Exploring Beyond the Core

Science literacy in an undergraduate integrated curriculum

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What is iSci?

iSci is an innovative four-year undergraduate program offered by the Faculty of Science at McMaster University. With an intake of fewer than sixty students, a focus on learning by research, and a unique pedagogical model, iSci attracts high-achieving students who want a varied, challenging and integrated science degree.

"Teaching unenriched by research can seem impoverished."[1]

iSci students work on consecutive "research projects" which provoke, guide, and structure their learning. The research projects contain both group and individual elements, and require positive interdependence[2], with students sharing information and results. We introduce students to group work techniques and encourage reflective practice and collaborative authorship skills. Our typical group size is four[3].

iSci is both learning by research and learning to research. iSci students are learning to become scientists by doing science[4] not only in the classroom and laboratory, but also by practicing how scientists communicate to academic and general audiences, how data is gathered in the field, and how research is planned and performed. This research experience at the undergraduate level will prepare students for their professional lives[5].

What is Science Literacy?

Science literacy, as we define it, is **the writing, reading, communication and information research skills required to practice science**. Science literacy (or more colloquially, 'Sci Lit') is a core component of the program from years one through three. In Level 1, Sci Lit is a two-hour weekly class. Concepts developed in the interactive, collaboratively-taught science literacy classes support the research projects that form the basis of learning in iSci.

Science Literacy Skills

We aim to introduce and develop skills in the following areas across the program:

- Academic integrity
- Personal and team time and task management
- Information retrieval
- Source selection and evaluation
- Citations, bibliographies, styles, bibliographic software
- Individual and collaborative writing
- Poster and oral presentation
- Communicating with different audiences
- Preparing visual information (slides, posters, graphs)
- The peer review process
- Drafting and editing of written work
- Reading and writing academic papers
- Research ethics and informed consent
- Research processes and approaches
- Professional communication and interaction
- Career development

Awareness of ethics, informed consent, and research project design in an area outside science were strengthened by discussing this pedagogic research project with students.

Teaching Techniques

Team Teaching: The Sci Lit component and class is co-administered and co-taught by Symons and Colgoni. Each brings unique skills to Sci Lit, with Symons an active researcher and Colgoni a professional librarian.

"Students really only begin to get the knack of discovery and research by repeating the process."[5]

Classes and Context: The Level 1 Sci Lit classroom content often directly supports upcoming project content. Sessions are a mixture of traditional blackboard teaching, learning activities, formative quizzes, discussion, and student presentations. The students are provided a scaffolded learning experience such that an upcoming project presentation has class support for slide design, delivery and practice.

Assessment and Alignment: Assessment comes from individual writing and communication tasks including writing science blog posts and seeking feedback on written work being prepared for other parts of the course. In the higher levels, students can gain credit for a wide range of science communication activities.

Feedback: Many projects use peer feedback groups[2] during the authorship phase. Students are also invited to give feedback on the course itself, which promotes a sense of involvement in program design as the course evolves.

References

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2. Johnson, D.W., Johnson, R.T., & Smith, K.A. (1998) Active Learning.
3. Raine, D.J. & Symons, S.L. (2005) PossiBiLities. http://goo.gl/zKv66
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6. Seago, J.L. (1992) The American Biology Teacher. 54(7) pp. 401-405.

Survey Methods

Background

- Part of a longitudinal study of the iSci program
- All current students invited to participate at the end of their academic year
- Ethics approved, informed consent, methods described and discussed (awareness of research activities)
- Piloted survey instrument in April 2012
- N=84; 91% response rate

Instrument

- Survey instrument was an online LimeSurvey using Likert scale questions, plus two paper-based "graphing" questions
- Eight pairs of questions on different skills:
  - How important do you think this skill is?
  - How confident are you that iSci helps you develop this skill?
- Two questions on library resources
- A question about Science Literacy in the iSci program at (up to) three levels of the program
- A question about the relative amount of feedback within iSci compared with other courses

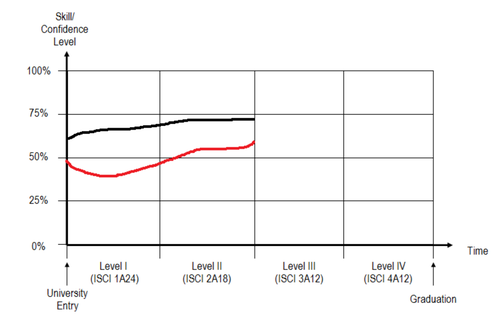

Figure 1: A sample graphing question which asked students to draw their perceived skill and confidence over time.

