THE NORTH CASCADES AND OLYMPIC SCIENCE PARTNERSHIP

Vision, Goals, and Outcomes

The vision of the North Cascades and Olympic Science Partnership (NCOSP) is the creation of a positive achievement spiral where improved teaching and learning in both K-12 and higher education results in ever-increasing science competencies for all students and teachers. The NCOSP will transform the roles of teachers, principals, counselors, administrators, and community members throughout the districts. Districts will plan their science programs, identify and choose research-based curriculum materials, and build administrative and community support for necessary change. Teacher Leaders at each school will access services and resources at Western Washington University (WWU), and receive direct support from higher education scientists and science Teachers on Special Assignment (TOSAs), thereby joining a professional learning community that extends beyond their own districts. These Teacher Leaders will participate in content-based professional development and be equipped to provide similar experiences to their peers through learning communities within their buildings. Special recruitment programs will increase the number and diversity of highly qualified teachers of science; content-specific mentoring will retain these new and diverse teachers. Transformations will occur in partner higher education institutions as well. Scientists will collaboratively address reform of introductory undergraduate science courses and preservice science method courses, applying their knowledge of national standards to better prepare students for science teaching careers. They will facilitate professional development in support of science education reform. Well-prepared preservice teachers familiar with reform curricula and assessments will provide focused tutoring support for at-risk students and enter the workforce better prepared to contribute to district reform. The administration will sustain these transformations through supportive policies and dedicated resources. The project will create a multidisciplinary group of science education researchers at WWU focused on a compelling research agenda in collaboration with all NCOSP partners.

The NCOSP unites 26 predominantly rural school districts, two Washington Educational Service Districts, Washington State LASER (Leadership and Assistance for Science Education Reform), Everett, Whatcom and Skagit Valley Community Colleges, Northwest Indian College and Western Washington University. All are committed to the following goals:

1. All students succeed in challenging science curriculum aligned with standards.
2. Administrators understand and support science education reform goals and programs.
3. Knowledgeable and confident teachers use curriculum with integrity and fidelity.
4. The quantity, quality and diversity of teachers entering the workforce increases through effective recruitment, preparation, and retention.
5. Science education research provides evidence-based contributions to the learning and teaching knowledge base.

Among the expected quantitative outcomes by Year 5 are: 90% of students will meet or exceed standards on the state science assessment, 147 Teacher Leaders will complete 360 hours of professional development, 1000 teachers will complete 86 hours of professional development, 90% of teachers will use research-based curriculum as intended, new science content and methods courses will be in place in higher education, and the percentage of preservice students from underrepresented groups will double to 16% (See Outcomes and Benchmarks).

Core Partners

School Districts: The 26 partner districts include 1140 teachers of science serving 72,000 students (Supl. Fig. 8). They range in size from 47 to 10,000 students, with 17 districts having fewer than 3500 students, 8 having 3500-6000, and 1 with 10,378 students. They are located in northwest Washington in primarily rural communities, many with low socioeconomic status. Nine districts meet the ESEA qualifications of a high-need LEA; nearly 35% of the students in the partnership receive free or reduced lunch (Supl. Fig 11). The region has growing Hispanic, Asian, and East European immigrant populations, and a

significant Native American population. The partner districts serve students from 9 American Indian reservations in the region.

The school districts' primary objective is to improve their science program to maximize student achievement, indicated in part by performance on the state science assessment. Effective in 2008, a passing score on the 10th grade assessment is necessary to graduate from high school. The partner districts therefore identified grades 3-10 as a priority, focusing on the core knowledge and skills in science that are expected of all students. The districts are concerned with the alignment, developmental appropriateness, and coherence of their science curriculum. They are equally concerned with the ability of their teachers to deliver the curriculum to all students, especially those who have historically underachieved, and with the development of their principals as educational leaders.

Higher Education: Western Washington University, a comprehensive, regional university with 12,500 students, is the lead institution. WWU scientists have a 30-year history preparing future teachers and providing professional development for inservice teachers in the region. The formal, institutionalized involvement of science departments and scientists in the preparation of secondary and elementary teachers makes WWU ideally suited to lead an effort aligned with the intent of the Mathematics and Science Partnership program. The Science, Mathematics, and Technology Education (SMATE) program at WWU, sited in the College of Arts and Sciences, is responsible for the science pedagogy training of all preservice teachers. The SMATE program is housed in a 15,000 square foot facility that includes state of the art classrooms and a resource room with the latest curriculum, assessment, instructional, and technology materials. SMATE faculty members, active researchers in their respective science disciplines, teach all of the science education courses at the undergraduate and graduate levels, including the elementary and secondary science methods courses, supervise the science experiences for all preservice teachers, and supervise all secondary science student teachers. SMATE faculty members work closely with the Woodring College of Education and the regional schools. Over 500 students each year receive their initial teaching certificates from WWU, the state's largest producer of new teachers including teachers of mathematics, science, and technology. NCOSP will engage 10 science faculty in education research on the reform of preservice content and pedagogy courses and K-12 science teaching and learning, support the appointment of a senior science educator in the College of Education and SMATE, and prepare 2500 diverse and highly-qualified teachers of science.

The community college partners include Everett, Skagit Valley and Whatcom Community College, and the state's only Native American college, Northwest Indian College. The public institutions have 5000 students, on average, with students of color representing nearly 25% of their enrollment. The 250 on-campus students at Northwest Indian College are 71% Native American. Significantly, nearly 50% of teachers certified through WWU begin their higher education experience at these partner institutions and nearly 30% of the teachers in the partner districts are WWU graduates (Supl. Fig. 18).

Long-term, systemic reform of teacher preparation will require close collaboration between the partner higher education institutions to closely align content courses, improve the preservice preparation of teachers in both science content and pedagogy, and coordinate efforts to recruit diverse science teachers. These include experiences that encourage students to actively consider science teaching as a career. This is especially true for students from underrepresented groups, who predominantly attend the partner community colleges. In addition, the proximity of Northwest Indian College (NWIC), WWU, and the Lummi Tribal School provides an opportunity for collaborative preparation of Native American students who will return to their communities as science teachers. All school district and higher education partners have signed agreements of substantive commitment (See Supplementary Documentation).

Supporting Partners

*Washington State LASER***:** LASER, housed at the Pacific Science Center and co-directed by Dennis Schatz, is one of eight regional NSRC Implementation and Dissemination Centers funded by NSF. For the past five years LASER has provided leadership by facilitating effective implementation of high quality science programs in diverse communities. A recent analysis of curricula used in K-6 classrooms

by 70 LASER districts in Washington State, representing 46% of all K-6 students, revealed that 45% of the districts have adopted STC materials, 30% FOSS, and 6% are piloting FOSS or STC. The remaining 19% are using other curriculum materials, predominantly from INSIGHTS or GEMS. An analysis of middle school curricula is underway. LASER will provide Strategic Planning Institutes, Curriculum Showcases, and Specialized Symposia for the partner districts (described below on pages 4-6).

