UNIVERSITY OF CALGARY | FACULTY OF SCIENCE

CURRICULUM REVIEW REPORT

NATURAL SCIENCES PROGRAM

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Executive Summary

The Natural Sciences (NTSC) Program is a multidisciplinary undergraduate Program within the Faculty of Science. It offers students the flexibility to tailor their degree around their scientific interests and the opportunity to gain a big picture perspective on science as they build collaborative competencies. Our staff numbers are small (9 academic staff members, 1 administrator) but our student numbers are substantial (Fall 2014 – 539 students), and the needs in the Faculty of Science that we contribute to are significant.

The Natural Sciences Program offers a novel alternative to traditional degree programs. Capstone courses incorporate blended- and inquiry-based teaching strategies to enhance student participation and understanding. By capitalizing on the inherent multidisciplinary nature of science, the program promotes scholarship and a deep understanding of scientific principles. Students in the Natural Sciences develop leadership skills and are able to contribute effectively in teams composed of individuals with very different backgrounds and areas of expertise. The Natural Sciences Program is an excellent platform for entrance to any professional program such as law or medicine and career choices open to holders of a Bachelor of Science in the Natural Sciences are huge - limited only by the student's imagination, interest and ability.

To encourage and develop collaborative competencies among our students, faculty members routinely collaborate when developing and running Natural Sciences courses. Such collaborations can begin with the members of our program, as each one is cross-appointed with a home Department in the Faculty of Science (Biological Sciences, Chemistry, Geoscience, Math and Statistics, and Physics and Astronomy), as well as one member from the Faculty of Arts (Geography). Our collaborative focus within the program also compliments the connections made beyond our Program, as we routinely seek out collaborations with people in other STEM disciplines, the Werklund School of Education, and the Taylor Institute for Teaching and Learning. These collaborations connect strongly with the learning experiences we offer; we teach in ways that invite discussion, use of evidence, and thoughtful writing. Students are encouraged to share their ideas about science to peers and others beyond their disciplines.

The students and faculty in the Natural Sciences Program have made good gains building undergraduate learning experiences that cross disciplinary borders and push us to think deeply about our contributions to the worlds' challenges. Our greatest barrier to the continued growth and development of this important work lies in forging new workflow paths connecting with Departments within our Faculty; doing this well would allow the Natural Sciences Program to operate as a true resource for collaborative skill development within the Faculty of Science.

Overview and Context of the Program

The Bachelor of Science (BSc) degree in Natural Sciences is an innovative, multidisciplinary program with unparalleled opportunity to tailor the focus of a student's education. The Natural Sciences Program caters to students who have an intense interest in science and fosters an appreciation of the fundamental importance of a multidisciplinary approach to science. The Natural Sciences Program differs from traditional science programs by giving students greater flexibility and options in the educational path. Students are encouraged to meet with faculty regularly to discuss and plan.

Each Natural Science student builds a unique program based primarily on personal interests while concentrating studies in two areas within the Faculty of Science (Biological Sciences, Chemistry, Computer Science, Energy Science, Geoscience, Mathematics, and Physics and Astronomy). By concentrating in two specialties, students capitalize on the strengths of two departments within the Faculty of Science and are exposed to a wider range of scientific perspectives than would normally be possible. The Energy Sciences concentration is a unique program that trains students in the science of development and use of sustainable fuels. The Energy Science concentration accomplishes this training with a solid grounding in basic physics and chemistry, an introductory course in energy systems, independent study courses, and a capstone, group project-based course. The program also offers several courses in specific non-fossil sources of energy such as hydroelectricity, geothermal, nuclear.

Our current Faculty of Science is built around strong, discipline-specific Departments. The Natural Sciences Program fits between Science Departments and offers courses to help students see connections across science as a whole. Students increasingly need courses and programs that engage them in thinking beyond disciplinary silos. Such thinking will help them make important contributions in a world that is grappling with enormous challenges. Addressing world challenges relating to climate, energy, or health will require people (especially scientists) to connect, collaborate, and integrate ideas. The need for collaboration across disciplines is highlighted on many levels, from the priority of Interdisciplinarity within our own Academic Plan to the priorities of significant international groups like the United Nations (e.g., UNESCO meeting, 19-21 December 2016, to address Complex Global Issues [that] Require a Broader and "Connect-the-Dots" Science Approach http://en.unesco.org/news/complex-global-issues-require-broader-and-connect-dots-science-approach). Educators and educational institutions around the world are working to strengthen how we prepare our students to tackle these challenges (e.g., Project 2061 through the American Association for the Advancement of Science). Students need to learn about science in a multi-faceted way, infused with team collaborations, hands-on learning, and high-impact teaching practices in classroom and laboratory settings throughout their program of study.

The Natural Sciences Program at the University of Calgary is positioned to help students develop a multi-faceted approach to science and build collaborative skills they will need when facing complex challenges. Our core offers multidisciplinary courses in: Research Design and Statistical Analysis, Science in Society, and Capstone Projects. For Natural Sciences students with an Energy Science concentration, we offer Energy Science content courses, such as: Fundamentals of Nuclear Energy Production and Fundamentals of Geothermal Energy. Additionally, students outside of the Natural Sciences Program can

also benefit from our multidisciplinary courses; our science-writing course serves Geology and Chemistry majors, and our course in the nature of science serves non-science students. These courses have been collaboratively built and involve a variety of high impact teaching practices. Experiences in these classes have been informed by findings from current scientific research and educational research on learning.

