. An analysis of the subject terms related to these articles revealed an overwhelming predominance of terms related to medical and social sciences and minimal reference to other scientific disciplines. The emphasis on the using of such a review type within the social and medical sphere is also reflected within literature discussing the development of review methodologies. Employment of modern meta-review methods may be dated from the mid-1970s when Glass (1976) suggested the term meta-analysis to describe the quantitative analysis, and Glass (1977) the description of the relationships and characteristics of results in a large group of studies. By the early 1990s review methodology had been formally structured by such bodies as the Cochrane Centre in the UK with their handbook by Higgins and Green (2011). As the use of meta-analysis and systematic review methods evolved, publications appeared which considered the library and information professional's role, such as those by Schell and Rathe (1992), Mead and Richards (1995), and Beverly, Booth and Bath (2003). Arksey and O'Malley (2005) noted that a wide range of terminology had been produced to describe various kinds of review, and clearly emphasized the difference between a systematic review (to focus on specifically defined research questions, possibly using a limited range of sources), and a scoping review (which may be used to encompass a much

broader subject enquiry using a non-qualitative range of literature sources). Furthermore, they proposed a methodological framework for undertaking a research-focused scoping study. Later studies by Armstrong, Hall, Doyle and Waters (2011), and Levac, Colquhoun and O'Brien (2010), re-examined the use and methodology of scoping studies, with the former noting that such work may have applications beyond just providing a basis for future systematic review work.

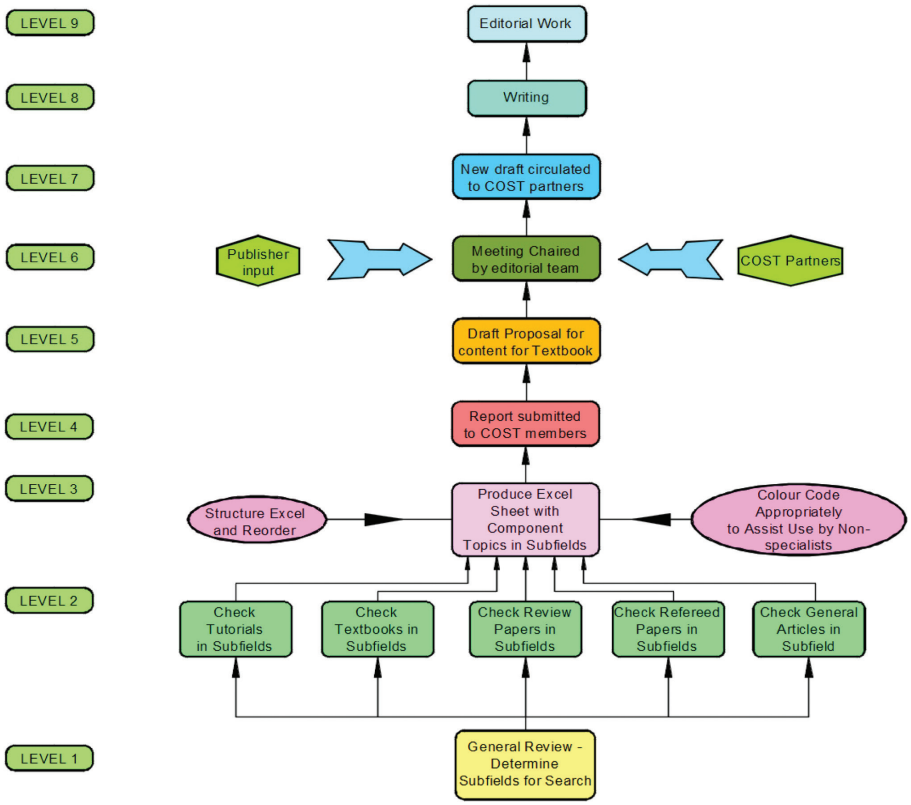
A more recent development of the scoping review was discussed by Sarrami-Foroushani, Travaglia, Debono, Clay-Williams and Braithwaite (2015), where the concept of a 'scoping meta-review' was put forward as a development of the scoping methodology to further assist in the review of an emerging new field of an interdisciplinary nature. This approach provides a contrast to previous discussions of the use of scoping studies which have tended to concentrate on the more traditional role of the methodology in support of specific research questions. Therefore the scoping meta-review offered a suitable framework for undertaking a large-scale assessment of the required subject area, and the subsequent classification and analysis of results to inform the construction of the proposed textbook's pedagogical structure.

