Form 1

COVER SHEET
NEW DEGREE PROGRAM PLANNING NOTIFICATION OF INTENT
(PLANNING NOI)

Program Information

Program Name: Integrated Sciences

Institution Name: University of Washington

Degree Granting Unit: College of Arts & Sciences
(e.g. College of Arts & Sciences)

Degree: B.S. Integrated Sciences *(e.g. B.S. Chemistry)* Level: Bachelor *(e.g. Bachelor)* Type: Science *(e.g. Science)*

Major: Integrated Sciences *(e.g. Chemistry)* CIP Code: 30.1801

Minor: *(if required for major)*

Concentration(s): *(if applicable)*

Proposed Start Date: Autumn 2012

Projected Enrollment (FTE) in Year One: 25 *(#FTE)* At Full Enrollment by Year: 2013 ; 60 *(# FTE)*

Proposed New Funding: $115,000

Funding Source: ☒ State FTE ☐ Self Support ☐ Other

Mode of Delivery / Locations

☐ Campus Delivery Seattle *(enter locations)*

☐ Off-site *(enter location(s))*

☐ Distance Learning *(enter formats)*

Substantive Statement of Need

Attach sheet

Contact Information (Academic Department Representative)

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Endorsement by Chief Academic Officer

September 15, 2011
Date

Program Description and Rationale

Overview: The College of Arts and Sciences at the University of Washington, in cooperation with the College of the Environment, proposes to create a new Bachelor of Science degree in Integrated Sciences. This degree is intended to meet the needs of undergraduates planning careers in secondary science teaching, informal science education at museums or other science institutions, science writing, or science policy and technology law, as well as students whose intellectual interests incline them toward a rigorous program of study across all the sciences. Such students require knowledge of a range of sciences, an in-depth understanding of what the process of science is, an appreciation of the ethical and social contexts in which science is done, and the ability to approach a scientific problem by drawing from and integrating knowledge from a variety of scientific fields. This contrasts with the more narrowly focused, in-depth program typical for students majoring in a single discipline in preparation for graduate study and research in that field.

The two distinctive features of the Integrated Sciences program are its focus on providing students with an intensive research experience and its expectation that students will come to understand science in its historical, social, ethical, and epistemological dimensions. They will not only learn scientific truths, but also come to understand how scientific truth is established and participate in the process. Moreover, by studying a range of sciences, they will be better positioned to engage in work that crosses disciplinary boundaries or is part of new scientific fields.

The proposed degree program will be rigorous, drawing from courses in mathematics and the biological and physical sciences plus newly designed integrative courses and a research experience. There are four components:

1. Basic Science and Mathematics (60 credits). Students will take two or three quarters from the standard introductory sequences in mathematics, physics, chemistry, biology, and earth and space sciences that are offered to majors in those fields. These courses collectively will give students extensive laboratory experience and opportunities to observe various fields joining together to address common problems. They provide the essential foundation for all that follows.

2. Disciplinary Track (18 credits minimum). An integrated science student will select one field of specialization from among Astronomy, Atmospheric Sciences, Biology, Chemistry, Earth and Space Sciences, Oceanography, and Physics. In that field, the student will take at least 18 credits of course work from an approved list of courses designed for the discipline's majors. A list of recommended programs of study and advice from program counselors will ensure coherence in the course selection. Through this component, the student will acquire an in-depth understanding of the problems and techniques typical of the given discipline to a level sufficient to participte in research in that discipline or allied ones.

3. Integrated Sciences Core (12 credits). Three new courses are being designed for the degree program. These courses will bring the majors together as a cohort and give them a rich perspective on the scientific process and its societal significance.

i. IntSci 401, Integrated Sciences Seminar (1 credit, taken twice). The seminar will introduce students to scientists or science educators who are actively engaged in careers that require an integrative science perspective. The focus may vary from quarter to quarter, one quarter being devoted to educational issues, another to law and policy. In Spring 2011, the seminar was run on a pilot basis with an education focus. Classroom guests included middle school science teachers, high school science teachers, science educators from the Pacific Science Center in Seattle, curators and staff from the Burke Museum of History and Culture on the UW campus, science writers, and more. In addition, each student visited a museum, school, or other institution to explore its work in more detail.

ii. IntSci 402, Nature of Science (5 credits). This course will be co-taught by a scientist and a philosopher or historian, with topics to include the underlying principles of science, methodologies of science, the differences between invention and discovery, science ethics, science versus other ways of knowing, and the communication of science. Typically, a given scientific theory of historic importance, such as the theory of continental drift, will serve as source material, with students exploring the scientific issues themselves as well as questions regarding initial resistance to the theory and its ultimate acceptance.

iii. IntSci 403, Science in Context (5 credits). This course will be co-taught by a scientist and a social scientist with an interest in science from an ethical or societal perspective, and will focus on a case study examination of how science operates within broad social, political, and ethical contexts. The course will consider the growth of multidisciplinary and interdisciplinary research, the societal impact of scientific results and developed technologies, the political environment surrounding scientific practice, ethical responsibilities of scientists, the acceptability of censorship, the complex mechanisms for funding scientific research, and the power inherent in claims to knowledge. Topics for case study may include global climate change, evolution, and stem cell research.

