Introduction to the use of the chemical literature: an innovative library workbook

PAPER

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A library workbook for chemistry students is described. Workbooks have been integrated into degree programmes at several levels and are tailored to assist with location of information of direct relevance to the practical, essay and project work being undertaken during the programme. The workbooks are reviewed annually, with account being taken of new developments in databases, the printed material available and students' feedback forms.

Introduction

Training of chemists in information skills at other universities

There are a number of reported examples of library and information retrieval training courses for chemists in universities. The majority of these are in the USA where chemical information specialists and academic staff have integrated such training into undergraduate and postgraduate courses. A pioneer in this area is Wiggins,[1] who first introduced a Chemical Information Specialist Program in 1969. This programme, which is probably the most comprehensive in existence, leads to a Master in Library Science. The programme is designed for students with a first degree in chemistry and is run jointly between the Chemistry Department and the School of Library and Information Science. Wiggins has also developed a World Wide Web 'clearing house' for chemical information teaching resources.[2]

The American Chemical Society has laid down requirements for training undergraduate chemists in information skills,[3] and cases of integration of chemical information instruction are well documented.[4,5] New approaches include capitalising on the availability of the Internet.[6] In the UK notable examples are the work of Breuer,[7] who has developed a literature-searching exercise as part of the second-year undergraduate course at Lancaster University, and Bailey[8] who has developed an information 'treasure hunt' making extensive use of the Internet and BIDS as part of a module on communicating chemistry at Heriot-Watt University. A useful bibliography is presented by Carr[9] and a recent paper which lists many sources which could be included in library exercises is that by Matthews,[10] which in addition to the author's own experience, provides an up-to-date overview of reports of current teaching of chemical information skills in the USA.

Background to the UMIST library workbook

In 1992 UMIST was awarded funding from the Enterprise in Higher Education initiative for the improvement of library user education. A member of library staff was appointed who developed a generic library workbook after research which identified similar resources already in existence. The basic framework of the UMIST workbook was the same for all subjects, and was tailored to the needs of specific departments by library subject specialists and academic staff.The chemistry workbooks are printed documents of around 25 pages in length and comprised of a series of exercises which require students to make use of printed and electronic sources of information to answer specific questions concerned with chemistry. Descriptions of the sources are given and the methods of using them. The completed workbooks are returned to students, and make useful documents for future reference.

The Chemistry Department was particularly keen to adopt the workbook and integrate appropriate versions into courses at various stages at undergraduate and postgraduate level, as its introduction coincided with a time when courses were being reorganised and the need to train students in information skills was recognised.

Although the chemistry workbooks are assessed, the overall objective is to familiarise students with information sources available and promote efficient use of those sources. Completion of the workbooks requires use of the main and departmental libraries.

Structure of the UMIST library workbooks

All versions of the workbooks are divided into sections, each covering a different aspect of library use or information retrieval. These are described in more detail below. Each section of the workbook contains background information, a list of objectives and an estimate of the length of time it is expected that the section will take. The background information includes a description of the materials to be used for the exercises, for example for the reference books a description of the scope and coverage of the book (see Figure 1). For databases, users are guided through an example, showing how a search strategy should be compiled and the use of logical operators before the assessed search is embarked upon. Extra handouts, such as guidance in the use of printed *Chemical Abstracts* and *Beilstein CrossFire*, are provided to assist with use of more complex systems.

The workbook is in print form only at present, as this allows the students to take it with them to the appropriate part of the library. It is expected that it will remain in print form until the sources covered are all electronic.

There are three versions of the chemistry workbook in use at present. These are designed to equip students with the information skills they need at the most appropriate time during their course.

Figure 1: Examples of descriptions of reference books used in the Library Workbook.

(ML = Main Library, CL = Chemistry Library)

The Merck index. (ML 540.3/MER; CL 540.3/M14)

Useful for natural products, drugs and general organic compounds. Contains structure drawings, IUPAC names, physical properties and references to preparations. Trivial and systematic names can be looked up in the Cross Index of Names, formulae in the Formula Index.

Chemical research faculties: an international directory. (ML 540.7/AME; CL 540.6/A2)

Lists chemistry departments in universities from around the world, along with their staff members. There are name and chemical information indexes.

The workbooks

The first-year workbook

This is completed during the first week of the first semester, with nine hours allocated. The workbook forms one week of the Techniques course (which additionally comprises laboratory and computing skills).

The first exercise addresses library catalogue use, essential to enable students to identify efficiently course books and additional reading material. It is also designed to help students become orientated in the library and be able to find the material they have identified using the on-line catalogue.

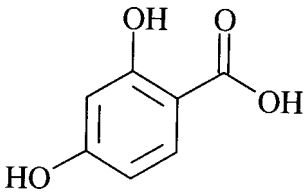
The second exercise involves answering a series of questions which require students to make use of reference and data books. The workbook gives examples of suitable books (see Figure 1), a brief description of their coverage and where they can be located in the libraries. Students do not have to use the books listed, but in their answers must quote the source. About ten questions are then presented, which include dictionary definitions, values for physical properties, safety information, determining research interests of departmental professors, the melting point of an organic compound and location of an IR spectrum in Aldrich (see Figure 2).