Within the scope of this project, the initial work to produce the basic subject structure was undertaken by a small group of academic experts with input from a librarian. One of the academic team members then undertook the substantial and lengthy task of evaluating the retrieved material from literature searches, and created the detailed mapping of the ASMR subject matrix. The information contained within the matrix then provided the basis for discussion within the wider COST Action membership in an iterative process which provided the basis for the textbook design. This sequence is discussed below.

2. The Review Process Explained

The ASMR, which is schematically illustrated in the diagram Figure 1, is a development of the earlier scoping methodologies discussed previously. The diagram represents this process in a series of levels and is discussed in the context of specifics for the COST Action MP1302 textbook project. The review process is divided into nine steps described below. Beyond the particulars of this project, this flow chart could be adapted for any ASMR project.

Fig. 1: ASMR process diagram.



- Level 1 – Conceptual Level

The initial proposals for this project emerged at optical nanospectroscopy conferences and led to the establishment of the COST Action MP1302 and the securing of funding by the EU Framework Programme Horizon 2020. A textbook working group was formed at the first meeting of the Action. Discussion within this group which included early stage researchers (ESR), gradually formed an initial conceptual framework for the project.

- Level 2 – Data Acquisition Level

Once the basic parameters of the project were agreed, work began to establish the possible scale of the ASMR library research. An initial review of literature

undertaken in 2014 revealed that the number of papers using the keyword 'nanospectroscopy' began to increase in the first years of the new Millennium; however 2008 was accepted as a start date to harvest a manageable body of material without excluding the most relevant information.

Another criterion for defining the scope of the ASMR was to critically examine the subfields that would need to be searched. It was surprisingly discovered that textbooks existed on most of the optical nanospectroscopy subfields but paradoxically none on the exact topic. In the course of the scoping exercise some other fields were discovered, but the initial mapping was close to being comprehensive. The library search process is more closely discussed below in section 3.

- Level 3 – Taxiometric level

Once data had been obtained, the process of using this material structure and ordering the subject fields and subfields within a spreadsheet matrix could be undertaken. A fuller discussion of the structuring, population, and completion of the subject matrix is given below in section 5.

- Level 4 – Reporting and Feedback (RF) Level

A comprehensive report detailing the ASMR project work was presented to the COST Action. The report provided the proposal for the book structure and content and led to the decision that a three-volume publication would best suit the requirement; the first two volumes would detail the fundamentals, and the third volume would illustrate applications based on these fundamentals.

- Level 5 – Evaluation Level

A further COST Action MP1302 meeting allowed leaders of the Textbook Working Group and the editorial team to further refine the structure and detail of the volumes. The scoping data obtained from the library research has the virtue of being objective in detailing the published material that can be evaluated quantitatively, but cannot allow for qualitative nuances. The "expert evaluation" (EE) given by this meeting was indispensable in particular in delivering the objective of a proper structuring of the volumes on the fundamentals. This EE process was enhanced by a report on tutorial support for the textbook which had also been informed by the scoping process analysis of available tutorials.

- Level 6 – Professional Level

Contracts with the publisher were signed for each volume. This underpinned the formatting of the text structure within the context of the multiple authorship of each volume.

- Level 7 – Revision level

Revision of the draft text was undertaken following review at Work Group meetings held in 2015 and 2016.

- Level 8 – Implementation Level

The textbook contents, were drafted using the guidelines from the publisher on style and directions were given to the team of authors from the Editors-in-Chief and Editorial Teams for the individual volumes. The Editors-in-Chiefs' input was of growing importance as the project reached its later stages. The Editorial team was almost self-selective and undertook the task of delivering the volumes. The timelines and other strategic information were given in the information circulated to the authors.

- Level 9 – Implementation Level

The editorial work completes the project. There is a practical challenge of cross-referencing between the volumes.

