Designing Instruction Activities to Guide Students Through the Research Lifecycle: A Science Librarian Approach

Li, Ye

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Designing Instruction Activities to Guide Students through the Research Lifecycle

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Trends in Instructions Provided by Librarians in Research Institutions
Collection Centered

Information Literacy

Research Literacy

Research Focused

Information Literacy
Research Methodology
Data Literacy
Laboratory Safety
Ethics

* Trends in Instructions Provided by Librarians in Research Institutions
* Teaching and Learning Environment

Curriculum-centric content delivery

* Research Environment

Working on a highly-focused topic in isolation

* Changing Environment in Higher Education

doi:10.1080/13614533.2012.665718
Gatekeeper

User-focused Resource Selector and Service Provider

Supporters for Researchers / Learners throughout Research Lifecycle

Internet and electronic resources

Data-intensive research

* Evolving Role of Subject Specialists
Subject specialists focuses more on supporting RESEARCH.
All steps involve obtaining, digesting, managing, synthesizing, and disseminating information

Librarians are good at connecting resources and people together

We can contribute to each step before and after lab!
Communicating research results

Still appear to be collection-centered.

Orientation to library resources and services

Finding, organizing, managing and evaluating scholarly information

Credit-bearing courses

Other

Types of Instructions from Sci & Engin Librarians at the Univ. of Michigan
Instruction Materials Posted on XCITR.org
(Data summarized from Content Map of http://www.xcitr.org)

- Library and Literature for Chemists 33%
- Search Skills 24%
- Grant Funding Resources 10%
- Information Management Tools 10%
- Communicating in Chemistry 15%
- Ethics, Copyright and IP 3%
- Other 2%
- Laboratory Work 12%
- In-depth specialized skills

Extending to the whole research lifecycle

*What Chemistry Librarians May Be Doing?
* Focusing on this step – “Find, manage, organize, and evaluate scholarly information”
  * In-depth/advanced searching skills
  * Critically evaluating information
  * Extending to other steps of the research lifecycle

* Current Focus in Instruction
* Undergraduate Student

“I participated in UROP (Undergraduate Research Opportunity Program) during my first year here. Although I was super busy in the lab, I didn’t think I learned how to do research. I still have no idea how to approach a new research project.”

* Graduate Student

“I know how to obtain ‘good enough’ articles quickly. Is there anything else I need to learn (from you)?”

“I’ve read ten articles on this topic, but how am I supposed to come up with an original proposal from them? I can’t discuss this with my advisor. ”

Gaps between learning knowledge/skills and applying the knowledge/skills into research need to be filled.

* What Students Have to Say?
* Most popular sessions requested by instructors
  * Scientific Writing and Presenting Your Research Results
  * Wikipedia Editing

* Basic search skills mostly requested as customized online tutorials and office hours

* Advanced search skills occasionally requested

Going in-depth with finding information is important but we also need to explore the breadth of our instruction scope.

* How about Professors?
Mapping instruction activities to the RLC can guide librarians to identify:

* Gaps in supporting research
* Opportunities to collaborate with other librarian colleagues and other units on campus for instruction development.

* Mapping Current Instructions to RLC
For Undergraduates

A basic for-credit course is in place. Needs to develop an advanced level course.
<table>
<thead>
<tr>
<th>Course</th>
<th>UC 174: Digital Research: Critical Concepts and Strategies</th>
</tr>
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<tbody>
<tr>
<td>Audience</td>
<td>First- and second-year undergraduates</td>
</tr>
<tr>
<td>Credit</td>
<td>1 Credit Hour</td>
</tr>
<tr>
<td>Length</td>
<td>2 hours / week, 7 weeks</td>
</tr>
<tr>
<td>Focus</td>
<td>Basics of “finding, organizing, managing and evaluating scholarly information”</td>
</tr>
<tr>
<td>Final project</td>
<td>An annotated bibliography on the topic selected by the student</td>
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<tr>
<td>Participation</td>
<td>~100 undergraduates / year ; ~30 in Sciences</td>
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</table>
To design another advanced level course for students in the Sciences

