PLANNING NOI for: UW Bachelor of Science in Integrated Sciences

Program Information

Program Name: Integrated Sciences

Institution Name: University of Washington

Degree Granting Unit: College of Arts & Sciences

Degree: BS in Integrated Sciences Level: Bachelor Type: (of) Science

Major: Integrated Sciences CIP Code: 30.0101

Minor: N/A

Concentration(s): N/A

Proposed Start Date: Winter 2009

Projected Enrollment: Year One: 20 FTE At Full Enrollment by Year: 2011 : 80 FTE

Proposed (Reallocated) Funding$120,.000

Funding Source: ☒Reallocated State FTE ☐Self Support ☐Other

Mode of Delivery / Locations

Campus Delivery: Seattle

Scheduling

Day Classes

Attendance Options

☒ Full-Time
☒ Part-Time
Total Credits: 65 Quarter credits

Contact Information (Academic Department Representative)

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Endorsement by Chief Academic Officer Date

I) Introduction

The College of Arts and Sciences at the University of Washington proposes to create a new Bachelor of Science degree in Integrated Sciences. This effort is motivated by the recognition that existing science degrees do not optimally serve the needs of UW undergraduates who are interested in teaching careers at the middle and high school level or who are interested in careers in informal education (e.g. museums, science centers), science writing, technical management, or technology law. For these workplaces and careers, experience in multiple science disciplines is essential training. For example, few secondary teachers can focus their classroom instruction solely on a single science specialty--teaching biology may require knowledge of geology and atmospheric science. Furthermore, contemporary societal problems (e.g. global warming, pollution, population pressures, disease prevention and control, and more) can only be evaluated or addressed by integrating knowledge from several scientific fields spanning both biological and physical sciences. A perspective broader than that of a single discipline is a growing necessity for teaching and other "allied" science professions.

Though interdisciplinary, the proposed degree program will be rigorous, including a thorough grounding in the foundations of mathematics, chemistry, physics, biology, and the earth and space sciences. Additional upper-division emphasis courses in a particular discipline will assure that students have also studied a science in depth. What is particularly innovative about this major will be four new courses that cut across specific scientific disciplines as much of contemporary research at the UW already does. These will provide students with a unique experience of the practice and methodology of modern science. These include:

1. Nature of Science: Topics will 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. Students will prepare a proposal for a science investigation. Following the requirements for a proposal to the National Science Foundation, they will communicate the reason for the study, the methods to be used, and the expected outcome including the broader impact of the work.
2. Case studies in Integrated Sciences. By considering recent examples of evolving science (e.g. global climate change) issues such as what constitutes acceptable science methodology and how disciplines are integrated together to solve problems will be investigated.
3. A seminar/clinic to provide additional content and stimulation. The seminar will include participation in formal and informal science education settings with subsequent reporting; presentations by science educators; reading and discussing research articles on science education and communication.
4. Integrated Science Capstone: An intensive “hands-on” participation in the planning and execution of a scientific investigation. Results will be modeled, interpreted, and communicated in oral and written forms.

The incremental cost of this program is relatively low since most of the required course work is available through existing disciplinary academic units. Beyond startup expenses

for course development and initial administrative costs, we expect principal ongoing costs to be associated with the need for one faculty FTE to teach the Integrated Science courses, TA support, program management, and academic student services. Indirectly, the emphasis within this program on the "Nature" and "Practice" of science will also provide a continuing stimulus within existing academic units for review and improvement of undergraduate curriculum for all science students.