3. The Search Process

The context of the information acquisition process within the wider review can be briefly summarised as follows:

- Analysis of review articles and inclusion of relevant ones in the subject matrix in order to establish a 'weighting' for topic importance was the starting point.
- From this point searching of relevant information sources was undertaken to identify review articles on Nanospectroscopy with a view to identifying potential topics and subtopics to be considered for inclusion in the subject matrix. This was intended to provide an objective map of Optical Nanospectroscopy.
- A second round of searching to identify general articles.
- Additional searching for relevant textbooks and tutorials.

- Population of the subject matrix with further relevant material (textbooks/tutorials).
- Statistical analysis and ranking of subject matrix to identify likely topics and subtopics to identify the essential ones to be considered in the proposed textbook.
- A second iteration of the analysis process was undertaken focussing on the tutorial material in order to inform the process of developing a series of complementary online tutorials to support the textbook volumes.

ITC Library online information resources were used to search for material within the specified topics. This exercise presented significant challenges – attempting to retrieve only review articles via the Institute's Web Discovery Service (Summon), proved to be difficult. The Web Discovery System's faceted filtering did not provide an adequate mechanism to isolate review articles from a larger result set. Attempts to use keyword combinations also proved to be less than satisfactory – this may be due to the variety of terminology used to describe a review paper, e.g. 'review paper' 'literature review' or 'review article' and the complications of excluding 'review' when used in other contexts, e.g. 'book review.'

Searches undertaken through specific online databases – ScienceDirect and Web of Science proved to be far more fruitful, and provided clear identification of review articles (Science Direct by labelling search results, Web of Science by offering a search results filter for review articles). One constraint put in place by reliance on ScienceDirect was the restriction to articles published by Elsevier, however the extension of searching to the Web of Science service successfully circumvented this limitation.

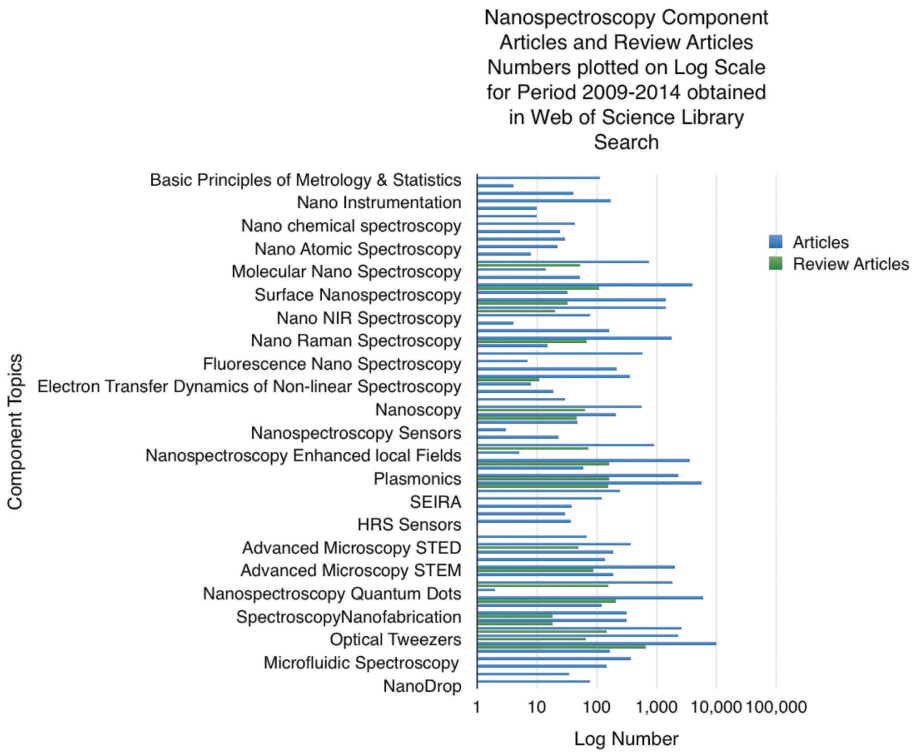
Further iterations of the search process were undertaken in order to identify refereed papers and more general articles, and also to locate previously published books on any aspects of Nanospectroscopy. As a proposal had been made that a series of online tutorials would also be developed, a final search was undertaken to locate any related online tutorials.