Educational Service Districts: Nine Educational Service Districts (ESDs) provide regional services to all 296 Washington State K-12 public schools. ESD 114 will manage a science materials refurbishment and distribution center and coordinate professional development for the 12 partner districts on the Olympic Peninsula. The nearby Naval Undersea Museum will provide additional support and a site for regional workshops and meetings. ESD 189 will assist in coordinating professional development for the 14 Whatcom and Skagit County districts.

Needs

All partners completed a comprehensive survey to establish baseline data. Drs. Nelson, Linneman and Landel attended regional meetings with the districts and community colleges to discuss the critical needs reveals by the analyses and develop an appropriate action plan. The partner agreements and scope of work were collaboratively developed through additional meetings and electronic and telecommunications.

Student Achievement: Washington's assessment system currently consists of both the norm-based Iowa Test of Basic Skills and Test of Educational Progress at grades 3, 6, and 9, as well as the Washington Assessment of Student Learning (WASL), a rigorous criterion-based assessment, administered in reading, writing, mathematics, and listening at grades 4, 7, and 10. A science assessment will be officially piloted in 2004 and included for 5^{th}, 8^{th}, and 10^{th} grade students in 2005. There is no district or state data on student achievement in science and Washington did not participate in the 2000 NAEP testing. In 1996 Washington scored at the national average in science at 8^{th} grade, 150 Washington vs. 148 national. Washington Hispanic and American Indian students' average scores were substantially lower, 125, and 130 respectively. Current mathematics assessment data for the partner districts show that, on average, 59% of students are not achieving the mathematics standards (Supl. Figs. 1-7). When the scores are disaggregated, the results show an achievement gap of about 20% between Asian and White students and American Indian, Black, and Hispanic students. It is reasonable to suspect that baseline achievement on the emerging science WASL will be comparable. All NCOSP districts will participate in the pilot of the science assessment this spring to provide one piece of baseline data.

Curriculum and Professional Development: Only 8% of high schools and 18% of middle schools have adopted standards-based science curriculum materials compared to 70% at the elementary level (Supl. Fig. 20). Despite the commitment to research-based curriculum at the elementary level, implementation support has been minimal; professional development to enhance teacher knowledge of the content supporting the curriculum has been absent; and access to services and content experts in the rural and isolated districts has been limited. Of the 26 partner districts, only 5 have attended a LASER Strategic Planning Institute and 11 have a science professional development plan (Supl. Fig. 16).

Teacher Workforce: Recruiting and retaining qualified teachers of science who reflect the increasing cultural and language diversity of the students is a clear priority at all levels. On average, the NCOSP districts lose half of their teachers every 6 years (Supl. Fig. 14). Although 23% of students in the partner districts are members of underrepresented groups, the teaching corps is 93% Caucasian (Supl. Fig. 10). Even in the Lummi Tribal School, which has a 98% American Indian student body, 76% of the teachers are Caucasian. Moreover, the smallest districts face the additional problem of science teachers having responsibility for multiple subjects, often outside their endorsements. These rural schools are significantly challenged to hire and retain teachers with appropriate content and pedagogical content knowledge, provide material and resource support necessary to implement the curriculum with high fidelity, support learning communities focused on improving knowledge and skills, and document evidence of problems and progress (Bergeson et al., 2002).

Teacher Preparation: Future elementary teachers enter the university with weak science backgrounds and current options for meeting the science distribution requirements do not provide a coherent learning experience that meets their needs. The elementary science methods and practicum courses are then compromised because significant time is spent learning science content rather than content-specific pedagogy. Moreover, field experiences are typically not in classrooms where research-based curricula are being used or best practice in science teaching is being modeled. As a result, few elementary teachers graduate ready to teach science effectively. At the secondary level, students graduate with substantial content knowledge, but little experience with research-based curricula. The number of quality secondary level teachers is not meeting current demand (Bergeson et al., 2002).

Results From Prior NSF Funding

Dr. George Nelson, Director of SMATE, was Principle Investigator on a number of NSF grants as Director of the American Association for the Advancement of Science Project 2061 (ESI-9618093, ESI-981908, ESI-103678, ESI-129398, ESI-102241, DUE-0090761). This funding produced research-based analysis tools for evaluating curriculum materials for alignment to standards and effective instruction (AAAS, 2003, in preparation), and assessment items for alignment with standards and effectiveness at probing student achievement. Professional development incorporating tools to improve understanding of standards, alignment, and effective instruction and assessment were developed and field tested. The *Atlas of Science Literacy* (AAAS, 2001a), and partially, *Designs for Science Literacy* (AAAS, 2001b) were produced with NSF funding. Former SMATE Director Dr. Joseph Morse developed a capstone course in investigative science for preservice elementary teachers (DUE-9981171, Morse, 1999).

Action Plan

The NCOSP proposes to provide transformative learning experiences for all partners and build sustainable capacity for reform. The typical components of systemic reform—alignment of curriculum materials, assessment systems, teacher education requirements, initial and continuing teacher licensure requirements, and other system components—are necessary (Smith and O'Day, 1991) but not sufficient to produce lasting improvement of science learning (Thompson and Zeuli, 1999). Together, the partners propose to take on the challenge of changing teachers' fundamental ideas about subject matter, teaching, and learning, and promote "learning through thinking" (Thompson and Zeuli, 1999). This paradigm is infused throughout the many strategies proposed (Fig. 1). These strategies are based on a constructivist model that reflects the growth of understanding over time as exemplified in the *Atlas of Science Literacy* (AAAS, 2001a) and the concept of facets and facet clusters (Minstrell, 2000; NRC, 1999a, 2001a). Each strategy applies to multiple goals, but is listed where it has primary focus. Research is integrated into all strategies to rigorously explore their impact on student learning and teacher practice.

Goal 1: Students succeed in challenging science curriculum aligned with standards.

Strategy 1A: Districts develop five-year strategic plans for effective adoption and implementation of a research-based science curriculum.

Tactic: All partner schools will use the SIP tool to analyze disaggregated student assessment data to inform strategic planning at the building and district level (Wagner, 1998).

In 2002, Washington State mandated that all schools complete a five-year improvement plan using the state's School Improvement Process (SIP). A research-based list of Nine Characteristics of High Performing Schools (See Supplementary Documentation) guides districts developing their plans to improve their students' performance on the state science assessment. Districts and buildings have access to their student assessment data and the state-supported on-line SIP tool to analyze individual student achievement levels, disaggregate data, and analyze classroom, building, and district achievement data, including performance levels of particular populations, such as English language learners, Black, Hispanic, Native American, and those receiving free or reduced lunch.

