Evidence-based program design: INTEGRATED SCIENCE

S L Symons, A Colgoni, C H Eyles, C T Harvey, S J Robinson
Integrated Science Program, McMaster University

An introduction to Integrated Science (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.

This poster uses Chickering & Gamson's "seven principles" (1987)to explore how the iSci instructional team incorporated results from educational research projects into the design of the iSci program:

Seven principles for good practice in undergraduate education

1. Encourages contact between students and faculty
2. Develops reciprocity and cooperation among students
3. Encourages active learning
4. Gives prompt feedback
5. Emphasizes time on task
6. Communicates high expectations
7. Respects diverse talents and ways of learning

1: A learning community

Seven "iCore" members oversee day-to-day program management, steering, design, and administration, while a wider team of instructors ("iTeach") are involved in teaching. iSci's base is in the Thode Science Library where our offices, teaching space, and study area are all designed to create a community learning environment.

iTeach: members of the iSci instructional team

2: Team work and individual learning

iSci students work on consecutive "research projects" which provoke, guide, and structure their learning. The research projects contain both group and individual elements, and often require positive interdependence (Johnson et al., 1998), 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 (Raine & Symons, 2005).

3: Active learning

"Teaching unenriched by research can seem impoverished." (Fernández-Armesto, 2010)

iSci is both learning *by* research and learning *to* research. iSci students are learning to become scientists by doing science (Hunter et al., 2007), 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. All faculty members involved in iSci also perform research, thus students have the opportunity of observing how we work, which strengthens their understanding of research (Seago, 1992).

4: Communicating achievement

Assessment and feedback in the iSci program is based on the idea of "alignment": learning objectives, pedagogical methods, assessment tasks, and feedback processes are all aligned to create a coherent scheme for learning. iSci students are exposed to both traditional methods (exams, homework) and project deliverables (papers, abstracts, posters, presentations) to prove competency in knowledge, skills, and ability to apply and communicate ideas. Feedback is aimed at improvement in conceptual awareness, critical thinking, information and science literacy skills, and reflective practice. Many projects use peer feedback groups (Johnson et al., 1998) during the authorship phase. Students are also invited to give feedback on the course itself, promoting a sense of involvement in program design as the course evolves.

Week	Level I	Level II
1	Basic Training and **Practise Research Project**	Intro to Level II
2		Preparatory Content & Reading
3		**Neuroscience**
4		
5		
6		Preparatory Content & Reading
7	**Mission to Mars**	**Secret Lives: Quantum Mechanics**
8		
9		
10	Preparatory Content & Reading	Preparatory Content & Reading
11	**Drugs, Diffusion, and Biodistribution**	**History of the Earth**
12		
13		
1	Preparatory Content & Reading	Preparatory Content & Reading
2	**Sustainable Energy in Challenging Environments**	**Drug Discovery**
3		
4		
5		Preparatory Content & Reading
6		**Plant-Animal Interactions**
7	Preparatory Content & Reading	
8	**Cancer: a 20th Century Plague**	
9		Preparatory Content & Reading
10		**Why Things Happen: Thermodynamics**
11		
12		
13	Review	Review

Research Projects through the year in Levels I and II

COMPONENT	ACTIVITY			
	Exams	Continuous	Projects	TOTAL
Math	32	20	28	**80**
Physics	32	20	28	**80**
Chemistry	32	20	28	**80**
Life Sciences	32	20	28	**80**
Earth Sciences	12	10	18	**40**
Science Literacy	None	10	30	**40**
TOTAL				**400**

COMPONENT	ACTIVITY			
	Exams	Continuous	Projects	TOTAL
Neuroscience	10		28	**38**
Quantum Mechanics	10		28	**38**
Earth History & History of Science	10		28	**38**
Biochemistry	15		23	**38**
Ecology	10		28	**38**
Thermodynamics	15		23	**38**
Math	30		8	**38**
Laboratory Techniques	None	18		**18**
Science Literacy	None	8	8	**16**
TOTAL				**300**

Aligned Assessment: mark distribution for iSci Level I (left) and Level II (right) reflect the inclusion of different modes of assessment throughout the course. Continuous assessment includes exercises, laboratory notes and reports, and writing for the iSci blog.

5: Time to learn

"Students really only begin to get the knack of discovery and research by repeating the process." (Seago, 1992)

Research projects in iSci take four or six weeks. and immerse students in an interdisciplinary subject area. Core learning is identified (Levels I and II), but there is room for exploration and diversification. The Level I iSci course takes up 24 of 30 first-year credits. This decreases to 18 credits in Level II and 12 in Levels III and IV.

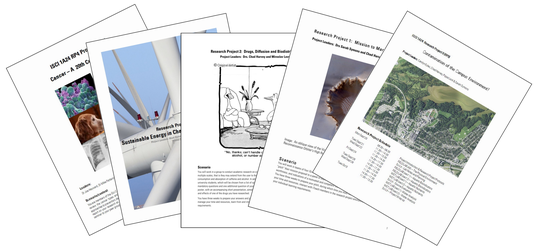
6: High expectations

The iSci program attracts students with high personal standards for achievement in grades. A successful iSci experience requires students to manage individual learning and collaborative effort to produce project deliverables, to interact efficiently with colleagues and faculty, and maintain a healthy study-life balance. We teach project planning techniques and personal management skills to help students understand our expectations and to identify their own learning goals (Johnson et al., 1998).

iSci students in the field: an environmental assessment exercise forms the practice research project in Level I. Field work in geology, biology, and environmental science continues throughout the course.

7: Different paths

We use instructional design methods, materials, activities, and technologies to build a course where students can access information in many different ways. Research projects begin with students identifying "what I have to do", "what I know", "what I need to find out", and "how I will work on this in the time available" (Raine & Symons, 2005). This research experience at the undergraduate level will prepare students for their professional lives (Russell et al., 2007).



Level I Research Project Packs guide students' individual learning and group deliverable creation

References

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