Evaluation

We also evaluated the instrument for development purposes, asking if each question was clearly worded, asking the external consent monitor for reflections on survey procedure.

Preliminary Survey Results

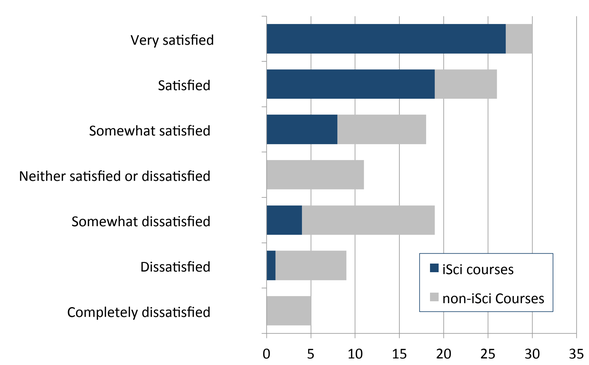

Figure 2: Satisfaction in opportunities for receiving feedback in the students' iSci course vs. non-iSci courses this year (Levels 1-3 aggregated). Number of responses is indicated on the x axis. Students indicate much more satisfaction with the opportunities within the program compared to external courses.

Level 1	Level 2	Level 3	
Information retrieval	Presentation skills	Presentation skills	Most
Information evaluation	Editing your own writing	Editing your own writing	
Presentation skills	Collaborative authorship	Information retrieval	
Individual authorship	Individual authorship	Information evaluation	
Editing your own writing	Information retrieval	Individual authorship	
Collaborative authorship	Information evaluation	Collaborative authorship	
Preparing visual materials	Preparing visual materials	Preparing visual materials	Least

Figure 4: A ranked order of students' perceived importance of science literacy skills by level in the program. Most important skills are at the top. Some skills, like editing one's own writing and presentation skills, become more important to students as they progress in the program. Both of the information use skills start off important, dip in Level 2, but rise again in Level 3.

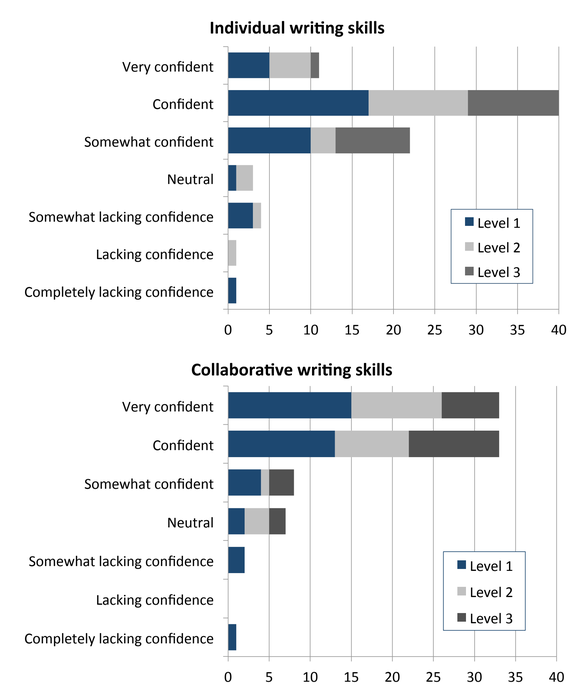

Figure 3: Confidence that iSci is developing students' skills in individual writing (top) and collaborative writing (bottom) by level of the program. Number of responses is indicated on the x axis. This data set suggests that students are increasingly confident that the program is developing their writing skills as they progress from year to year. Responses also demonstrate the generally positive student perception of writing support within the Science Literacy component and the wider course.

The graphing question (see Figure 1) revealed that all Level 1 students gained in both skills and confidence in writing and information skills. Level 2 and 3 students seemed to reflect more on confidence levels, sometimes showing dips, plateaus or recoveries through the Levels. Most often, confidence levels moved in parallel with skill level, however, this was not always the case.

Conclusions & Next Steps

Skills emphasis: Student's perceptions of presentation skills as very important suggest that the program may be over-emphasizing it relative to individual authorship and self-editing (these being more important for practicing scientists).

High vs. Low: Students value the high-stakes integrated and collaborative writing tasks much more than the low-stakes individual writing tasks.

Graphing Question: We see interesting personal journeys, but they are quite difficult to evaluate en masse. Students find it difficult to assess their own skills accurately.

Longitudinal: This survey is part of a long-term plan to gather student feedback during and after they leave the program. Will take student feedback to edit and clarify this instrument for coming year.

iSci Alumni: Surveys performed at one, three and five years post-graduation will identify whether the Sci Lit component of iSci has been preparing students for the kind of career they eventually choose.