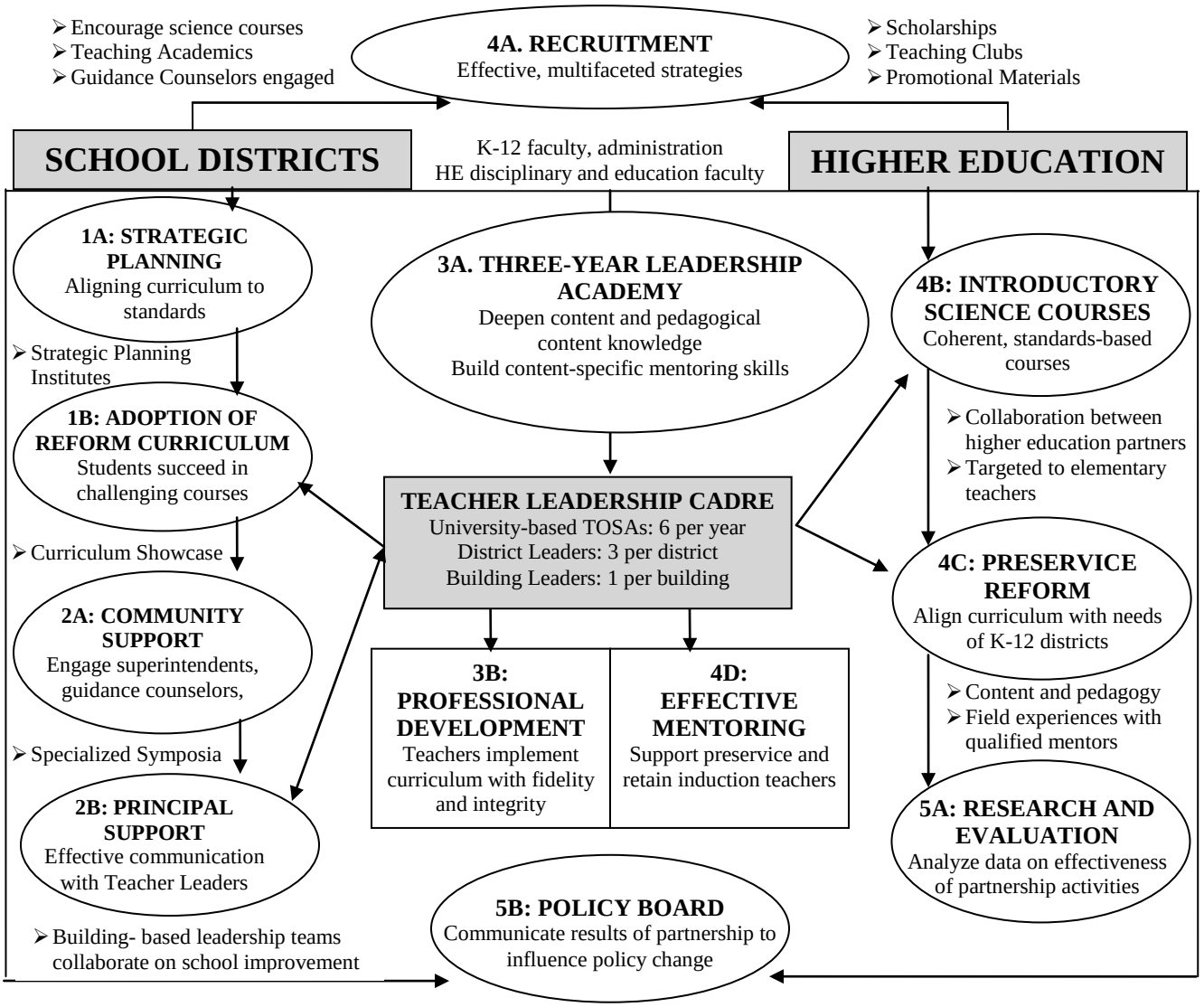

Figure 1. Schematic illustration of the proposed NCOSP strategies. The numbering system within the boxes and ovals corresponds to the strategies detailed in the action plan.

Tactic: All district partners will attend a Strategic Planning Institute in Year 1 or 2 to develop data-driven science education reform plans (Love, 2002).

Through a five-day program of interactive workshops and discussions, LASER Strategic Planning Institutes (SPI) provide the opportunity for district leadership teams to collaborate with regional and national experts, as well as members of other teams, to develop comprehensive five-year strategic plans to reform science education. District teams include a Superintendent, a Principal Leader, an Elementary, Middle and High School Teacher Leader, and a Community Member. Within six months of the institute, teams begin the process of simultaneously implementing each element of their strategic plan, including: (1) adopting and implementing research-based science curricula aligned to state and national standards, (2) implementing classroom-based assessments that are connected to the instructional materials and aligned with the state science content standards, (3) preparing teachers to guide students in inquiry-centered science instruction, (4) creating a materials support system that provides classroom ready materials in a timely and cost efficient manner, (5) deepening administrative and community understanding of the nature of the core curriculum and new models of instruction, and (6) forming community partnerships that understand the roles partners can play in science education reform.

Strategy 1B: School districts adopt research-based science curricula in grades 3-10.
Tactic: District partners will attend Curriculum Showcases to assist in adoption decisions.
LASER will provide one-day annual Curriculum Showcases for district representatives to participate in interactive workshops and discussions that focus on inquiry-centered, sequential science curriculum units, many developed with NSF support. Participants discover why inquiry-centered science curricula are effective and learn about exemplary research-based science curricula and how to evaluate them (Kesidou and Roseman, 2002; Berns, et al, 2001; NRC, 1999b). Higher education faculty will assist district adoption committees as needed.

Goal 2: Administrators understand and support science education reform goals and programs.
Strategy 2A: Establish support from key stakeholders through specialized symposia.
Tactic: Principals, guidance counselors, and community members will attend annual LASER Specialized Symposia in Years 1-5. District teams will attend Sustainability Symposia in Years 4-5.
LASER will provide one-day, annual Specialized Symposia modeled on Lenses on Learning (Nelson, 1997). Elementary school principals will explore the nature of reform science curricula, learn strategies to encourage teachers in the use of the curricula, and evaluate the impact of the science education program. Middle and high school principals and guidance counselors will examine similar concepts, as well as strategies for encouraging students to enroll in four years of high school math and science courses. Community members will learn about effective science education and become equipped to serve as advocates. Sustainability Symposia for district leadership teams will be held in Years 4 and 5 for districts to revise their strategic plans and initiate sustainability plans.

Strategy 2B: Principals collaborate with Teacher Leaders to improve science teaching in the building.
Tactic: 147 principals will participate in one day of the Teacher Leadership Academies each year and quarterly meetings with their Teacher Leaders.
Communication between teacher leaders and principals is an essential link to establish and maintain administrative support and ensure reform efforts are sustained (Fink and Resnick, 2001; Fullan 2002). The Teacher Leadership Academy design (described in Goal 3) will include one day that invites principals to learn alongside their Teacher Leaders to explore the curricula, content, and pedagogical skills required for students to develop a deep understanding of the content. Principals will attend break-out sessions in the afternoon to address their specific needs and questions. Beginning in Year 2, each principal and Teacher Leader will meet quarterly to discuss partnership activities, challenges, and successes. Teachers on Special Assignment (TOSAs; described below in Strategy 3A) will attend one quarterly meeting with each Teacher Leader each year.