Background

An Integrated Sciences Degree Committee was appointed in January 2006 by the Arts and Sciences Divisional Dean for Sciences to investigate the need for an undergraduate Integrated Sciences (INTSCI) major at the University of Washington (UW). Impetus for constituting this committee came both from the College of Arts and Sciences and from the leadership of the Teachers for a New Era (TNE) Project, funded by the Carnegie Corporation of New York. Committee membership included faculty from UW departments of astronomy, atmospheric sciences, biology, chemistry, curriculum and instruction, earth and space sciences, mathematics, physics, and technical communication. Other committee members included a middle school science teacher, a school district science supervisor, and two museum professionals who are involved heavily in professional development for educators. As discussed below, the need for a new degree in Integrated Sciences became clear. The program proposed here is based on the efforts of this committee and subsequent interactions with curriculum committees in the science departments of the College of Arts and Sciences (Astronomy, Atmospheric Sciences, Biology, Chemistry, Earth and Space Sciences, and Physics), as well as in consultation with staff who work on general curriculum approval at the university. In recommending the proposed degree program, the Integrated Sciences committee considered several key questions:

- Are there existing models of Integrated Science degrees at other colleges or universities that might guide consideration of an Integrated Science degree appropriate for UW undergraduates?
    - A number of universities have "general science" endorsements for education majors. Others offer "Integrated Science" programs to specifically meet either education major needs or as an alternative to a straight disciplinary degree. None of these programs appear to have specific curriculum designed to address questions concerning the nature or practice of science.

- For science majors who enter the Masters degree program in the College of Education at UW, what are the strengths and weaknesses of their undergraduate preparation to become science teachers?
    - According to College of Education faculty research, students entering the UW Science Education Masters program have strong content knowledge in their major field (i.e. they know the facts and how to solve mathematical problems). However, in many cases such students have less understanding of science "inquiry" (i.e. how to conduct an investigation or how evidence is used in relationship to hypothesis, theory, and scientific

argument). They have difficulty identifying "big ideas" and how ideas are integrated with one another.

- What do in-service teachers perceive as strengths and weaknesses of their own preparation to become science teachers?
    - In total, opinions from roughly 65 in-service middle and high school teachers were collected via an informal survey process. Several committee members had on-going projects and/or teacher workshops or had direct teacher contacts (i.e. the science supervisor and middle school teacher). Several local teachers also attended one committee meeting. Almost all teachers interviewed wished they 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 and/or district have required them to broaden their repertoire of subjects they teach. This happens 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 can encounter many different combinations of sciences (typically at least 3 are taught in a year) and these combinations can change radically if he is switched to a different grade level.

    - Washington State Grade Level Expectations (GLE) focus partly on facts and concepts, but also include a large component of "science process" (what is a system, how to conduct an investigation, what constitutes valid evidence). In retrospect, many teachers reported that their undergraduate training didn't provide adequate "tools" to teach science process to their students. They thought more time for consideration of and reflection on the principles of science would have served them better.

- For in-service teachers, when did they make the decision to become a science teacher?
    - Teachers rarely came to college expecting to become an educator. Some decided to become classroom teachers late in their undergraduate program. Others decided to pursue education after completing a degree. Others entered teaching as a second career. Implicit was the idea that career opportunities in science teaching and the path from a science bachelor's degree to teaching credentials are not always effectively communicated to undergraduate science majors.

In summary, an innovative new degree in Integrated Sciences has multiple benefits for the University community and for the state. Foremost, would be providing better educational opportunities for future secondary science teachers. Giving them the needed breadth as well as intellectual tools and resources to better understand science will serve them and their future students. Furthermore, the existence of the degree would cast a larger net to grow the cadre of future science teachers by increasing the visibility of a career path in science education. Additionally, the integrated science program, in working with faculty in several science departments could help influence the design and delivery of science for all students. In particular, it might increase the focus on the broader impact

of science, the “nature” and “practice” of science, and how interdisciplinary research is influencing the way science is done. Finally, in keeping with the goals of the TNE initiative, the integrated sciences program will provide an additional bridge between faculty in the College of Education and Arts and Sciences as further discussed below.