These courses complement the disciplinary track courses that students will be taking at the same time, both in providing a look at scientific issues outside the given track and in giving the students the tools to make better sense of the scientific knowledge they are studying in their disciplines and how that knowledge was developed. This is an important feature of the program's integrative experience.

4. Capstone Research Experience (15 credits). This is the heart of the program. Each student will participate in scientific research with a faculty member in a lab or in the field for 6 credits while taking, in parallel, a new sequence of integrated science seminars:

i. IntSci 491, Introduction to Research (2 credits). This course will prepare students for an intensive scientific research project. It will include discussions

of what constitutes scientific research, development of a research proposal in conjunction with research mentor and the course instructor, and presentation of the research proposal.

ii. IntSci 492, Reflections on Research (2 credits, taken twice). Students will take this course while participating in an ongoing research project. It will center on discussions of student research, data collection, and data analysis. The format will include formal and informal discussions, short papers and oral presentations.

iii. IntSci 493, Communicating Research (3 credits). Students will take this course near the end of or after completing their research projects. They will prepare their research findings for oral and/or written communication, working closely with their research mentor and instructor to prepare class and symposium presentations, research papers, or other forms of publication.

The combination of the research itself and these three seminars is crucial to the anticipated success of the capstone experience. Through the seminars, students will acquire a deeper understanding of the research process in which they are participating. Moreover, by meeting with others in their cohort, they will obtain a broader perspective on the challenges of doing and communicating research while simultaneously getting insight into the nature of scientific research in other fields.

A student who has successfully completed this degree will have gained abstract scientific knowledge in multiple fields, learned how that knowledge is integrated to solve problems that cut across disciplines, discovered how practicing scientists carry out research investigations in the lab or the field, and in addition studied and reflected on the scientific enterprise itself. These opportunities for reflection, through the new courses on nature of science and science in context and through the capstone seminar series, give the degree its distinctive character. The deeper knowledge that graduates will acquire about what it means to do science, how scientific truths are evaluated, and what the ethical and social implications of this process are will equip them to be outstanding educators, writers, analysts, or simply citizens.

Relationship to other degree programs: Central Washington University offers teaching major options within specific science departments, leading to endorsements for secondary teaching, but no major comparable to the one proposed here. Eastern Washington University offers a BA in Education with a secondary option in a science field, but again, no comprehensive integrated science degree program. Likewise, Washington State University has undergraduate education degrees coordinated with studies in a particular field of science, plus a general science endorsement, but again, no comprehensive program. The one program in the state that bears any relationship to the degree program proposed here is the BA in Education at Western Washington University in general science. It's an excellent program, geared specifically to future secondary teachers. However, like the others, it differs from ours in its more limited offerings on the nature of science and its lack of a research component.

Demand

Workforce and Community Demand: The 2009 Washington Higher Education Coordinating Board study *The System Design Plan: A Statewide Plan for Moving the Blue Arrow* describes improvements in science and math readiness as "critical to preparing more students to enter the science, technology, engineering, and math (STEM) fields needed in Washington. Today's students are ill-prepared to succeed in college in these fields, however, without considerable remedial work." It further notes that in "some high demand fields, the annual need for workers is twice that of the number of degrees we are conferring in these fields, which include science, technology, … " and warns that "[c]ompetition will be especially fierce for talent in research, scientific, medical and computer science fields."

To ensure that students are prepared to succeed in undergraduate science and engineering programs, and to encourage more students from diverse backgrounds to consider these fields, secondary schools need a larger corps of outstanding math and science teachers. The National Science Board's 2003 report *The Science and Engineering Workforce: Realizing America's Potential* has as one of its principal recommendations, "In partnership with other stakeholders, the Federal Government should act now to attract and retain an adequate cadre of well-qualified precollege teachers of mathematics, science, and technology." The report goes on to call for reinforcing "the profession of teaching as an important and rewarding career and includ[ing] teachers as an integral part of the scientific and engineering professions."

The Integrated Sciences degree will prepare future secondary science teachers as science professionals, through its rigorous course requirements and the capstone research experience. The lack of a pathway for this audience at UW, the state's largest university, has been a significant gap, one that the program will fill. In addition, students interested in science broadly may be attracted to this degree, and then through it to teaching as a profession. Moreover, the students completing this degree, whatever careers they plan, will be advocates for strong science education programs throughout the state.

The Washington Higher Education Coordinating Board's 2011 *Regional Needs Analysis Report* provides further data on the need to prepare more students for careers in science and engineering and, as well, additional teachers. For example, among what the report identifies as the top 50 growth occupations in King County are middle school teaching (with an anticipated increase of 14% between 2010 and 2020) and secondary school teaching (37%). There is large anticipated growth as well in a variety of professions that require a strong science and mathematics base, such as network systems and data communications analysts (41%).

The BS degree in Integrated Sciences will be an attractive option not just for future secondary science teachers but also for those students intending to do graduate work in more technical fields for which a more interdisciplinary or generalist outlook is valuable. For example, there is need for support staff for companies developing patents within biotechnology, and such staff must have literacy in science. Thus, the degree is likely to contribute to high priority workforce and community needs in a variety of ways.