Goal 3: Knowledgeable and confident teachers use curriculum with integrity and fidelity.
Strategy 3A: Develop Teacher Leaders in every building in every district.
Teacher Leaders expert in curriculum, content, leadership, mentoring, and professional development delivery are critical to creating and leading learning communities so that all teachers can advance along a life-long professional learning continuum (Elmore, 2000; NRC, 2001b). NCOSP Teacher Leaders will: (1) support the design and delivery of partnership activities, (2) enhance the capacity of the buildings to successfully transform their science education program, and (3) provide strong connections between districts and higher education to reform undergraduate science content and teacher preparation courses.

Tactic: Six TOSAs per year will work as peers with science faculty in project development and implementation, and support 147 Teacher Leaders in establishing effective learning communities.
Six full-time Teachers on Special Assignment (TOSAs) will serve as critical project liaisons between the university and the districts. Four will be located at Western Washington University and two at ESD 114 to provide local support for districts on the Olympic Peninsula. Teleconferencing and videoconferencing, coordinated by the NCOSP Communications and On-Line Support Specialist, as well as travel to WWU, will ensure that all TOSAs are well connected to all project activities. TOSAs will work directly with SMATE faculty in all partnership activities, including: designing the Teacher Leadership Academy (50%), providing professional development for District Leaders in the partner districts (20%, described in

Strategy 3B), reforming science methods courses and designing a science course sequence for elementary teachers (20%, described in Strategy 4B, 4C), and coordinating project activities and reports (10%). In Year 2-5, more time will be spent supporting Teacher Leaders (50%) and less on design work (20%).

Tactic: 147 Teacher Leaders will support learning communities at the building level. 67 of the 147 will serve as District Leaders to provide leadership and coordination across the district.
Every elementary, middle and high school will prepare one Teacher Leader to support building-based professional development for teachers of science (Elmore, 2000). Each district will select three Teacher Leaders to serve as District Leaders. In Year 1, District Leaders will collaborate with the TOSAs and higher education scientists to design the Teacher Leadership Academies. In Years 2-5, all Teacher Leaders will be released from their classrooms 162 hours per year to: (1) participate in 40 hours personal professional development, (2) provide 90 hours professional development to peers (See Strategy 3B), (3) provide 25 hours of mentoring for induction teachers or student teachers (See Strategy 4D), and (4) contribute 7 hours for project duties as needed. District Leaders will receive an additional 54 hours per year to coordinate activities across the district and prepare and submit project reports. Once capacity is in place, district funds will provide each Teacher Leader 54 hours per year to sustain the learning communities and training through the academies for replacement leaders, as needed.

Tactic: 147 Teacher Leaders will participate in 360 hours of professional development to acquire the skills needed to establish and sustain building-based science learning communities.
In Year 1, higher education scientists, TOSAs and District Leaders will assemble for a two-week Summer Development Institute to develop a shared vision for the project, increase familiarity with research-based materials, and create the initial design for the Teacher Leadership Academies (Desimone et al, 2002; Hawley and Valli, 1999). Nine Design Teams, including 2 higher education faculty and 6-8 Teacher Leaders, will collaboratively develop: 3 elementary and 3 middle school sessions in earth, life and physical science; 3 high school sessions focused on scientific inquiry, problem solving, and nature of science. All of the Design Teams will interact throughout the Development Institute to ensure coherence within and across grade levels. During the academic year, TOSAs and SMATE faculty will refine these initial designs and District Leaders will provide additional feedback. The Leadership Academies for Teacher Leaders will begin in Year 2. The Academy Table and Disciplinary Partners Table in the Supplementary Documents summarize the proposed design for the academies and the role of higher education science faculty.

The Leadership Academy design will draw upon the curriculum of the NSF-funded National Academy for Science and Mathematics Education Leadership and Northern New England Co-Mentoring Network**.** Participants will learn to: (1) link specific content, developmental appropriateness, curriculum coherence (AAAS, 2001a and b), research on student conceptions (Driver et al,1994), and instructional strategies to state and national standards, (2) apply their knowledge of standards-based curriculum, instruction, and assessment, to make sound curriculum selection and implementation decisions (Kesidou and Roseman, 2002; AAAS, 2003), (3) use classroom assessments to improve instruction, (4) use classroom observation instruments to evaluate instructional practices (Piburn and Sawada, 2000; Weiss, 1999), (5) use protocols for examining and scoring student work and apply them in school-based learning communities (Loucks-Horsely et al., 1998), (6) use a research-based framework to design and deliver professional development, (Loucks-Horsely et al., 1998), and (7) support preservice and induction teachers using content-specific mentoring (Villani, 2002).

These themes will be addressed during a three-year experience that includes three 80-hour summer academies (240 total hours) and 40 hours of professional development throughout the academic year (120 total hours), provided by both WWU science faculty and the TOSAs (see Disciplinary Partners Table). Additional sessions will be designed in Year 4 and delivered in Year 5 to meet the evolving needs of the districts. Beginning in Year 5, repeat sessions will be offered to accommodate teacher turnover and teachers from throughout the state will have access to the academies (See letters from Anne Kennedy and Louise Fayette). Teacher Leaders who complete the three-year program will receive 24 credits toward a

45 credit Masters degree in Science Education. Through the combination of content-focused summer academies, mentor training, workshops, site visits, and electronic networking, NCOSP will build strong science teacher leaders, establish effective building-based science learning communities, and provide mentors to support preservice teachers and retain new teachers.

Strategy 3B: Implement building/district-based professional development to support effective science teaching and learning.

Tactic: 1000 grade 3-10 teachers of science will spend 42 hours per year engaged in building and district-based science learning communities facilitated by Teacher Leaders.

Building and district learning communities exploring the needs of students, student achievement scores, high quality instructional materials, and research on cognition, teaching and learning provide an ideal venue for teachers to share ideas, gain the benefit of one another's teaching experience, and engage in common study to enrich their content and pedagogical content knowledge (Loucks-Horsely et al., 1998). Through the summer academies and continued professional development during the year, Teacher Leaders will acquire the skills needed to support their learning community. Each year 1000 teachers will attend 3 six-hour workshops (18 hours) on: (1) kit or unit introduction, (2) content in the context of the kit/unit, and (3) assessment of student learning, all led by the TOSAs and Teacher Leaders and explicitly tied to the content of the summer academies and school curriculum. The teachers will also observe demonstration lessons performed by Teacher Leaders (3 hours), examine their own instructional practices based on classroom observations performed by Teacher Leaders (12 hours), and attend study groups to evaluate student work, examine case studies, and reflect on their professional practice (9 hours).

In Years 2-4, all teachers will participate in a minimum of 42 hours (126 hours total) of professional development, some as groups, and some through individual instruction. In Year 5, the six-hour sessions will be offered for new teachers; demonstration lessons, classroom observations and study groups will continue for all. Teacher Leaders will spend 90 hours per year in Years 2-5 supporting such learning communities. The NCOSP will help teachers and administrators think about how to apply the release time to ensure the project isn't an "add-on", but an integrated, sustainable part of a teacher's professional time. Since each school schedule is different, NCOSP leadership will work with each school to determine the best strategies for their context. Evaluation of the varied implementation models will be a central research question to investigate effective strategies for transforming the school culture to support building-based professional development.