The search process to identify general and refereed articles followed the same path as that for the review articles, but a comprehensive and systematic process to identify existing textbooks entailed the casting of a wider net:

interrogation of a much broader range of online resources had to be undertaken. Almost inevitably the major online monograph resources, for example, the Library of Congress, the British Library, OCLC Worldcat and Google Books, provided primary sources of material; further checking of the local ITC web discovery service also proved to be invaluable.

The final element of the search process – location of tutorials – combined the identification of tutorial material in print form, with the interrogation of Google to locate online material in a variety of formats (html pages, .pdf files), and on a mixture of platforms (education and commercial web sites, YouTube). The setting of criteria to define what constituted an online tutorial of satisfactory quality proved to be an exacting task as examples were found ranging from one page pdf files to multi-step interactive programmes – ultimately this was a judgement to be left to academic expertise.

Fig. 2: An example of a quantitative result of the ASMR process.



On completion of the extensive search exercise, analysis of the retrieved material was undertaken to evaluate results and to fully develop the subject matrix. Analysis of the review articles allowed a clear path of development within the field of Nanospectroscopy. For example a 529% increase in publications was found in Web of Science during the period 2004–2009, with a concomitant growth of identifiable topic subdivisions of the field from 12 to 19. Intriguingly the results post-2009 actually reduced even though a larger cohort of researchers was now active within the field.

Figure 2 illustrates the kind of quantitative vision of the subject from the review articles and general article publications of the field of Nanospectroscopy within the period of interest.

4. Developing the Subject Matrix

The objective of preparing the subject matrix was as a means of mapping and defining the subject area of Nanospectroscopy. This work defined Ground Zero of this new and emerging science. Within the COST Action MP1302, it founded the basis for the discussion amongst academic experts to identify a likely list of subtopics, ranging from the general to the particular for inclusion in a review of Optical Nanospectroscopy. This exercise is briefly outlined below.

4.1. Review Articles

Once the initial matrix population was completed, extensive searching of the ITC Library's online electronic resources was undertaken, as described in section 3, in collaboration with two members of the library staff to identify review articles which related to the sub-topic-components. A useful definition of a review article can be found on the University of Texas Library website (2011).

The initial library search was an exercise in surveying all of the review papers covering the sub-topics from 2008 to the present. The use of Science Direct was found here to be the best approach as this enabled downloading of the pdf versions of a very large number of important review papers. These papers are of course limited to Elsevier journals, therefore a search via Web of Science was necessary to gain access to a wider range of material.

Some thirty plus full text Science Direct review articles within the period 2009–2015 were found from a 'nanospectroscopy' search, but no review articles specifically titled 'nanospectroscopy' or 'optical nanospectroscopy' were flagged by the search process. The graphing of the number of articles found was a useful tool in analysing the value of a specific scoping search. The growth of Nanospectroscopy is quite significant as shown by 'orders of magnitude' differences which appear over the last decade.

The basic idea of scoping analysis is to use a hierarchy and penetrate to more general levels. In a past age postgraduate students were asked to spend several weeks, or often months, in libraries learning how to find important papers. The procedure was to work down from encyclopaedia articles, to textbooks and to review papers that were cited in these articles, from there to check references in textbooks and the review papers for important references.

All this occurred before starting the serious business of looking at appropriate journals. Today things are very different. Nevertheless this idea of digging deeper is still relevant and the ASMR basically has been guided from these now widely lost skills of academic research.

Review articles are of special importance in scoping, and these are pretty straightforward to spot and separate from general research articles. It can be seen from Figure 2 that the identified sub-topics have provided column headings. When the review articles have been classified as being in a specific column there, these subcategories grew and developed, with extensions being inserted in the row at appropriate places. It was found that it became easier in practice to populate these sub-categories as the process evolved, but how the sorting is delivered may be a matter of personal preference. Inserting comments in the cells for a subcategory allows all of the review papers that have been found to be pasted in the comment.

When the process is complete it is useful to put at the top of the comment in the sub-category table cell the number of papers that have been discovered. The next task was to review and sort the cells, ensuring that topics have a meaningful structure, and to demonstrate where close relationships existed. At this point the Editorial Team played a crucial role in establishing the correlation and connectivity of the sub-categories. This ordering defines the organic connectivity which was the fundamental requirement of the EU project for textbook coherency.