- Go in-depth?
- Extend to other steps of RLC?
<table>
<thead>
<tr>
<th>Course</th>
<th>UC 174: Digital Research: Critical Concepts and Strategies</th>
<th>UC 270: Digital Research in the Sciences</th>
</tr>
</thead>
<tbody>
<tr>
<td>Audience</td>
<td>First- and second-year undergraduates</td>
<td>Junior and senior undergraduates</td>
</tr>
<tr>
<td>Credit</td>
<td>1 Credit Hour</td>
<td>2 Credit Hours</td>
</tr>
<tr>
<td>Length</td>
<td>2 hours / week, 7 weeks</td>
<td>2 hours / week, 12 weeks</td>
</tr>
<tr>
<td>Focus</td>
<td>Basics of “finding, organizing, managing and evaluating scholarly information”</td>
<td>Expanding the “basics” and Extending to “write a research proposal / presenting research”</td>
</tr>
<tr>
<td>Final project</td>
<td>An annotated bibliography on the topic selected by the student</td>
<td>A mini literature review and a mini research proposal</td>
</tr>
<tr>
<td>Participation</td>
<td>~100 undergraduates / year; ~30 in Sciences</td>
<td>A trial in 2013</td>
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*Overview of UC 270 - An advanced level research course*
Understand RLC and Scholarly Communication
Identify and organize large sets of reference for an interested research direction
Find background information to help digest the references
Read, outline and evaluate articles selected from the large set
Identify a research topic based on the readings

Write a mini-review on the selected research topic
Understand research methods and identify valid scientific hypothesis
Propose valid research questions and design research plans
Write a mini-proposal
Present the research proposal and process led to the proposal

- 8 Assignments + 3 Reflections build up to a mini-review, mini-proposal, and an oral presentation
- Depth: practice advanced search skills with the goal to select a research topic
- Breadth: RLC steps beyond finding, organizing, and evaluating information
- Students run demonstrations of databases and software
- In-class discussions on issues in scholarly communication, such as open access and negative citations, etc.
Scholarly Publication Types

- Basic concepts
  - General knowledge
  - Overview
  - Techniques
  - Future directions

- Tertiary Sources
  - Review Articles
  - Handbooks
  - Reference books
  - Textbooks
  - Edited books
  - Encyclopedia

- Primary Literature
  - Letters and Communications
  - Research Notes
  - Full Research Articles
  - Patents
  - Technical Reports
  - Dissertations and Theses

- Secondary Sources
  - Catalogs (e.g., Mirlyn)
  - Search Engine (e.g., Google Scholar)
  - Databases (e.g., Web of Science)

- Access point to Primary and Tertiary Sources

- Research 'story'
  - Technical details
Research Output

Electronic Lab Notebook

Research Records
Text files (Word, TXT, Google Docs etc.)
Spread sheets (Excel, Google Spreadsheets, CSV etc.)

Research Life Cycle
Generate Ideas
Find and communicate with collaborators
Find, organize, manage, and evaluate scholarly information
Define research topic/questions
Write grant proposal/obtain funding (GOV, NGO, Industry)

Undertake research
Collect data
Disseminate results
Preserve data
Discover and re-use data and research results
Disseminate/share data and research results

Apply research results/Solve real world problems
Process, analyze, visualize and interpret data

Data and associated metadata in a format commonly usable in the community
Data in various formats associated with various computing software
Raw data in various formats (mostly proprietary)
Resource management files (e.g. cell/mice colony management)

Paper Lab Notebook

Organize and cross reference all records, documents, and data

RLC and Scholarly Communication

- Popular magazines
- Business magazines
- Newspaper
- News websites
- Social network

- Letters and communications
- Research notes
- Full research articles
- Patents

- Data depositing to disciplinary or institutional repositories
- Technical report
- Dissertation and theses
- Research reports