Program Learning Outcomes (PLOs):

By the end of the Natural Sciences Program, students will be expected to be able to:

1. Collaborate with people from different disciplines to enable a multidisciplinary approach to solving problems.

2. Find, read, and evaluate scientific evidence and use this evidence to support or reject a scientific argument.

3. Negotiate conflicting sources of evidence and interpretation to arrive at well-reasoned conclusions.

4. Communicate scientific ideas to a range of audiences in written, oral or graphical formats to create a bridge between scientific research and society.

5. Apply scientific knowledge and skills to design experiments and draw valid inferences from data analyses.

6. Develop awareness that science is a human endeavor and is situated in social contexts.

Guiding Questions

Natural Science Program Questions:

1. How does the Natural Sciences Program prepare students for further study?
2. How can the Natural Sciences Program enhance the student experience through teaching and learning activities?
3. Does the Natural Sciences Program provide interdisciplinary opportunities and develop collaborative competencies?

Faculty-Wide Questions:

Based on the data from the National Survey of Student Engagement, the Faculty of Science is seeking additional information regarding High-Impact Educational Practices. High-Impact Practices (HIPs) share several traits: They generally demand considerable time and effort, facilitate learning outside of the classroom, require meaningful interactions between faculty and students, encourage collaboration with diverse others, and provide frequent and substantive feedback. Examples of HIPs include, but are not limited to:

- Learning community or some other formal program where groups of students take two or more classes together
- Courses that included a community-based project (service-learning)
- Work with a faculty member on a research project
- Internship, co-op, field experience, student teaching, or clinical placement
- Study abroad
- Culminating senior experience (capstone course, senior project or thesis, comprehensive exam, portfolio, etc.)

1. Are High Impact Practices being used regularly in the Natural Sciences Program?
2. If not, what is preventing these practices from being used?

Action Plan

Recommendation	Action Item	Who is Responsible?	Due Date
Program goals: Align with Faculty of Science values on interdisciplinarity and support this alignment to enhance student learning *[to address our Guiding Question 3 & the Faculty-Wide Questions]*	1. Encourage **conversation** at Faculty of Science level surrounding the value of a multidisciplinary approach and how the Natural Sciences Program can serve as a resource for this.	Program Director in consultation with other NTSC faculty members	Ongoing to 2021
	2. Encourage **conversation** at Faculty of Science level around how to best support students, faculty, and courses within the Energy Science concentration.	Program Director in consultation with other NTSC faculty members	Ongoing to 2021
	3. Build **community** via a HIP at the program level to improve our communication with students and the wider community about the advantage a NTSC degree offers	Program Director in consultation with other NTSC faculty members	Ongoing to 2021
	4. Develop **connections** with Natural Sciences Student Association to promote program (e.g. inquire about NTSC gear at U of C bookstore)	Program Director in consultation with other NTSC faculty members	Summer/Fall 2017
Course design: Highlight expectations of the development of skills throughout required courses *[to address our Guiding Questions 1&3]*	5. Add PLOs and Graduate Attribute information to our course syllabi to reveal these goals of **progression** to students in the required courses (SCIE301, SCIE403, SCIE501/529)	Course Lead faculty members in consultation with other NTSC faculty members	Fall 2018
	6. Prepare notes on direction for further course **design of SCIE423** (e.g. would be ideal for CLOs to develop PLO1); these notes would be starting point for next instructor staffing the course.	Program Director (or delegate)	Summer 2017
Teaching and Learning: Provide professional development opportunities for academic staff to communicate successes in teaching and learning innovations	7. Develop an online resource for NTSC faculty members to stay connected about important curricular issues within the	Curriculum Review Lead	Completed December 2016.

Teaching and Learning: (continued) *[to address our Guiding Questions 2&3]*	program and beyond to continue the process of Curriculum Review 8. Plan **session** for instructors to share strategies and techniques. 9. Explore resources for enhancing student experience through **in-class experiment** opportunities 10. Generate a list of titles for historic **SCIE507 offerings** 11. Introduce a 400-level special topics option and a one-semester research project course option	Program Director (or delegate) to schedule and plan agenda & goals for session in consultation with faculty members. NTSC faculty members Program Administrator Program Director (or delegate)	Summer/Fall 2017 Fall 2019 Winter/Summer 2017 Fall 2019

Conclusion

The Natural Sciences (NTSC) Program is a multidisciplinary undergraduate Program within the Faculty of Science. The Natural Sciences Program fits between Science Departments and offers courses to help students see connections across science as a whole. The Natural Sciences Program at the University of Calgary is positioned to help students develop a multi-faceted approach to science and build collaborative skills they will need when facing complex challenges. The students and faculty in the Natural Sciences Program have made good gains building undergraduate learning experiences that cross disciplinary borders and push us to think deeply about our contributions to the worlds' challenges. Our greatest barrier to the continued growth and development of this important work lies in forging new workflow paths connecting with Departments within our Faculty; doing this well would allow the Natural Sciences Program to operate as a true resource for collaborative skill development within the Faculty of Science.