4.2. Refereed Papers and General Articles

Refereed papers and general articles were also surveyed for the ASMR and are of more significance for the authors of the textbook than in defining the content for the textbook volumes.

The same methodology as described for the search of review papers applies equally well to the more specialist studies usually found in refereed papers. The value of this exercise is to assist the authors of the textbook content to guide their writing. This step might even be more useful for the development of such course/academic material.

General articles are more often than not written with broad brush strokes and may be composed for a very specific readership. Scoping such general articles proved useful for the applications volume discussed below, but could not deliver enough additional useful wider insight for the project.

4.3. Textbooks, Tutorials and Supporting Material

The scoping exercise identified many of the textbooks on topics that are a subset of optical nanospectroscopy (let us call these sub-topics-components). These were added to the scoping matrix with appropriate comments on content. Furthermore, the search revealed the existence of tutorials on a large number of these sub-topics which were highlighted in the tutorial row in the spreadsheet.

These considerations were always directed towards the educational needs of ESRs.

5. From Subject Matrix to Completion of the Spreadsheet

The last component of the scoping exercise was, in many respects, the most complex – the quantitative analysis to identify the nature of topic expansion illustrated by the material harvested during the search process. It was followed up by full population of the subject matrix to complete the mapping of the field of Nanospectroscopy. Once the population had been satisfactorily completed, the task of ordering the matrix to reflect the full mapping of the field and to establish the potential structure for the proposed textbook

could begin: analysis of the number of articles retrieved in tandem with the increase/decrease of publication in subfields over the specified period gave a general overview of the likely topics for inclusion. The ordering of the subject matrix was further enhanced by colour coding to visually highlight subfields and offer a 'weighting' in terms of relative importance (e.g. 'hot topic,' 'industrial topic' etc.).

These subfields can be seen from Figures 3 and 4, as screenshots of the Excel spreadsheet for the ASMR. The top levels of the spreadsheet are all colour-coded to show that they are separate from the main scoping analysis. The results from this search on textbooks are entered in the Excel cells in the appropriate column and give details of all these textbooks. The details of the columns containing the results were created in cells containing comments with the full list of the "hits" found by the scoping. The cells were all given a short name to indicate the collection of papers in the comment. The number in each cell indicated quantitatively the number of papers in the cell comment. The columns of cells were ordered in a logical way with close proximity between near-related topic cells, and with the most fundamental subjects being put at the top of the column and the most complex at the foot. The full extent of the coding used in the present analysis is something that is too specific to be of importance to the reader but Figure 3 clearly illustrates that this is of practical utility in the ASMR Process.

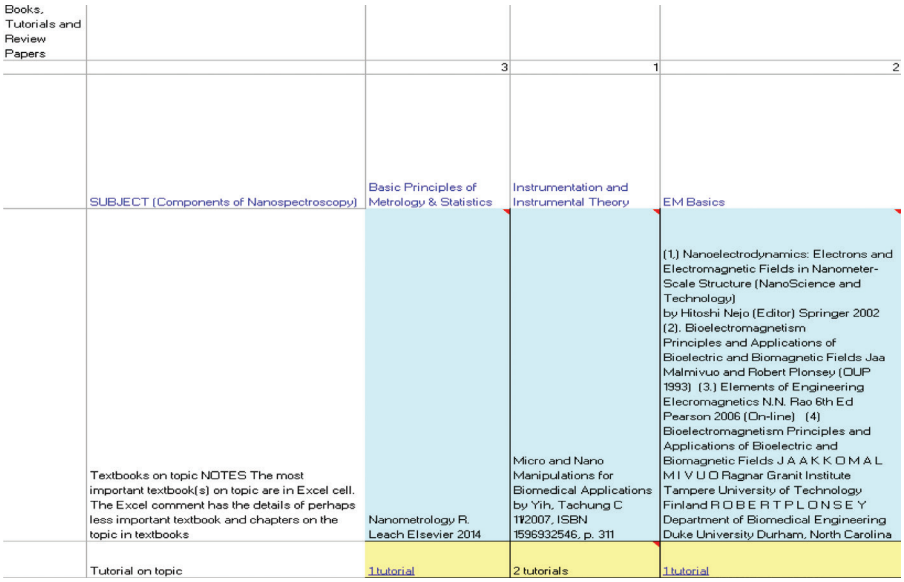
The colour coding simplifies the structuring of the library data and is of great value to anyone trying to make sense of the spreadsheet that has been so carefully constructed. The basic positioning of cells, columns and rows attempts to group related topics and fields as closely as possible.