The final exercise in the first-year workbook is an introduction to the computerised databases which will be of use in the early part of the course. This exercise was introduced partly due to increased availability of databases and partly because of requests on feedback forms. The two databases covered at present are the *Chemical Safety Data Sheets* available as part of the BIDS-RSC service and the *Wilson Applied Science and Technology* database available on the local CD-ROM network (see Figure 3). Information is given about the subject coverage of the databases and how to use them. This is followed by exercises which ask the students to find hazards associated with working with specific chemicals and the type of topic set for essays.

Figure 2: First-year and MSc workbooks: questions from the reference books section

5. Find an infrared spectrum for β-resorcylic acid. You will have to start from its systematic name or empirical formula. If you don't know its systematic name, try looking up the formula in the formula index of Aldrich.

   What is the Aldrich spectrum number (page number and letter)?



6. What might happen to you if you are exposed to 1,3-dinitrobenzene?

Source:

Figure 3: First-year workbook: question in database usage section

Now try a search for articles on methane and the greenhouse effect. To begin a new search, press Esc, then select Enter a New Search.

- Indicate here your chosen search terms:
- How many references did you retrieve?
- Give a complete citation for one relevant article which is likely to be available at UMIST. You may want to use the following as a model:

  F. Pearce, Methane: the hidden greenhouse gas. New Scientist, 1989, 122, pp.37-41.

The second-year workbook

Undergraduate chemistry students at UMIST have to complete a more advanced workbook during the second semester of their second year, and they are allocated nine hours for its completion. This workbook builds on themes present in the first-year version, contains two sections, and is intended to prepare them for their third and/or final year. Second-year students go on either to the final year of the BSc course in Chemistry, or to the third year of the MChem course, or may go to a university abroad for a year or to an industrial placement either in the UK or abroad. In either their third year or their final year (or both) all students will carry out an individual or teamwork project involving chemistry research. The workbook is intended to prepare them for this activity.

The first section, location of material, is intended to enable students to identify different types of references they may encounter during the course of their research. Examples of typical references for a journal article, conference paper and chapter of a book are given to assist with this process. Then six references are presented and students are expected firstly to identify them correctly and then to locate these publications in the library. To add a personal touch, all the examples in this and the next section use UMIST chemistry department staff names or departmental research topics.

The second section covers use of indexes and abstracts, both printed and electronic. The first of four exercises covers printed *Chemical Abstracts* (there is no free at the point of use electronic version available at UMIST at present). Use of Author, Subject and Chemical Substance Indexes is included, as well as use of the Index Guide for identification of appropriate subject headings. The General Subject Index search exercise is shown in Figure 4.

Figure 4: Part of the advanced workbook text covering use of Chemical Abstracts

Imagine that you want to find information about uses of ZSM-5 zeolites for alkylation.

First, use the Index Guide for Chemical Abstracts for 1987-1991. Look up ZSM.

• What is the correct term to search for in the General Subject Index of Chemical Abstracts?

Now use the General Subject Index to find references.

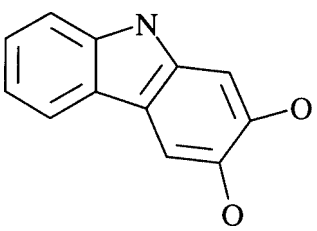
• Write down the full abstract number (including volume number) for a relevant patent (recognised by a P before the abstract number).

Now refer to the abstracts and look up the number you have identified.

• Give the title and bibliographic details for the patent.

Figure 5: Example used for a sub-structure search of the Beilstein CrossFire database

Use the database to find structures and substructures (a substructure is when you wish to find structures where additional substitution is allowed) of:



- How many compounds did you retrieve?
- Give an example of a structure that you found which is similar to the one drawn.
- Give one full bibliographic referece to a preparation of this compound:

The workbook then moves on to electronic databases, and covers the *Science Citation Index* and *Analytical Abstracts*, both available through BIDS. Again author and subject searching are covered. The final and most demanding exercise, to be introduced in 1998, is *Beilstein CrossFire*, available through the MIDAS service. This is included because it is the most important chemistry database which is available free at the point of use, and as it gives students the opportunity to gain experience of using a structure and property based database, also introducing the concept of sub-structure searching. One of the *CrossFire* exercises is given in Figure 5.

The MSc workbook

All taught-course chemistry MSc students have to complete a library workbook during the first two weeks of their UMIST course; there is no earmarked time for completion of the exercise. The workbook is an amalgamation of the first-year and second-year undergraduate versions already described. Although some of the exercises could be deemed rather elementary by some postgraduates who may have encountered similar library catalogues and databases before, it is hoped that they will recognise that the intention is to familiarise them with the UMIST libraries and the particular databases to which we have access. In addition, many of our MSc students are from overseas and some have had little experience of using computers and databases. The *Beilstein CrossFire* exercise mentioned above has just been completed in 1997 for the first time by these students.