II) Relationship to Institutional Role, Mission, Program Priorities

In 2003 the University of Washington was awarded funding by the Carnegie Corporation of New York for a new initiative entitled “Teachers for a New Era (TNE)”. The proposal stated "The University of Washington is ready to reinvent the way it prepares teachers. Despite decades of dramatic social, cultural, economic, and intellectual changes, teacher preparation looks remarkably like it did fifty years ago. Yet we have learned a great deal from research about the dynamics of schools, classrooms and communities, learning, and what teachers need to understand and be able to do.” The development of the Integrated Sciences Degree Program represents a strong engagement of the College of Arts and Sciences with the College of Education. Curriculum design in Arts and Sciences is being undertaken with recognition that we have a new opportunity to better educate the next generation of teachers. The aim of the degree proposed here is fully supported by faculty and College leadership in both colleges.

The proposed Integrated Sciences degree is fully consistent with mission, vision, and goals for the College of Arts and Sciences (ascc.artsci.washington.edu/mission.asp). For example, a vision is articulated that “as the heart of a leading public university, the College will play a vital leadership role in the educational, intellectual, cultural and civic life of local, national and international communities”. A specifically identified goal under this vision is to “strengthen the College’s involvement in K-14 education”. The proposed degree also contributes to the articulated value of “Preparing the next generation of informed and involved citizens through a liberal arts education”

III) Documentation of Need for Program including:

A. Community and Workforce Demand

- Attached as Appendix A is John Glenn’s Forward to “Before It's Too Late,” the report released in 2000 by the National Commission on Mathematics and Science Teaching for the 21st Century. That report (as well as innumerable more recent studies) point to improving K-12 science education as the critical requirement for the well-being of our nation. In his forward, Senator Glenn makes the following points: (1) high quality science education is essential, (2) we are currently not doing an adequate job of teaching science, and (3) we should concentrate on improving the quality of science teachers as well as increasing their numbers. The shortage of qualified math and science teachers noted in that report remains a crisis to the present. The Integrated Science Program proposed here addresses all of these recommendations. It will improve preparation for science education careers and it can increase the number of students who may elect to become science teachers.

- The need for science and math educators in Washington state is critical enough that the HECB has chosen to single out teacher and student preparation, particularly in math and science for a taskforce addressing higher expectation for students in their

2008 Strategic Master Plan, Moving the Blue Arrow: Pathways to Educational Opportunity.[1] There has been concern about determining the extent for demand of science and math teachers in the state, which may be a focus of the HECB's taskforce. One thing, however, is clear from anecdotes, as well as the robust demand for graduates in science and math in Washington state: there is more work to be done by higher education and all sectors in general in motivating and drawing talented students into the teaching profession. Money and career options will play a role in developing the profession, but a significant barrier now is the lack of a pathway to teaching science and math at the state's largest university. The foremost goal of the program, of course, will be to better prepare students who intend to go into teaching, but a side benefit should be that students otherwise inclined are drawn into teaching.

- More generally, the demand for graduates prepared in science and math is a priority for the state. The discussions around providing STEM degrees (science, technology, engineering, mathematics) in higher education have established that well. The HECB's State and Regional Needs Assessment notes that notes that several industries have been identified by the Department of Community, Trade and Economic Development that rely "heavily on significant numbers of workers with strong background [sic] in math and science" while some of these education opportunities for training in these areas are underdeveloped in the state.[2] Seattle-King County, by common consent and according the HECB's own report, has a considerable number of the companies highlighted in industries slated for development (biotechnology, aerospace, marine services in particular), as well as industries such as engineering, including computer and software engineering. The BS in Integrated Sciences no doubt will be an option for some students who do graduate and post-graduate work in more technical fields, but these industries also create jobs which require significant science and/or mathematics backgrounds, but with more interdisciplinary or generalist capacities. A notable example is developing patents within biotechnology, but support staff in these professions often have to be "literate" in science. (Another example of such need is the new MS in Biomedical Regulatory Affairs.)

