

*Academic Program and Unit Review*  
Science and Mathematics Teaching Center  
University of Wyoming

## *Executive Summary*

<b>Background</b>	The Science and Mathematics Teaching Center was established to provide high quality professional development for Wyoming teachers in 1970 by a group of scientists concerned about the quality of K-12 education. As a collaboration between the College of Arts and Sciences and the College of Education, SMTC currently offers three master's degree programs, engages in outreach throughout Wyoming, collaborates with faculty to expand their broader impacts by providing professional development to teachers, conducts research with external funding and coordinates the Wyoming State Science Fair.
<b>Program Productivity</b>	78 graduate students completed their degrees between 2011 and 2016 in SMTC graduate programs: Middle level Science - MSC (24), Middle level Math – MMA (15) and Natural Science Education – NED (39).
<b>Program Quality &amp; Reputation</b>	SMTC graduate programs are well-known and highly regarded. The SMTC is often contacted as a reliable source on education-related issues. Students benefit greatly from the collaborative nature of the programs and frequently comment that their courses through the SMTC are the best that they've ever had.
<b>Mission Centrality</b>	In addition to serving STEM teachers by offering master's degree programs designed to fit their work schedules, SMTC engages in outreach efforts by providing professional development to Wyoming primarily through grant-funded outreach in collaboration with UW faculty. SMTC also puts on the Wyoming State Science Fair which brings more than 300 students and many teachers to campus each March. The event links teachers and students from throughout the West -- UW faculty too!
<b>Financial Viability</b>	Current endowments are valued at \$1,303,280 (not including gift annuities); between 2010-2016, \$308,988 in scholarships were awarded to 275 <sup>1</sup> recipients in SMTC programs providing significant support and incentives for enrollment in the programs. Since 2010, External grant funding: \$9,863,020 <sup>2</sup> ; Internal UW awards: \$69,792; and Contracts/Service Agreements:\$434,972. The SMTC receives only a small amount of state funds and the unit as a whole operates on very limited resources.

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<sup>1</sup> Data provided by UW Foundation, 8/26/16, does not identify individual recipients; students in the MSC and MMA programs receive multiple scholarships throughout the program.

<sup>2</sup> Data provided by the UW Research Office, 9/2/16.

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**Title of Program/Specialization:**

Master of Science in Natural Science with concentrations in:

- Middle-level Science Teaching (MSC)
- Middle-level Mathematics Teaching (MMA)
- Natural Science Education (NED)

Master of Science Teaching – Mathematics (MST – Math) – discontinued when grant funding ended in 2015.

**Indicate whether undergraduate or graduate program/specialization:**

Graduate

**Department and College:**

Science and Mathematics Teaching Center, College of Education and College of Arts and Sciences

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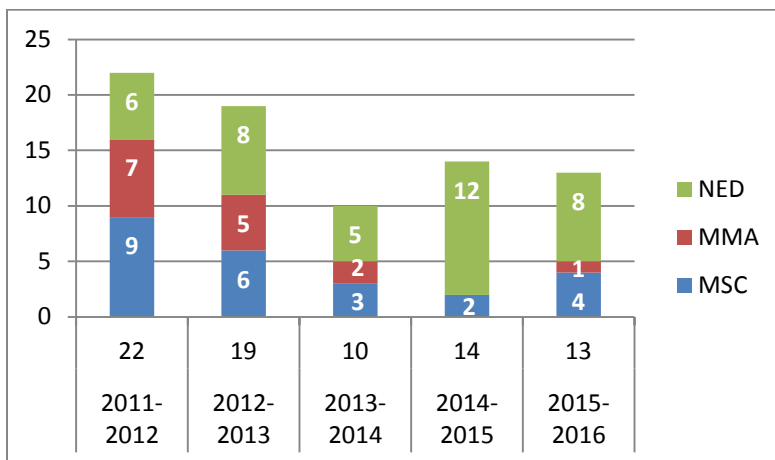
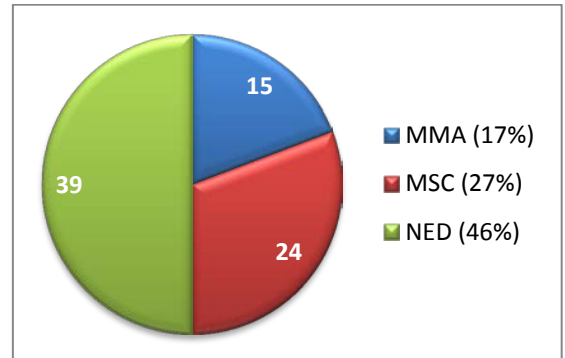
**Part 1 – Program Review**