A closely related library workbook has also been introduced for the MSc course of the Department of Instrumentation and Analytical Science at UMIST.

Updating the workbook

Literature and database searching is a rapidly developing area, so the library workbooks are necessarily dynamic in nature. They are reviewed every year and are updated with new examples where appropriate and to include new databases and information sources as they become available. In order not to increase the length unduly, as new material is included some older material is withdrawn. Students' comments obtained through evaluation forms are also reviewed at this stage.

Assessment

All the workbooks are assessed and contribute to the students' mark for the year. In 1994 when the workbooks were first introduced, the MSc version was not assessed. This resulted in very few students completing the workbook, whereas in the same year the assessed first-year workbook produced almost 100% submission.

Clearly it is impossible to prevent students working together while completing the exercises. Indeed, this is considered to be desirable, as long as the students go through the procedures together rather than simply copying answers. For the first- and second-year workbooks, students have a week allocated for completion of the workbooks and the marks awarded form part of the practical laboratory

assessment (i.e. one sixth of the mark for the six-week techniques course).

For a number of the questions there is the possibility of more than one answer being correct. In particular, for the use of reference and data books exercises, the same properties and definitions can often be located in several sources, sometimes with different values given. As far as possible prior to marking all relevant books are checked, including those not specifically listed in the descriptions (see Figure 1), and marks are given for correct answers obtained from any suitable source (students are asked to specify in which book they found the answer to each question). In the section on database usage often there is no correct answer when students are asked to indicate the search strategy they have used. For these exercises students are expected to demonstrate an understanding of the concepts of use of logical operators, use of synonyms, truncation of words and sub-structure searching where appropriate. In cases where no thought has been given to these aspects, low marks are allocated.

Feedback

Each student is given a feedback form to complete, which invites comments on the clarity and length of the instructions, the usefulness or otherwise of the different sections, and to add additional comments. Students are also asked whether the workbook will help them to become more efficient in their use of the library. The feedback has been very favourable, a typical response being from the 1995 first-year group, where 71 out of 106 students completed the form. 50 thought they would be more efficient in their use of the library, four thought they would not and 16 were unsure. Comments on the feedback forms have led to inclusion of exercises on the use of databases in the first-year workbook (see above) and the possible inclusion of the use of the Internet in future versions (see later).

Future developments

As stated above, there are no immediate plans to enable the workbooks to be completed electronically. A number of the questions make use of printed sources of information and if the workbook had to be completed at a computer terminal this would involve extra work for the student in transcription of the questions and answers. The workbook does not lend itself to multiple choice questions and there is also the problem of the possibility of a number of different answers being correct for some of the exercises as mentioned above. The possibility of moving to electronic versions of the workbooks will be kept under review should appropriate technology become available which would enable more automated assessment.

In terms of the scope of the workbooks, a common recent request has been for coverage of material available through the Internet, and this may be included in the 1998 workbooks. As soon as a viable free at the point of use electronic version of *Chemical Abstracts* becomes available this will also be included.

Transportability

Exercises which make use of local library catalogues could form the basis of such exercises in any university, although account would have to be taken of the local catalogue system when writing instructions for use. Similarly, many of the databases used are available in most universities, although it may be preferred to tailor the examples to be of direct relevance to the material being studied by the students at the institution in question at that time.

Because many of the examples in the workbooks make use of reference and data books which are available in most good academic libraries, they could be used with little or no modification in many university chemistry courses.

It would also be straightforward to add new sections to the workbook as new resources become available or if universities have significantly different holdings.

Conclusion

The library workbook has been in place within UMIST's chemistry degree courses for four years, and has been well received by staff and students. The increasing emphasis on transferable skills and the developments in databases and information retrieval should ensure its continuation for the foreseeable future.

Acknowledgement

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Summary of sources covered

Books

Luxon, *Hazards in the chemical laboratory*.
Sax, *Dangerous properties of industrial materials*.
Sigma-Aldrich library of chemical safety data.
CRC handbook of chemistry and physics.
Lange's handbook of chemistry.
Kaye and Laby, *Tables of physical and chemical constants*.
The Merck index.
Chemical research faculties: an international directory.
Dictionary of organic compounds.
Aldrich library of infrared spectra.
Handbook of data of organic compounds.
Tables of chemical kinetics.

Abstracts and databases

Wilson Applied Science and Technology Index (local CD-ROM network)
Chemical Abstracts (printed)
Beilstein CrossFire (through MIDAS)
Science Citation Index (through BIDS)
Analytical Abstracts (through BIDS)
Chemical Safety Datasheets (through BIDS)

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Copies of the workbooks are available by email as a word file from Helen Schofield.