- Emails
- Research blogs
- Group webpages
- Reports
- Preprints
- Conference abstracts, papers, proceedings etc
- Research proposals
<table>
<thead>
<tr>
<th>Major Section</th>
<th>Authors need to explain</th>
<th>Readers need to identify</th>
<th>Readers need to evaluate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Introduction</td>
<td>• What is in the paper?</td>
<td>• What is the subject?</td>
<td>• Background information sufficient?</td>
</tr>
<tr>
<td></td>
<td>• Why is it an interesting and worthwhile issue?</td>
<td>• What is known?</td>
<td>• Reasoning logic?</td>
</tr>
<tr>
<td></td>
<td>• Who contributed what previously?</td>
<td>• What remains to be known?</td>
<td>• Research questions valid? relevant?</td>
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<tr>
<td></td>
<td></td>
<td>• How or why a certain new question or questions arose?</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• What did the authors do to evaluate and answer the new questions?</td>
<td></td>
</tr>
<tr>
<td>Methods</td>
<td>• How did they do the work? (for others to duplicate and confirm)</td>
<td>• Initial facts and assumptions</td>
<td>• Methodology valid? Relevant?</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Object, materials, place, instruments, programs, etc. involved.</td>
<td>• Assumptions of the methods valid for the research question?</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Protocols and methods to obtain/collect and analyze data.</td>
<td>• Sampling representative?</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Well planned and executed?</td>
</tr>
<tr>
<td>Results</td>
<td>• What facts are revealed by the work?</td>
<td>• Statement about each findings</td>
<td>• Data presented accurate, organized?</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Multifaceted and complex data</td>
<td>• Facts, opinions, or facts under certain assumptions?</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Links among data identified by the authors</td>
<td>• Consistent? Logic? Assumptions reasonable?</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Authors’ interpretations</td>
<td></td>
</tr>
<tr>
<td>Discussion</td>
<td>• What do the results mean?</td>
<td>• New points illuminated by results</td>
<td>• Argument strong or weak? (1) well-structured?</td>
</tr>
<tr>
<td></td>
<td>• What are the answers to the proposed questions?</td>
<td>• How did or did not previous knowledge get changed by new findings?</td>
<td>(2) Clear? (3) Well-supported by relevant evidences in Results? (4) Logic?</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Comparisons with the results of others and discuss the consequences of those comparisons.</td>
<td></td>
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Defining a Research Topic from a Vague Research Direction

**Brainstorming**

- Identify P (Problem or Process etc.) and I (Intervention or improvement etc.) within your research direction
- Find background information from reference works (e.g., Encyclopedia, Handbooks, textbooks, or review articles)

**Exploring Possibilities**

- Outline the structure of knowledge body for the key concepts/processes involved.
  - Use synonyms or subject descriptors that databases assigned to search
  - Use wildcard symbol (*) to truncate terms
  - Use less search terms

- Use filters (Subject, document type, publication year etc.) to narrow down
  - Use subject descriptors that database assigned to search
  - Add more search terms with AND when you find specific aspects to focus on. E.g. C (Comparison) and O (Outcome) you identified

**Choosing a Topic**

- List potential sub-topics
- Read and evaluate selected articles

- For most important documents selected
  - Go backward in time by finding the references cited in the document
  - Go forwards in time by finding the articles that cite this document

- Evaluate potential sub-topics to choose one topic that:
  - Contains at least the P (problem, process...) and I (intervention or improvement) components
  - Is well defined and focused
  - Is not fully understood
  - Draws interest from researchers in the field
  - Has the potential for you to ask multiple research questions about.

The process is never linear. You always need to go back and forth to reach a good research topic.
Research Methods

Empirical Science
- Classical Scientific Methods
  - Experimentation
    - Testing Hypothesis
    - Measuring a Value
    - Measuring a Function or Relationship
  - Correlational Observation
  - Comparative Observation
  - Perturbation Study
  - Observation
    - Measurement of Behaviors
  - Description
- Modeling (Physical and Computer-based)
  - Models for Predictions
  - Models as Experimental Tools
- Applied Science
  - Programming
  - Designing
  - Engineering
  - Case Study
  - Action Research
  - ..........
* Students showed initial interests to register for the course (10-15 people registered) but then gave up when semester was about to start (only 3 students showed up on the first day)

* Course trial turned into a guided study

* Only one student finished the course

* Course load may be more appropriate for 3-credit hours

* Instructor may not be able to advise the research topic students selected

  * May need to form an instruction team with subject specialists in multiple disciplines

* Challenges Identified from the Trial of UC 270
* “I really enjoyed taking this class, especially since this class was not like the lecture-style classes that I normally take at engineering school.”

* “I do think I've benefited a lot from this class, especially for deciding about my future plan in going to graduate school.”

* (Most valuable things learned from the course?) “Critical Thinking Skills, Especially when I had to design my own research to write the proposal; Reading scholarly journal articles, searching database, writing skills, reviewing articles.”
“Currently, I am finding the class to be more demanding than a regular 2 credit 200-level course, based on the Mini-review comments you provided. The comments did help me a lot in enhancing my review article writing skills. However, I do not think I will be able to meet the criteria you gave as a feedback if I spend about 6 to 8 hours per week.”

