Information literacy competencies of university students in science and technology for solving research and development problems.
Information Literacy Competency Standards for Higher Education
Association of College and Research Libraries (ACRL), approved in 2000, currently under revision

http://www.ala.org/acrl/standards/informationliteracycompetency

Information literate student

1. Determines the nature and extent of the information needed

2. Accesses needed information effectively and efficiently

3. Evaluates information and its sources critically and incorporates it into knowledge and values

4. Uses information effectively to accomplish a specific purpose

5. Understands economic, legal, and social issues; accesses and uses information ethically and legally

Problem:
When not applied in real-life study and research situations, IL competences and skills may not enable higher cognitive levels - such as the use of knowledge, analysis, synthesis and evaluation
Research example: a case study

- Postgraduate programme of scientific and technical informatics
- Combination of heuristic and mathematical-statistical information methods with experimental laboratory work
- Informatics applied in chemistry: microencapsulation technology and applications
Methodological model

1. Definition of the research field
2. Preparation of profiles for advanced search queries
3. Construction of a specialised in-house information system
4. Analysis, structuring and synthesis of information
5. Design and laboratory verification of selected processes
6. Identification of process parameters - properties relationships
7. Development of a QSPR model
8. Laboratory process optimisation, transfer to industrial reactors
9. Development of new formulations and market products
10. Generalization of the methodology to support R & D activities

Integration of IL competency standards with solving study and research problems in science and technology
(1) Definition of the research field, selection of the priority niche

Microencapsulation

Chemical methods (industrially important):

1. In situ polymerization
Preparation of advanced search profiles for the acquisition of scientific literature and patents

Advanced search in WoS
333 scientific articles in journals with IF
Web of Science
http://apps.webofknowledge.com/

Basic research

Expert search in FPO
249 patent documents
Free Patents Online
http://www.freepatentsonline.com/search.html

Applied research
(3) Construction of a specialised in-house information system to support R&D activities

Integrated information system:
specialised bibliographic database
6 factual modules

- **1. BIBLIOGRAPHIC MODULE**
  - Determines the nature and extent of the information needed
  - Accesses needed information effectively and efficiently
  - Evaluates information and its sources critically and incorporates it into knowledge and values
  - Understands economic, legal, and social issues; accesses and uses information ethically and legally

- **2. TECHNOLOGIES**
  - Educational materials
  - Technology transfer
  - Research projects

- **3. ANALYTICAL METHODS AND TESTING**

- **4. MARKETING**
(4) analysis and synthesis of information from full text documents, to identify relationships between raw materials, process parameters and the final properties of microcapsules

Analysis of documents
Comparison and overlapping of processes
Result: hypothetical process backbone (for further laboratory optimisation)

Legend
- process
- raw material

Information density
(predicting probability)
- 80 - 100 %
- 60 - 79 %
- 40 - 59 %
- 20 - 39 %
- < 20 %

4. Uses information effectively to accomplish a specific purpose
(5) Design and verification of selected microencapsulation processes in the laboratory

In situ polymerisation microencapsulation
(6) Identification of the relationships between the main process parameters and properties of microcapsules, to design a matrix

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**Legend**

- 1 - smallest
- 2
- 3
- 4
- 5-biggest

4. Uses information effectively to accomplish a specific purpose
(7) Development of a prediction QSPR (Quantitative Structure-Property Relationship) model to predict the successfulness of microcapsule synthesis

QSPR Microencapsulation Efficiency Coefficient:

$$k\mu = \log P + (\log D/10) + (1-PS/100) + (1-POL/10) + (1-ST/10) + (1-PT/100)$$

Legend:
- $\log P$ (octanol/water);
- $\log D$ (at pH of synthesis);
- PS polar surface (angstrom$^2$);
- POL polarizability ($10^{-24}$cm$^3$);
- ST surface tension (dyne/cm);
- PT vapor pressure at 25°C (mmHg).
(8) Laboratory microencapsulation of new materials, and transfer of optimized processes into industrial reactors

Laboratory reactor 1L

Pilot industrial reactor 10L

Industrial reactor 200L

Scaling-up

4. Uses information effectively to accomplish a specific purpose

5. Understands economic, legal, and social issues; accesses and uses information ethically and legally
(9) Incorporation of microcapsules into new formulations and market products;

4. Uses information effectively to accomplish a specific purpose

5. Understands economic, legal, and social issues; accesses and uses information ethically and legally

Use: carbonless copy paper forms
Introducing the methodology of data structuring – prediction matrix

PRESSURE-SENSITIVE COPYING PAPERS

TWO ACTIVE LAYERS

ONE ACTIVE LAYER

SINGLE MICROCAPSULES

DOUBLE MICROCAPSULES

1 2 3

4 5 6

7 8

4. Uses information effectively to accomplish a specific purpose
Identifying two systems with the largest number of innovations

Searching for original patent free niches

4. Uses information effectively to accomplish a specific purpose
New applications and products

Self-contained printing inks

MICROCAPSULES - LEUCO DYE

Bank mailers with printed microcapsules

Fragranced papers

MICROENCAPSULATED PERFUME

Perfumed paper stickers

4. Uses information effectively to accomplish a specific purpose
New applications and products

- Microencapsulated antimicrobial agents for textile shoe insoles
- Microencapsulated animal repellents with prolonged activity
(10) Generalization of the methodology to support R & D activities in academic and industrial environments

1. Definition of the research field
2. Preparation of profiles for advanced search queries
3. Construction of a specialised in-house information system
4. Analysis, structuring and synthesis of information
5. Design and laboratory verification of selected processes
6. Identification of process parameters - properties relationships
7. Development of a QSPR model
8. Laboratory process optimisation, transfer to industrial reactors
9. Development of new formulations and market products
10. Generalization of the methodology to support R & D activities
Outcomes / results

1. Specialised information system to support R&D

2. Scientific and technological innovations - scientific articles, patents, market products

3. Methodological approach for university education in scientific and technical informatics

4. Competent students and researchers
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