**1. Program Productivity/Demand:**

a. 78 graduates over 5-year period<sup>3</sup> (2011-2016):

- Middle-level Science Teaching (24)
- Middle-level Mathematics Teaching (15)
- Natural Science Education (39)

This chart represents the percentage of graduates from each program out of our total of 78 graduates. 46% (n=39) were from the NED program with Teton Science Schools, indicating this partnership has yielded excellent results.



This graph on the left shows the number of students who graduated from the three SMTC graduate programs each year over the past 5 years. On average, 16 students were graduated per year over this time period.

<sup>3</sup> Report from UW Institutional Analysis, 8/24/16

- b. Enrollment in MS in Natural Science concentrations over the 5-year period averaged:
  - Middle level Science Teaching (14/yr)
  - Middle level Mathematics Teaching (11/yr)
  - Natural Science Education (9/yr)
  
- c. Opportunity: The demand for teachers in math and science remains high and the expectation that teachers need to improve their practice and impact is growing even higher. Science, Technology, Engineering and Math (STEM) education is a great example of an area where there is a growing demand for teachers. According to the Wyoming Department of Education<sup>4</sup> there are 595 science and math teachers in Wyoming middle schools and high schools without master's degrees. In addition there are many elementary teachers who are interested in becoming certified to teach middle school. The course work in the SMTC middle level math and science programs meets the requirements of the Professional Teaching Standards Board (PTSB) for middle level endorsements and the federal definition of "highly qualified" to teach grades 5-9 thus opening employment opportunities for both elementary and high school teachers since many Wyoming schools are K-8 or 8-12. The master's programs in middle-level science and math are the only content-rich programs designed specifically for working teachers in Wyoming; generous financial support helps them decide to enroll in the program; a bump in salary when the degree is completed increases motivation too.

## 2. Program Quality: Is the program of high quality?

- a. Program accreditation
  - i. The MMA and MSC programs prepared for the National Council for Accreditation of Teacher Education (NCATE) accreditation review that was conducted in the College of Education in 2015. However, that cycle of reviews was focused on undergraduate programs rather than graduate programs. The two SMTC programs were referred back for evaluation to the Wyoming Professional Teaching Standards Board (PTSB), the organization that had previously evaluated both programs and recognized them. The PTSB uses nearly identical criteria as NCATE. Paperwork was revised and submitted and the MMA was accredited during AY 2015-16; the MSC program has been submitted for accreditation this year (FA16).
  - ii. There is no specific accreditation for the NED program through NCATE.
  - iii. The SMTC programs have not had previous Academic Program Reviews (APR)
  
- b. Credentials of faculty
  - i. Faculty. The SMTC has only two tenured or tenure track faculty and one Senior APL (extended term). The coordinator of the Wyoming State Science Fair (WSSF) is in a Temporary Assistant Lecturer position.

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<sup>4</sup> Report and mailing list from WDE to the SMTC on 11/16/15

Faculty	Highest Degree	Discipline of Highest Degree	Gender	Ethnicity
Jacqueline Leonard <sup>5</sup>	PhD	Mathematics Education	F	African American
Ana Houseal	PhD	Secondary & Continuing Education – Science Educ	F	White
Sylvia Parker	MA	Technology in Education	F	White
Erin Stoesz	MS	Geology and Celtic Studies	F	White