The structure (classifications of the taxonomy) of this developing topic of Optical Nanospectroscopy is clearly still in its youth and is in a process of emerging from several diverse fields being brought organically together in a process driven by various academic, industrial, political and social pressures.

The headings in the ASMR process were constantly honed and refined through this search process as it was recognised that the subject was in a process of rapid evolution.

The other important lesson here is that the online search has its own terminology. It is arguable that this "library web vocabulary" is more efficient to

Fig. 3: Example of the layout of the Scoping Review matrix illustrating ordering of topics with details of books and tutorials.



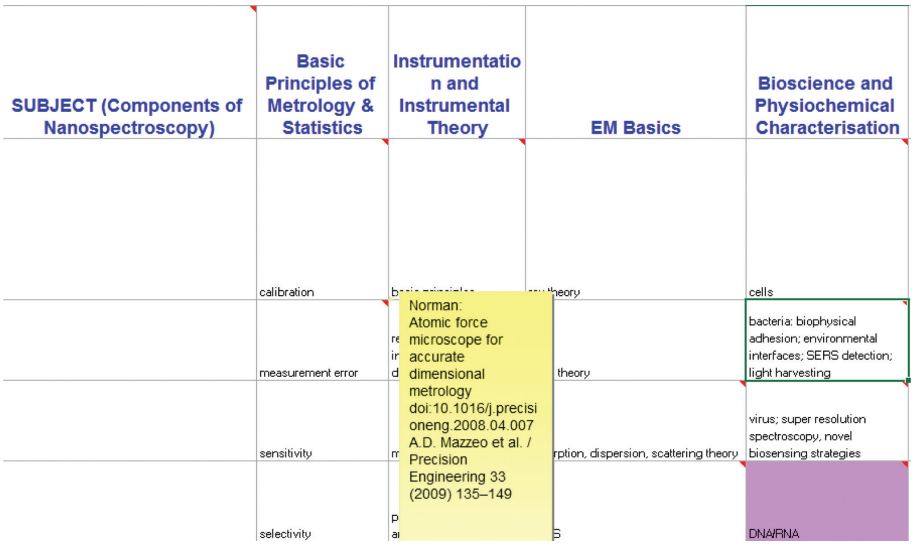
Books, Tutorials and Review Papers		3	1	2
	SUBJECT (Components of Nanospectroscopy)	Basic Principles of Metrology & Statistics	Instrumentation and Instrumental Theory	EM Basics
	Textbooks on topic NOTES The most important textbook(s) on topic are in Excel cell. The Excel comment has the details of perhaps less important textbook and chapters on the topic in textbooks	Nanometrology R. Leach Elsevier 2014	Micro and Nano Manipulations for Biomedical Applications by Yih, Tachung C 1st2007, ISBN 1596932546, p. 311	(1.) Nanoelectrodynamics: Electrons and Electromagnetic Fields in Nanometer-Scale Structure (NanoScience and Technology) by Hitoshi Nejo (Editor) Springer 2002 (2). Bioelectromagnetism Principles and Applications of Bioelectric and Biomagnetic Fields Jaa Malmivuo and Robert Plonsey (OUP 1993) (3.) Elements of Engineering Elecromagnetics N.N. Rao 6th Ed Pearson 2006 (On-line) (4) Bioelectromagnetism Principles and Applications of Bioelectric and Biomagnetic Fields J A A K K O M A L M I V U O Ragnar Granit Institute Tampere University of Technology Finland R O B E R T P L O N S E Y Department of Biomedical Engineering Duke University Durham, North Carolina
	Tutorial on topic	1 tutorial	2 tutorials	1 tutorial

use in the ASRM than any others for defining the structure and taxiometric relationships. It is important to note here that this process is not just an add-on but is key to the success of this whole time consuming process.