Goal 4: Increase the quantity, quality, and diversity of teachers entering the workforce through effective preparation, recruitment, and retention.

Strategy 4A: Initiate effective, multi-faceted recruitment strategies (Darling-Hammond et al., 1999; NCTAF, 2002)**.**

Tactic: The NCOSP will award 40 scholarships in Year 2, 60 in Year 3, and 80 in Years 4 and 5.

The core partners will develop a collaboratively administered scholarship program with eligibility weighted by three criteria: (1) member of an underrepresented group, (2) pursuing a secondary science endorsement, or (3) seeking an elementary certification with a general science degree. Awardees must enroll in coursework toward certification and participate in science education experiences in the partner districts. Beginning in Year 2, each higher education institution will award eight $1000 scholarships, four each for freshmen and sophomores. Students who remain in good standing and continue in a science teacher preparation program will receive funding for each successive academic year. Students at the partner community colleges will continue to receive scholarship support upon enrolling in the teacher preparation program at WWU in their junior and senior year.

Tactic: All school district and higher education partners will support future teacher clubs with information on, and opportunities in, science teaching.

Partner districts will support Washington State Teachers Recruiting Future Teachers (WSTRFT). WSTRFT "Teaching Academies" in high schools recruit talented and diverse students for teaching careers. High school students participate in 180 hours of instructional time and prepare a portfolio

identifying the units of study, activities, and performance achievements for the identified competencies. Student who successfully complete the program are granted pre-enrollment status to Woodring College of Education and portions of their portfolio are used to receive an accelerated admission process. Sixty former Teaching Academy students are currently enrolled in the College of Education. 13 of the 27 NCOSP partner districts have certified programs. The program historically focused on future vocational education teachers, but by involving high school science teachers, the NCOSP will add an emphasis on future science teachers and the science preparation of future elementary teachers. Martin Chorba, current WSTRFT President-Elect, will coordinate this effort.

The partner higher education institutions will support "Teachers of Tomorrow" clubs to provide undergraduate students interested in teaching science with opportunities to acquire tutoring or other early field experiences with mentors from the Teacher Leadership Cadre. Higher education science faculty will support these clubs and advise students on course selections to prepare for a career in science teaching. To support these clubs and the high school Teaching Academies, the higher education partners will design a series of promotional posters and informational brochures featuring opportunities in science teaching and strategies for success in science teacher preparation programs. Promotional materials will target: (1) first and second year college students enrolled in science courses and, (2) high school students interested in science. Partner districts and higher education institutions will distribute promotional materials through campus recruiting offices, guidance counselors, teaching clubs and other similar venues.

Strategy 4B: Reform introductory science courses for preservice education students.
Tactic: All partner higher education institutions will implement a common standards-based, yearlong undergraduate science course sequence for future elementary teachers (Nelson, 2002).
Introductory science courses designed for transformative learning are critical to successful long-term reform (Thompson and Zeuli, 1999), yet their introduction is subject to numerous barriers in the higher education setting (Sunal et al., 2001). Science course reform within the partner institutions is timely for several reasons: recent completion of the state-funded Pathways Project, which examined alignment of science at the partner higher education institutions; WWU is currently reviewing proposals for revisions to its General University Requirements (GUR); and the WWU College of Education is revising its Elementary Education program. Andrew Bodman, WWU Provost, and Michael Henniger, Chair of Elementary Education, support the proposed course sequence as a GUR and a requirement for admission to the elementary education program. Keith Clay, Physics Instructor and Director of Project TEACH, led the development and implementation of a course sequence with similar intent at Green River Community College and will serve as a consultant to assist the NCOSP.

In Years 1-2, scientists at each partner institution will spend 50% of their quarterly release time in multidisciplinary GUR working groups (See Disciplinary Partners Table) to define course outcomes using "Science for All Americans" (AAAS, 1989), assemble instructional units, and design assessments. Working groups will meet weekly within their institution and as a multi-institutional group monthly. Each institution will pilot the course sequence in Year 3 and evaluate how well the courses met the intended outcomes. Refinements will be made in Year 4 and the course sequence will become an approved part of the higher education partners' offerings in Year 5. Dr. Andrew Boudreaux, WWU Research Associate, will coordinate faculty research on the effectiveness of course format, curriculum, instruction, and assessments (biographical sketch with supplementary documentation).

Strategy 4C: Reform preservice science methods courses to align with needs of K-12 school districts and improve the quality of future science teachers.
Tactic: SMATE faculty will revise science methods courses to produce teachers well-prepared in content and content-specific pedagogy (Schulman, 1986).
Reform of preservice science methods courses will draw upon the design of the summer academies, strengthening both science content (particularly at the elementary level) and pedagogical content knowledge (at both elementary and secondary levels) and connecting to reform curriculum in use in the partner districts. Reforms will also include providing field experiences in classrooms with Teacher

Leaders using research-based curricula. Such a model partnership was established in 2002 as WWU faculty were involved in the science curriculum selection and implementation for Mount Vernon School District. WWU science practicum students were then placed with those elementary teachers piloting the research-based instructional materials (Linneman & Ohana, 2003, in preparation).

In preparation for these reforms, SMATE faculty and TOSAs will participate in monthly staff development seminars and discussions to deepen their own understanding of K-12 education reform and clarify learning outcomes for teacher education courses and programs. Critical topics include: (1) aligning science methods courses with the state content standards and national program standards from NCATE and INTASC; (2) articulating science curricula and assessments between K-12, community colleges and 4-yr institutions; (3) developing and sustaining transformative teacher leaders; and (4) teaching science to underrepresented groups, including English language learners. Through Methods Course Working Groups (See Disciplinary Partners Table), WWU faculty (50% of released time) and TOSAs will develop a set of common course outcomes for the elementary and secondary methods courses in Year 1, and investigate the addition of a middle school methods course. These working groups will continue in Year 2 to design curriculum and assessments required to achieve these outcomes. SMATE Faculty will pilot the courses in Year 3 and evaluate and revise in Years 4 and 5.

The NCOSP will also investigate the benefit of targeted service learning opportunities to provide preservice teachers early field experiences. Funds are allocated to support 50 undergraduate students per quarter to establish and support science clubs in elementary and middle schools of select partner districts. For several years Co-PI Chris Ohana and her science practicum students have successfully organized such clubs at Columbia Elementary School in the Bellingham School District. These clubs engage a broad range of students in performance-based assessments tied closely to the curriculum in use and the content of the state assessment. Coordinated science tutoring experiences at all grade levels during before or after-school hours, targeted to those at risk of not passing the state assessment, will also be offered.

Strategy 4D: Support preservice and retain induction teachers through high-quality mentoring.
Tactic: 147 Teacher Leaders will provide induction teachers with 25 hours of content-specific mentoring per year, in addition to content-based professional development.
The costs for recruiting, hiring, and orienting new teachers are substantial, particularly for small, rural districts. Effective mentoring can reduce teacher turnover, allowing these resources to be redirected to supporting and sustaining new and veteran teachers (Villani, 2002). Content-specific mentoring, in combination with support for all teachers in improving science education, will ensure that the content and pedagogical needs of new teachers are addressed in the discipline they teach.