- ii. 93 Affiliate Faculty members in the Colleges of Agriculture (5), A&S (37), Education (21), Engineering (5), Other UW (7), Community Colleges (3), and Emeritus (15). Affiliates assist with reviewing applications, teaching classes, mentoring students, serving on graduate committees, collaborating on grant-funded projects and providing professional development to teachers.
- iii. Grants awarded to academic personnel and/or managed by SMTC since 2010 (see Appendix)
  - External grant funding: \$9,863,020
  - Internal UW awards: \$69,792
  - Contracts/Service Agreements: \$434,972
- iv. Publications/presentations by academic personnel 2011-2016
  - Jacqueline Leonard, Professor: 13 Journals, 1 article, 5 chapters, 1 book; 36 presentations, 3 proceedings
  - Ana Houseal, Assistant Professor: 5 Journals, 2 articles, 3 reports, 2 curricula; 32 presentations
  - Sylvia Parker, Senior APL (extended term), 3 papers, 25 presentations
- c. Program reputation
  - i. The SMTC programs are not ranked. Information about their reputation is largely anecdotal. Many teacher leaders in the state are graduates; graduates refer their friends and colleagues. Those who are in the program are fiercely loyal.
- d. Curriculum of the Concentrations in the Natural Science Major

<b>Middle Level Science (MSC)</b>		Credits
Summer 1	NASC 5120 Earth Science in a Global Context	3
	ASTR 4000 Astronomy for Teachers	2
	NASC 5300 Natural Science Assessment	2
	NASC 5400 Spatial Data and Instructional Technology	1
Summer 2	NASC 5130 Life Science in Global Context	3
	ENTO 5601 Insects for Teachers	1
	SOC 4890 Global Populations & Environments	1
	NASC 5320 Science, Technology and Society & Plan B Research	2
	BOT 4790 Field Techniques	1

<sup>5</sup> Dr. Leonard joined the SMTC as Director in the fall of 2012 and resigned on 7/31/16; her work is included in this report.

Summer 3	NASC 5110 Physical Science in Global Context	3
	NASC 5600 Math & Stats in Science Teaching	2
	NASC 5510 Integrated Instructional Strategies	2
	EE 4800 Energy Policies and Impacts	1
+ 6 additional credits for a total of 30 + a Plan B non-thesis		
<b>Middle Level Mathematics (MMA)</b>		
	MATH 5160* Social and Historical Issues	3
	NASC 5205* Methods for Teaching Middle Level Math	3
	NASC 5170 Connecting Geometry	3
	NASC 5225 Assessment for Middle-level Math	3
	MATH 5190* Mathematics of Change	3
	MATH 5140* Numbers and Operations	3
	NASC 5215 Technology	3
	NASC 5185 Analysis of Data	3
+ 6 additional credits for a total of 30 + a Plan B non-thesis		
*Taught online during the school year		
<b>Natural Science Education (NED)</b>		
	ZOO 5430** Ecology of Yellowstone Ecosystem	3
	ZOO 5420** Ecological Inquiry	3
	NASC 5610** Field Studies: Environmental Education	4
	NASC 5620** Field Ecology	5
	NASC 5650 Place-based Learning	3
	Graduate level Research Class	3
+ 9 additional credits for a total of 30 + a Plan B non-thesis		
**Taught at the Teton Science Schools by UW Adjunct faculty during the school yr		

- e. Distance delivery of programs/major
- i. The MMA program is designed to serve the work schedule of teachers and enable them to complete the course work in two years. Six credits are offered in Laramie for 3 weeks in June each summer and a 3-credit synchronous course is offered online each fall and spring usually on Tuesday evenings.
  - ii. The MSC program requires more hands-on experiences and coursework is designed to be completed in three summers (4 weeks, on campus in June). Electives may be taken online.
  - iii. The NED program is offered in conjunction with the Teton Science Schools in Jackson. Students are admitted as UW students, take classes and work in field science education in the graduate program in year 1 in Jackson (classes are taught through the Outreach School by adjunct faculty and transcribed at UW). Those students who choose (and meet requirements) may come to UW on campus for the second year of the program to complete their master's degree.
  - iv. Most students complete their coursework, electives and Plan B projects within the established cohort program, but some find it challenging to finish their Plan B when they are working fulltime. The SMTC Outreach Educator created a 4-credit course offered each fall to provide the structure and skills to SMTC graduate students to design and complete their Plan B projects. It is an online synchronous course through