“Maybe instead of writing the mini-review, we could have just written informal reviews throughout the semester via blog. For example, every other week, I could read an article, and then write some brief summary about the article and its topic, and make some comments on the articles.”
* Do faculty and students view librarians as trusted instructors for research beyond topics directly around finding information?

* Am I getting too far from our comfortable zone (our specialty)?

* Did I step on toes ... ?

* Questions Remains...
For Graduate Students

No for-credit courses.
Create workshop series around the Research Lifecycle.
* Orientation to Library Resources and Services
* Research Lifecycle Overview
* Advanced Database Search
* Reading, Outlining and Evaluating Research Articles
* Reference Organization and Management
* Data Literacy Workshop Series
  * Data Lifecycle and Your Data Story
* Communicating Research Results
* Publishing in the Sciences

* Workshop Delivered by Subject Specialists
<table>
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<th>Workshops</th>
<th>To collaborate with</th>
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<tr>
<td>Finding Grant Source/Opportunities</td>
<td>Grant Librarian</td>
</tr>
<tr>
<td>Data Management Plan</td>
<td>Data Librarian</td>
</tr>
<tr>
<td>Data Documentation, Organization, and Metadata</td>
<td>Data/metadata Librarian</td>
</tr>
<tr>
<td>Copyright and Intellectual Property</td>
<td>Copyright Librarian</td>
</tr>
<tr>
<td>Data Citation and Re-use</td>
<td>Data Librarian</td>
</tr>
<tr>
<td>ORCID, Bibliometrics and Altmetrics for Measuring Research Impact</td>
<td>Data Librarian</td>
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* Workshops to Collaborate with Other Librarians*
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<tr>
<td>Identify Expertise on Campus and Beyond</td>
<td>Office of Vice President for Research</td>
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<tr>
<td>Writing Literature Review (for Your Paper / Dissertation)</td>
<td>Writing Center</td>
</tr>
<tr>
<td>Research Methods in the Disciplines</td>
<td>Faculty</td>
</tr>
<tr>
<td>Research Ethics, Compliance to Policies and Guidelines</td>
<td>Office of Vice President for Research</td>
</tr>
<tr>
<td>Writing Grant Proposal</td>
<td>Writing Center</td>
</tr>
<tr>
<td>Safety Information and Lab Protocols</td>
<td>Lab Safety Officers in Departments</td>
</tr>
<tr>
<td>Using Electronic Lab Notebooks</td>
<td>ITS</td>
</tr>
<tr>
<td>Data Processing and Visualization</td>
<td>ITS, Center for Statistical Computing and Analysis</td>
</tr>
<tr>
<td>Data Storage, Backup and Security</td>
<td>ITS</td>
</tr>
<tr>
<td>Data Preservation, Sharing and Licensing</td>
<td>Institutional Repository</td>
</tr>
<tr>
<td>Tech Transfer Basics and Resources</td>
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* Workshops to Collaborate with Other Units on Campus*
* ... the primary goal of Science is not the research output but the people who do science - scientists, one generation after another...

* ... start from deep and profound understanding of the subject matter and collaborate with students to find answers to interesting questions together ...

* ... work with student collaborators to translate how research is done to how education is done...

--- Summarized from Prof. Brian Coppola’s talk at the 246th ACS National Meeting, Indy, IN, September 10, 2013
Designing instructions based on what’s needed at each step of the research lifecycle

Designing instructions based on sources/resources in our collection

Continue going in-depth with chemical information literacy skills

Continue extending the breadth further throughout the research lifecycle via collaborations with other librarians and other units

*What’s Next for Chemistry Librarian?
Designing instructions based on sources/resources in our collection

Designing instructions based on what’s needed at each step of the research lifecycle

Continue going in-depth with chemical information literacy skills

Continue extending the breadth further throughout the research lifecycle via collaborations with other librarians and other units

* What’s Next for Chemistry Librarian?
* Thank Doreen Bradley and the UC 174 instruction team at MLibrary for the UC 174 materials and their support to this work

* Thank my colleagues, especially members of the Research Lifecycle Committee at MLibrary for inspiring this work

* Thank all students participated in the UC 270 trial
Thank you!

Did I get carried away and lose the focus on our unique specialty?

Contact Ye Li at liye@umich.edu