Teacher Leaders prepared as mentors through the summer Teachers Leadership Academies and ongoing professional development will spend 25 hours per year serving as mentors (see Strategy 3A). New teachers will receive mentoring support over a three-year period to meet their evolving needs during this critical career phase. During the first year, Teacher Leaders will focus primarily on supporting the new teacher while elevating their own skills and knowledge of science teaching and learning. In the second year, together, Teacher Leaders and new teachers will examine and implement successful strategies for curriculum, instruction, and assessment based on standards and informed by research. In year three, induction teachers will apply the skills and knowledge they have gained to guide them in self-assessment of their own teaching, identify their strengths and weaknesses, and prepare portfolios and performance-based state requirements to obtain their professional certification.

Tactic: Teacher Leaders will serve as mentors for practicum students and student teachers.
For preservice students, the quality of field experiences significantly affects future performance in the classroom. Teacher Leaders who model best classroom practice with research-based curricula familiar to students from science methods courses will serve as mentors for science practicum students and student interns. WWU graduates hired in the partner districts will receive content-specific mentoring and content-based professional development to support them in their first three years.

Goal 5: Science education research provides evidence-based contributions to the learning and teaching knowledge base.

Strategy 5A: Collect and analyze data documenting the effectiveness of the partnership in achieving project goals (Cohen and Hill, 2000; Fullan, 2001a; Love, 2002)**.**

Tactic: Experienced research scientists will apply their expertise to science education research and report their findings to the broader science education research community.

An extensive research and evaluation plan has been designed to carefully document the efficacy of the partnership. Higher education science faculty, one postdoctoral research associate, and four graduate students will conduct research related to the reform goals of the partnership. The project will rigorously examine the necessary elements to recruit, produce, retain, and maintain scientifically literate and competent teachers. The unique organizational structure of SMATE provides the ideal setting to examine the impact science faculty can have on improving curriculum selection and implementation, teacher practice, and student learning. Individual faculty will target specific research questions connected to their role in the project. All partners—teachers, school districts, colleges, and universities—will collect data and apply research findings to institute necessary changes to achieve the project goals. Broad research questions supported by the evaluation plan will assess whether the actions of the NCOSP will: (1) build a cadre of K-12 colleagues committed to partnership with higher education faculty as peers to support preservice, inservice, and novice teachers and improve student learning in science, (2) reform school culture to support building-based, job-embedded professional development for all teachers of science and improve student learning, (3) improve teacher practice through the integration of research-based science curriculum into preservice science methods courses, (4) increase teacher content and pedagogical content knowledge through reforms in introductory science course sequences, (5) create a multidisciplinary community of education researchers focused around an important research agenda.

Strategy 5B: Communicate results of partnership to influence needed policy changes by establishing a Policy Advisory Board.

Tactic: A Policy Advisory Board will meet annually with the NCOSP Leadership Team to discuss science education research and evaluation findings.

Emerging NCOSP student achievement and teacher preparation data will inform policy agencies in order to influence changes in Washington State educational policies (Cohen and Hill, 2000; Fullan, 2001b; Elmore, 2002). A Policy Advisory Board will meet annually in the state capital, Olympia, to review project outcomes and their implications for policy, and to review new state policy and implications for the partnership. The Policy Board will include: (1) Terry Bergeson, State Superintendent of Public Instruction, (2) Andrew Bodman, Provost, Western Washington University, (3) Larry Davis, Executive Director, State Board of Education (pending), (4) Marc Gaspard, Executive Director, Higher Education Coordinating Board, (5) Dave Quall, State Representative, 40th Legislative District, and Chair, House Education Committee and (6) Jan Yoshiwara, Director of Educational Services, State Board of Community and Technical Colleges.

Timeline. Figure 2 below summarizes the project timeline.

Evaluation Plan

Dr. James Minstrell of Talariainc will lead the external evaluation (See Supplementary Documentation). The external evaluation team will attend select project activities, conduct participant interviews, compare project goals to delivery, assess impact of project activities, analyze data summaries and documents prepared by the internal evaluators, and submit a written report to the project directors annually. Their work will serve to: (1) advise the project on the implementation and refinement of the evaluation plan, (2) review data and reports constructed by internal evaluators, and (3) compare data to internal evaluation to determine integrity of the analyses. They will communicate through regular meetings, telephone and electronic mail. They will provide an outside perspective to identify alternative views and interpretations not initially considered or recognized and help connect the NCOSP to the science education community.

<table>
<tr><th>YEAR ONE</th><th>YEAR TWO</th><th>YEAR THREE</th><th>YEAR FOUR</th><th>YEAR FIVE</th></tr>
<tr><td colspan="5">School Improvement Process used to assess science education reform efforts in all years</td></tr>
<tr><td colspan="2">Strategic Planning Institutes (1 per year)</td><td></td><td></td><td></td></tr>
<tr><td colspan="5">Curriculum Showcases (1 per year).
Curriculum adoptions of reform science curricula completed in all partner districts by Year 5</td></tr>
<tr><td colspan="5">Specialized Symposia (1 per year) for superintendents, principals, and community members</td></tr>
<tr><td></td><td></td><td></td><td colspan="2">Sustainability Symposia (1 per year)</td></tr>
<tr><td colspan="5">Hire TOSAs (6 per year), 4 resident at WWU, 2 on Olympic Peninsula</td></tr>
<tr><td rowspan="2">Summer Development Institute</td><td colspan="3">Summer Leadership Academies and on-going professional development during the academic year for Teacher Leaders</td><td rowspan="2">Repeat academy sessions as needed
Academy sessions open to state</td></tr>
<tr><td colspan="3">Building-based science learning communities serving all teachers of science</td></tr>
<tr><td></td><td colspan="3">Principals attend 1 day of summer Leadership Academy per year</td><td></td></tr>
<tr><td></td><td colspan="4">Principals attend quarterly meetings (3 per academic year) with Teacher Leaders</td></tr>
<tr><td>Design scholarship program</td><td>Award 40 scholarships</td><td>Award 60 Scholarships</td><td colspan="2">Award 80 scholarships per year</td></tr>
<tr><td colspan="5">All districts and higher education institutions have future teacher clubs supporting science teaching by Year 2</td></tr>
<tr><td colspan="2">Develop introductory science sequence outcomes, curriculum and assessments</td><td>Pilot introductory science sequence</td><td colspan="2">Evaluate and revise</td></tr>
<tr><td colspan="2">Develop preservice science methods course outcomes, curriculum and assessments</td><td>Pilot science methods courses</td><td colspan="2">Evaluate and revise</td></tr>
<tr><td></td><td colspan="4">Teacher Leaders provide mentoring support for preservice and induction teachers</td></tr>
<tr><td colspan="5">Data collection and analysis informs project and contributes to emerging science education research community</td></tr>
<tr><td colspan="5">Partnership Leadership Team and Policy Advisory Board meet annually to discuss research and evaluation findings</td></tr>
</table>

Figure 2. NCOSP Timeline

Dr. Chris Ohana, a Western Washington University faculty member with joint appointments in Elementary Education and Science Education, will lead the internal evaluation which will coordinate the overall project evaluation and collect, summarize, and analyze evaluation data. The effort includes SMATE faculty, one postdoctoral research associate, and four WWU graduate students, who together will provide mid-year and annual reports, as well as monthly formative assessments, to all stakeholder groups. Both the Internal and External Evaluators will participate in monthly management meetings. While WWU will manage the overall evaluation plan, teachers, districts, ESDs, colleges, and universities will all participate in data collection and interpretation.