B. Student Demand

UW does not offer an undergraduate education degree – students enter a masters program here. The Integrated Sciences degree can provide a more defined gateway into that graduate education program. In all science departments a small but not insignificant number of students realize in their junior or senior year that they are probably not interested in pursuing a strictly disciplinary science career. Some fraction of these students eventually becomes teachers. It would be a goal of the Integrated Sciences Program, through outreach and counseling, to reach these students and to provide them with appropriate information and mentoring. Many students who eventually pursue

[1] Moving the Blue Arrow: Pathways for Educational Opportunity (2008 Strategic Master plan for Higher Education in Washington), p. 35. Higher Education Coordinating Board. Available online at http://www.hecb.wa.gov/news/newsreports/documents/2008MasterPlan-fromPRT.pdf

[2] State and Regional Needs Assessment, p. 31. Higher Education Coordinating Board. Available online at: http://hecb.wa.gov/news/newsreports/documents/StateandRegionalNeedsAssessmentReportRevisedFebruary2006.pdf

careers in diverse directions, including patent law, museum technology, management in scientific and technology areas, public policy, and insurance risk estimation, have undergraduate degrees in science. The Integrated Sciences Program could better serve such students. They would find themselves among a compatible cohort, potentially receive better academic counseling, and would have the advantage of graduating with a better understanding of the nature and process of science.

The surveying of in-service teachers the committee did as part of the planning for the major also speaks to student, community and workforce demand. From interviews with current teachers, we learned that students need a clearer path to a teaching credential in sciences, as well as a path that is adapted to subjects they actually will have to teach. A clearer path, created by the BS Integrated Science with also be clarifying for students at the UW who are considering teaching high school science, as provides a lead-in to a teaching credential, at the UW or elsewhere.

IV. Relationship to Other State Supported Institutions

Central Washington University, Eastern Washington University, Washington State University
All above offer "Endorsement in General Science" as an enhancement of a Bachelor of Arts in Education.

Western Washington University
Offers a Bachelor of Arts in Education in "General Science" . The degree requires core courses in life and physical sciences at 100 level plus electives in a single scientific discipline sufficient to meet state endorsement standards for that discipline.

At Other Universities
A "General Science" endorsement is found at many universities having undergraduate education programs. Several universities offer specific "Integrated Science Education" degrees. Required curriculum in these programs ranges from choosing 100-level survey courses to requiring completion of "foundation" science courses in both physical and life sciences. Specific courses in science inquiry and process are not mentioned as explicit components of the programs reviewed in preparation of this proposal.

University of British Columbia
An Integrated Sciences Program (ISP) BS is offered as an alternative to a traditional Major or Honors program for students whose interests cross disciplinary boundaries within the Sciences. The program gives 3rd or 4th year students the opportunity, and the guidance, to design their own curriculum. No specific courses are required.

Stanford University
Stanford's Program in Science, Technology, and Society (STS) offers undergraduates integrated studies of the natures and relationship of science, technology, and engineering, and of the social relations of science and technology. They report that they are "among the oldest" such program in the country. One major thrust of the program appears to be

public policy. The degree requires 50 "technical" credits that can be satisfied taking an unspecified distribution of courses from disciplinary science departments.

V) Program Description and Curriculum

A) Catalog Description

Integrated Science

Although disciplinary training focused in one area of science is appropriate for many, some students may wish to explore a broader spectrum of physical and life sciences. Such breadth benefits those with interests in careers in education (either in schools or in museums) or in other careers requiring a broad technical background since few contemporary world challenges (from global warming, to pollution and disease) can be addressed within the confines of a single scientific discipline. The Integrated Sciences degree requires courses to establish a foundation in mathematics, chemistry, physics, biology, and the earth and space sciences. Emphasis courses in a single discipline insure better depth. In addition, the degree emphasizes the nature and practice of science, providing an opportunity to reflect on science as a human endeavor, and developing knowledge and skills necessary for scientific inquiry

Bachelor of Science

Department Admission Requirements

open

Integrated Sciences degree

Synopsis	
65 credits	Core Science Courses
20 credits	Core INTSCI Courses
15 credits	Major Emphasis
100 credits	**TOTAL**