Student Demand: Demand for science degrees at UW vastly exceeds the available resources. For example, the number of majors in Chemistry increased over the last decade from about 660 to almost 1500, while the number of Bachelor's recipients annually in Chemistry increased from about 130 to 300. It is urgent that the College of Arts and Sciences offer alternative (but still rigorous) options for students interested in studying science and pursuing science-based careers.

The Integrated Sciences degree will be an attractive option for students with an interest in science who do not anticipate advanced graduate studies in a particular scientific discipline. Indeed, while our disciplinary major programs provide superb preparation for students intending to go on to graduate school or narrowly-defined careers, a broad-based course of study, combined with an intensive research experience and opportunities to reflect on the scientific enterprise, will be still better preparation for many of our students, such as those who eventually pursue careers in patent law, museum technology, management in scientific and technology areas, public policy, and insurance risk estimation. They will form a compatible cohort, receive academic counseling tailored to their needs and interests, and leave with a better understanding of the nature and process of science.

Another set of students for whom the Integrated Sciences degree would be the right one are those planning to enter Master's programs leading to careers in secondary science teaching. According to research by faculty at UW's College of Education, students entering the UW Master's in Teaching program in science have strong content knowledge in their major field, but in many cases they have less understanding of science inquiry; that is, how to conduct an investigation or how evidence is used in relationship to hypothesis, theory, and scientific argument. In addition, they have difficulty identifying big ideas and how ideas are integrated with one another.

Five years ago, in the initial stages of planning for this degree, a survey was taken of in-service science teachers in the region, with about 65 teachers responding. Additional information was collected through existing contacts some of our faculty have with teachers, and some teachers were invited to a committee meeting. We learned from these outreach efforts that almost all teachers wished they had had more breadth in their undergraduate science training. For many, even though they might have prepared in a particular science discipline, the needs of their school or district have required them to broaden the repertoire of subjects they teach. This can happen in several ways. A high school chemistry teacher may find herself asked to teach biology. A biology teacher may find himself teaching the 10th grade general science course that encompasses earth and space science. A middle school science teacher may encounter many different combinations of sciences and these combinations can change if he is switched to a different grade level.

We also learned from many of the teachers that their undergraduate education did not provide adequate tools to teach science process to their students. More time for consideration of and reflection on the principles of science would have served them better. Indeed, the need to develop such skills in future teachers is a given, in light of the *Washington State K-12 Science Learning Standards*. Inquiry is one of the three

underlying themes of the standards, with students expected to acquire an understanding of what a system is, how to conduct an investigation, and what constitutes valid evidence.

The Integrated Sciences degree has been designed to address all these issues. It will serve future science teachers well, and may even serve to increase the interest in teaching careers from among UW undergraduates. Efforts will be made to publicize this option and provide high-quality advising for students thinking about teaching careers, in collaboration with faculty and staff in the College of Education. Particularly valuable in this regard is the availability of the minor in Education, Learning, and Society, offered jointly by the College of Education and the College of Arts and Sciences.

Preliminary Budget

It is estimated that the annual cost for running the Integrated Sciences program will be $115,000. Most of the required course work is available through existing disciplinary academic units. The on-going costs for the program, once it reaches capacity, will be:

1. Buyout of existing faculty from their departmental teaching duties in order to teach IntSci 402 and 403, the Nature of Science and Science in Context courses. ($33,000)
2. Salary of a 50% senior lecturer to oversee the IntSci 491-492-493 capstone research series and to coordinate research opportunities for majors. ($32,000)
3. Buyout of faculty member's departmental time in order to direct the program. ($20,000)
4. Salary of a 50% academic counselor. ($20,000)
5. Additional staff support and overhead. ($10,000)

The College of Arts and Sciences has allocated funds to get the program started. Some additional funding may need to be reallocated once the program is fully developed.

Conclusion

The new degree program in Integrated Sciences outlined in the first section will provide many benefits to the university community and the state. A new science program will better serve the needs of many of our students now selecting other science majors. Among these, certainly, are students preparing to be science teachers. But equally well, the degree will better meet the needs any student whose ultimate career will require a broad scientific base and an in-depth understanding of scientific process, such as the aforementioned museum professionals, science writers, patent lawyers, policy analysts, and for that matter those students who simply want an education in the basics of science.

In meeting the needs of such a range of students, the degree will also contribute to some urgent state workforce needs. Most notably, improved K-12 science education is a prerequisite for preparing the state's students in their post-secondary studies and careers in science, engineering, and technology fields. The graduates of this program will be well prepared to educate the coming generations of students, and to keep up with changes in scientific knowledge in the years to come.

As a side benefit, the program will encourage conversations among faculty members across the university on science education issues. Indeed, this has already begun to happen as part of the planning process for the degree, with science and science education faculty from the College of Arts and Sciences, the College of the Environment, and the College of Education meeting regularly for lively and stimulating discussions about how best to offer this new degree. The faculty's collective interest in improving science education on this campus is immensely encouraging, and a sign of the benefits to come.