The evaluation will include "controls" in a quasi-experimental design. Non-participating classrooms, districts, and higher education institutions will be identified and studied as a comparison. In addition, interviews and classroom observations (both in higher education and 3rd-10th grade classrooms) will be conducted before the first interventions to provide a pre-assessment measure of the current state of teaching in the targeted classrooms and a backdrop for anticipated changes in practice. Dissemination of research and evaluation findings will take place through professional meetings (e.g. NARST, AETS, AACTE) and publications in appropriate journals. Expected quantitative outcomes and annual benchmarks are in the Supplementary Documents. Expected outcomes and evaluation strategies include:

Institutional Outcomes. The bold institutional changes proposed by this project will result in increased capacity for all partners, sustainability of project outcomes, and ultimately support student achievement now and into the future. The core partners at all levels—schools, districts, colleges and universities—must communicate and collaborate to effect systemic, sustainable change. In addition to the collaboration, both districts and colleges/universities are expected to effect local changes. Districts will educate their counselors and principals, provide release time for teachers, and align their curricula with national and state standards. District hiring practices will value placing qualified teachers in every class. Colleges and universities will change their courses for preservice teachers, understand and support science reform efforts, implement new teaching strategies in college classrooms, make changes in requirements for endorsement that reflect these expectations, and initiate and support recruitment of new

teachers from diverse backgrounds. These outcomes will be studied through document analysis and interviews from district personnel and higher education representatives.

***Higher Education Faculty Outcomes*.** Several changes are expected of university and college faculty. They will become fluent in the national standards for science content and teaching, change their courses to align with these standards, and work with the College of Education to revise preservice requirements to reflect these changes. Through preservice science methods courses, faculty will model appropriate pedagogy for diverse learners and help their students learn these methods and strategies. Faculty will also work more closely with schools, districts, and teachers and therefore need to become more knowledgeable about the constraints and opportunities for change in schools. Faculty will strengthen their own science education research agenda, collecting and analyzing data to document the impact of the project activities. Data will include classroom observations in undergraduate courses, examination of syllabi, and interviews with both faculty and preservice students, individually and in focus groups.

Preservice Teacher Outcomes. Preservice teacher preparation reforms in the NCOSP are designed to change teacher classroom behavior by improving teacher understanding of both content and pedagogy. The desired outcome is teachers who can identify the content focus of lessons, address student prior knowledge and misconceptions, provide students opportunities to develop conceptual knowledge of subject, provide context for subject, facilitate application of concepts by students, and address the nature of science. Products from preservice courses (e.g. lessons, units) will be examined and observations in classrooms supportive of intended changes will be performed using protocols established by Horizon Research, Inc. and Piburn & Sawada (2000). Preservice teachers will be surveyed and interviewed about their perceptions of the project. The increases in the diversity of the preservice population from the proposed recruitment strategies will also be measured.

Inservice Teacher Outcome. The outcomes for inservice teachers mirror those for preservice teachers. Teacher understanding of content and pedagogical content will be evaluated using embedded assessments currently being developed by Horizon Research. Samples of teachers will be observed in the classroom using the same protocol used for the preservice teachers. Teachers will also be interviewed and surveyed concerning their perceptions of the professional development and changes in their teaching.

Grades 3-10 Student Outcomes. The results of the combined changes in teacher preparation and teacher professional development are expected to lead to sustainable, improved student outcomes. Improvements in content understanding, understanding of the nature of science, attitudes toward science, and science course-taking patterns are anticipated. More high school students will explore and pursue science teaching as a career. The existing achievement gap between different student populations will decrease. These outcomes will be assessed through scores on the state science assessment (Grades 5, 8 and 10) as well as performance on formative and summative assessments tied to the curriculum at all grades. Students will complete surveys about attitudes toward science and the nature of science to detect changes. Data from districts will be collected about student course-taking. All data will be disaggregated by racial/ethnic group, gender and (as far as possible) by socioeconomic status (e.g. Title I). A sample of students will be interviewed about teaching as a profession.

Partnership Management and Governance Plan

***Capacity and readiness to work together*.** Western Washington University offers the resources of the SMATE facility, the Woodring College of Education, and science faculty dedicated to science education reform. WWU has the capacity and commitment to lead the NCOSP and is recognized by the partners as the natural lead institution. All partners enter NCOSP committed to using their resources to build and sustain the capacity described in the action plan.

Although the partnership is new, there is substantial history of cooperation and collaboration among the partners. In Skagit County, district curriculum directors have collaborated on science education reform. SMATE faculty participated in curriculum selection and implementation in some of these districts. The partner districts on the Olympic Peninsula, supported by ESD 114, the Naval Undersea Museum, and

LASER, formed a Science Education Alliance to choose and implement reform science curricula. Bellingham School District and the Whatcom and Skagit County districts have a special relationship with WWU through the teacher preparation program and past professional development experiences. During the last two years, WWU and Everett, Skagit Valley and Whatcom Community Colleges have participated in a state-funded project to improve articulation between the two- and four-year institutions for future teachers. The analysis of science courses revealed a need to jointly develop a yearlong science content course sequence for future elementary teachers. Through an emerging partnership between the Northwest Indian College and Woodring College of Education, NWIC will join this effort.

Management strategies and approaches. Figure 3 below depicts the management structure. The Partnership Leadership Team includes broad representation from school districts, Education Service Districts, LASER, and higher education and will meet monthly, often using the state's K-20 network for videoconferences, but face-to-face at least quarterly.