The final completion and ordering of the subject mapping matrix, now fully populated with the material retrieved in the search exercise, provided the platform for discussion among the members of the COST Action to agree the structure and contents of the proposed textbook. The analysis and ordering of the subject matrix enabled a consensus amongst the members that a three-volume publication – covering fundamentals and applications – was best suited to fully realise the aims of the Action.

To enhance the pedagogical structure, it was envisaged that online tutorials should be created to complement the printed material. The work undertaken to search for existing online tutorial material and inclusion of this in the subject mapping matrix has proved to be invaluable in informing this decision. The librarians involved in the project were able to offer advice on

Fig. 4: Example of the layout of the Scoping Review matrix illustrating ordering of topics and subtopics with details of review articles in cell comments.



aspects of tutorial provision (commercial site vs non-commercial, longevity and management). It was decided that all possibilities found (filmed lectures, short films, animated graphs and figures, static diagrams, interactive exercises and suggestive examples), should be used and gathered in one single platform—a webpage—that could take the form of a wiki, enabling each author to update at any moment their own material to be shared with the interested students.

6. Conclusions

Traditional use of meta-analysis and various forms of review have tended to focus on answering specific research questions. In the present case the Advanced Scoping Meta Review methodology has been successfully employed to map an emergent subject area and provide the structural basis that can be generalised for multi-authored textbooks. Additionally, important subject insights can be derived from the search results for Nanospectroscopy.

It should be noted that some of these insights are significant because they are new, while many have been previously understood and are now quantitatively supported by the library scoping study.

The development of the subject matrix, which has proved to be the core of the Advanced Scoping Meta-Review Methodology, and hence provided the platform for the structuring of the proposed textbooks, was impossible to complete without the extensive and complex searching of library resources to identify material for inclusion. The search process therefore required the closest form of collaboration between librarians and academics in order to ensure that this process was successful. For the librarians involved, the task of searching for information of a highly specialised nature in an emergent field proved to be a demanding one requiring familiarisation with a highly technical vocabulary. The existence of the subject matrix pre-populated with known areas of interest proved to be an essential tool in achieving this. Once an understanding of the subject and sub-topic range was acquired, advice was then offered to the involved academics regarding the most appropriate online information resources, and on the technicalities of the search process (what may now be viewed as the more 'traditional' aspects of literature searching, such as use of Boolean operators manipulation of search results, full-text access and methods of identification of specific types of materials such as review articles).

Ultimately this exercise has proved to be a textbook example of successfully bridging the 'grey' area between librarians' understanding of the information landscape and search techniques, and the academic expertise in the topic under review. The gap in expectations and perceived abilities between the academic librarian and academic staff has been noted by Creaser et al. (2014), while Dudden and Protzko (2011) noted that research staff may not have the knowledge of the search methods and skills required to maximise information retrieval. The involvement of library and academic staff in a carefully developed subject mapping exercise, structured by the use of the advanced scoping meta-review methodology provided an ideal opportunity to achieve a fruitful collaboration. A recent study by Meert, Torabi and Costella (2016) confirms the positive impact of the inclusion of a librarian or information professional as a member of a systematic review team on the outcome of the review process. Further development of this work may be to create a more structured and sustainable collaborative model as suggested by Swinkels,

Briddon and Hall (2006). The use of the methodology, underpinned by the subject matrix, enabled a carefully controlled search process to be undertaken. By using academic expertise to establish the initial topic, time and material type criteria this process ensured that a manageable amount of data was retrieved rather than an overwhelming one: a common enough problem to researchers as noted by Hey and Hey (2006). In practice, in this Cost Action project this difficult but vital process was delivered by editorial leadership of a high standard.

The flexibility of the methodology and subject matrix has ensured that a comprehensive mapping of the Nanospectroscopy subject area could be produced, analysed and then manipulated to inform the work of the COST Action MP1302 members in deciding the requirements for the structure of the envisaged textbook volumes.

Future use of this methodology could be suggested for a number of different purposes – researchers may find it of benefit to map, as has been done here, an emergent subject area, define the scope of a new textbook or start preparing collaborative coursework. The same technique may be also of use for libraries wishing to develop research collections and, as noted above, should prove to be an exercise on which to base closer collaboration between librarians and academic staff.

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