Degree Requirements	
Core Science Courses	
15 credits	*Any of the following strings of courses:* Math 124, 125, 126 Math 124, 125, STAT 311 Math 144, 145, 146 Math 145, 146, STAT 311

10 credits	Chem 142, 152
15 credits	*Any of the following strings of courses:* Phys 114, 115, 116,117, 118,119 Phys 210, 211, 212 Phys 121, 122, 123
10 credits	Biol 180, 200
15 credits	ESS 211, 212, 213
65 credits	***subtotal***

Core Integrated Science Courses

4 credits	Nature of Science — to be created
4 credits	Case Studies in Integrated Science — to be created
2 credits	*Two quarters of* Seminar/Clinic — to be created
10 credits	*Capstone Research Experience*
20 credits	***subtotal***

Recommended Supplementary Courses

3 credits	Science Writing Course
5 credits	Astro 101 —or— 150
5 credits	Atmos 211
5 credits	Ocean 101
5 credits	Biol 114 — Astrobiology

Physics Emphasis

15 credits	Phys 224, 225, 331

Earth & Space Science Emphasis

15 credits	*3 out of* ESS 311, 312, 313, 314, 315

Biology Emphasis

5 credits	Biol 220 *or approved biology course with lab*
3 credits	Biol 354 or 356
3 credits	*Bio 350 or 355*
5 credits	Biol 491, 492 or 499

Chemistry Emphasis

15 credits	*15 credits from* 162, 237,238,239,241,242,or 312 NOTE: requires students take Chem 142, 152 and Phys 114 or 121

Atmospheric Science Emphasis

15 credits	*3 out of* ATMS 301, 340, 370, 431 NOTE: requires students take Phys 121, 122, 123 and Math 124, 125, 126.

New Integrated Sciences courses:

INTSCI 201 Seminar/Clinic
A seminar/clinic to provide additional content and stimulation. One credit is given per quarter. Students would be required to have two credits in the Seminar/Clinic but could continue taking the seminar during all quarters of participation in the program. The seminar will include participation in formal and informal science education settings with subsequent reporting; presentations by science educators; reading and discussing research articles on science education and communication.

INTSCI 301 Nature of Science
Investigate the underlying principles of science, science methodology, the differences between invention and discovery, science ethics, science versus "other ways of knowing" and the communication of science. The course should also address common misconceptions about science process. Students will prepare a proposal for a science investigation. Following the requirements for a proposal to the National Science Foundation, they will communicate the reason for the study, the methods to be used, and the expected outcome including the broader impact of the work.

INTSCI 302 Science Case Studies
By considering recent examples of evolving science (e.g. global climate change) issues such as what constitutes acceptable science methodology and how disciplines are integrated together to solve problems will be investigated.

INTSCI 400 Research Capstone
The capstone course would be 10 credits either as a single intensive summer quarter class or divided between quarters during the academic year. The course would be about the "doing" of science via inquiry methods. Students would conduct a scientific investigation under most circumstances as part of a larger "research group". There would be continuing opportunities for reflection and adjustment, as well as required presentations and communications with other students and faculty. The starting basis for the work will be a research proposition – created in the format of a grant proposal to a funding agency. A "hands-on" effort in data collection must be coupled with a strong analysis of the research. Results will be modeled, interpreted, and communicated in oral and written forms The final products will be a "paper" prepared like those considered for publication in science journals and an oral presentation modeled after professional science meetings. Work that crosses disciplinary boundaries will be encouraged.

This course could accommodate a number of approaches that might meet needs of individual students. A number of NSF funded REU summer programs are organized as specified here. Furthermore, several departments (both at UW and elsewhere) run intensive summer field schools in subjects ranging from geology, environmental geology, archeology, and oceanography. With Integrated Sciences oversight, these programs may serve students well. Finally, students working in various research groups on campus could satisfy the requirement during the academic year, while meeting with an INTSCI faculty mentor to supervise the scope and direction of the research.