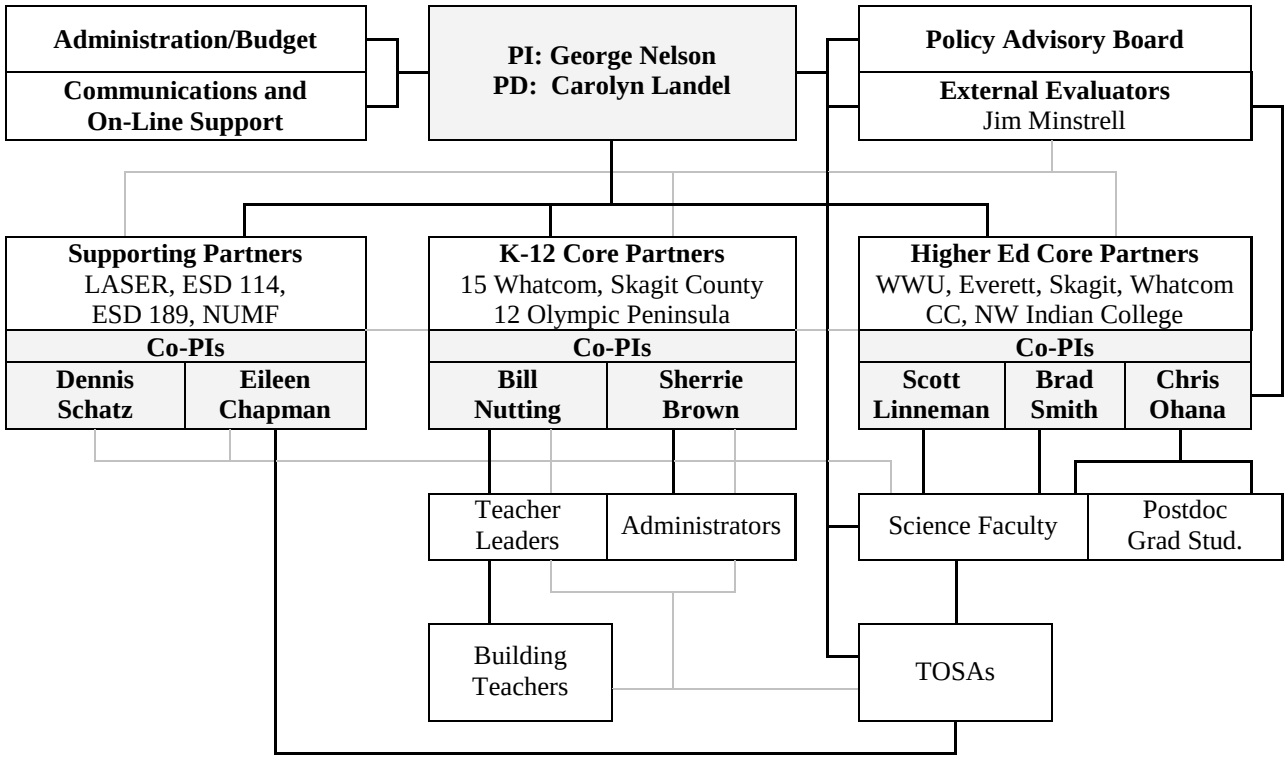

Figure 3. The NCOSP organizational structure. Gray boxes indicate members of the Partnership Leadership Team. Dark connecting lines represent direct reporting responsibilities; gray lines signify secondary interactions.

Effective management will result from frequent, open, and clear communication. All partners will submit monthly electronic reports as a primary communication tool. These reports, organized by NCOSP strategies, will include activity records, budget updates, student, teacher, and faculty data, problems and successes. The Partnership Leadership Team, in consultation with the evaluation team, will determine the content of the report forms. The on-line forms will be developed, distributed, and subsequently stored in a searchable database by the Communications/On-line Support Specialist. The data will be shared with the evaluation team and used to inform project decisions. The other "Strategy Working Groups", lead by the corresponding Co-PIs, will also meet either virtually or face-to-face at least quarterly, though most more frequently. The core WWU team: Drs. Nelson, Landel, Linneman, Ohana, and the TOSAs, Postdoctoral Research Associate, and Graduate Students will interact daily. Additional information on the Partnership Leadership Team, supporting staff and consultants is detailed in the Supplementary Documentation.

Leadership roles and responsibilities of key personnel include:

Dr. George D. Nelson: Supervise overall conduct of the project, including the budget; coordinate the Policy Advisory Board.

Dr. Carolyn C. Landel: Manage day-to-day operations; coordinate TOSA activities (assisted by Ms. Chapman); supervise Communications/ On-line Support Specialist and Administrative Assistant.

Mr. Dennis Schatz: Organize and run Strategic Planning Institutes (Strategy 1A), Curriculum Showcases (Strategy 1B), Specialized Symposia (Strategy 2A and 2B).

Ms. Eileen Chapman: Coordinate NCOSP activities on the Olympic Peninsula; investigate strategies for collaboration between partners separated geographically (Strategy 3B, 4D).

Mr. Bill Nutting: Coordinate building-based professional development (assisted by Ms. Chapman, and Ms. Brown; Strategy 3B); ensure teacher leaders are using release time effectively.

Ms. Sherrie Brown: Coordinate mentoring to support preservice and induction phase teachers (assisted by Mr. Nutting, Ms. Chapman, and Dr. Landel; Strategy 4D).

Dr. Scott Linneman: Develop and coordinate the Three-Year Leadership Academies (Strategy 3A) to develop the teacher leadership cadre (assisted by Drs. Smith and Landel); lead higher education faculty in science education courses reform (assisted by Dr. Nelson; Strategy 4C).

Dr. Brad Smith: Coordinate recruitment efforts at the community colleges to increase the number and diversity of future science teachers (assisted by Martin Chorba; Strategy 4A); lead the reform/development of introductory science content courses for preservice teachers (assisted by Drs. Linneman and Nelson; Strategy 4B).

Dr. Chris Ohana: Lead the internal evaluation coordinate with the external evaluator; coordinate NCOSP research agenda (Strategy 5A)(assisted by Dr. Andrew Boudreux).

Dr. James Minstrell will serve as the external evaluator. Although the internal and external evaluators will interact closely with the Partnership Leadership Team, they will not be formal decision-makers. A description of External Evaluation Scope of Work is included in the Supplementary Documents.

29 scientists will be directly involved in the project. Ten scientists work directly in the SMATE program; the remaining faculty come from the community colleges. Faculty will be directly engaged in reform of introductory undergraduate science courses and preservice science method courses, facilitating professional development in support of science education reform, and infusing research into all activities to contribute to the emerging teaching and learning knowledge base (See Disciplinary Partners Table).

Institutional Change and Sustainability

NSF funds in this proposal are primarily used to build capacity for the development of courses, services and professional development aligned with the state's student academic and achievement standards. Through effective reforms, the capacities established in schools, districts, ESDs, and higher education will become integral and sustainable parts of the reformed science education environment. A research group inclusive of all stakeholders will be established, evaluating programs and student learning, providing continuous feedback to the community colleges, universities, and schools, and contributing to the emerging learning and teaching knowledge base. Coherent introductory science content courses and preservice science methods courses grounded in research and standards-based curriculum will prepare highly qualified teachers of science. Skilled mentors in partner schools will support practicum students and student teachers, and sustain induction teachers. Partner districts will collect and analyze high-quality data to inform continuous school improvement. Summer academies for Teacher Leaders will continue to serve the partners and expand to districts outside of the NCOSP, supported by districts funds. Districts will maintain and sustain science learning communities providing ongoing content and pedagogy training for all teachers with ESEA funds. Intensive recruitment will result in a larger, more diverse teacher workforce. Partner districts will have implemented research-based curriculum. A qualified teacher able to use that curriculum will teach every grade 3-5 class, and a certified teacher with the appropriate science endorsement will teach every grade 6-10 science class. All students will achieve in science and meet or exceed standards on the state science assessment.