Outreach although some participants who live in the area choose to attend in person. Two intensive weekends conducted face-to-face enable students to form a professional learning community in which they plan, share, provide feedback and mentor each other establishing relationships across the state and across programs. Completion rates have increased dramatically since this course was implemented.

f. Quality of Assessment Plan/data

- i. The SMTC has a strong commitment to both assessment and evaluation. SMTC faculty members have extensive knowledge, skills and experience in this area and teach teachers how to do effective assessments. The SMTC has common student learning goals for all three of our programs.

*SMTC Student Learner Outcomes*

Upon successful completion of the MS NS program, a student will be able to:

- Engage in teacher research to transform STEM instruction:
  - Design and implement a research project that asks and answers a question using appropriate materials, concepts and methods, and ethical practices, and
  - Effectively communicate all aspects of the research project in both oral and written forms.
- Use professional and academic standards to ensure high-quality interdisciplinary instruction (i.e., place-based, culturally relevant, and/or social justice pedagogy) to maximize student learning.
- Engage in mathematical and/or scientific discourse and scientific thinking as active participants in communities of practice.
- Use emerging technology and science investigations as tools to engage students.

- ii. The three MS Natural Science graduate programs are at assessment Tier 2 status. We will proceed in the coming year with the next steps in the SMTC Student Outcomes 5 Year Assessment Plan (2014-2019) asking a research question on which we will gather data and answer a question. Faculty who teach in the MMA and MSC programs meet together each year to plan the upcoming courses including the content, activities, assignments and a common performance assessment making sure that there are direct assessments of each standard required for accreditation. Data are being used to improve the programs but not yet for summative purposes that would move them to a Tier 1. The rubric and process developed for assessment of the research outcome in all SMTC programs is being modified by other departments for use in their programs. The rubric is distributed to all incoming graduate students and to their committee members so they are aware of the expectations from the beginning. Focus groups are held each summer by an interviewer from outside the SMTC and the anonymous comments also feed into the continuous improvement process.

g. Strategic Plan

- i. The SMTC developed a draft strategic plan related to UP4 in 2013-14. The SMTC as a unit is well-aligned with and continues to make progress in University Areas of Distinction including STEM; Energy; Environment, Agriculture and Natural Resources; and Education. Progress is reported here on three action items.

- Action Item 1: Maintain distinction in fields serving the State's critical needs in STEM and STEM education
  - *Maintain quality graduate programs*: implemented continuous improvement plan; modified courses and assessments; added a course and support group to enable students to complete their degrees; increased expectations and standardization of Plan B projects; published all Plan B papers on WY Scholars Repository (WySR) through which students reach an international audience.
  - *Provide professional development (and follow up support) to teachers related to STEM*: primarily achieved through grant-funded work such as the Engineering Initiative through which we worked with Electrical Engineering to conduct workshops with 65+ teachers this summer; a graduate student in the NED program will provide follow-up support to the teachers in this school year along with undergraduate engineering students. NOTE: **since 2011, 122 NASC professional development offerings have reached 1,393 students and generated 2,581 credits.** Almost no state funds are used to serve educators throughout the state this way.
  - *Increase the number and quality of STEM teachers in the state*: obtained a Noyce Scholarship grant from NSF to enable underrepresented and first generation college students majoring in STEM fields to also get elementary teaching certification.
  - *Expose underrepresented students, females, students with disabilities and minorities to pre-engineering skills*: obtained ITEST grant from NSF to provide opportunities for students to increase their interests in engineering through gaming and robotics, in order to create a diverse ICT/STEM workforce.
  - *Provide leadership in the development and implementation of Wyoming Science Standards*: served on State Standards Committee; obtained service agreements to provide professional development to districts on how to modify curriculum and instruction to meet the standards; added components to graduate classes and graduate committee advising to assure understanding and use of new standards; engaged in public outreach (PBS, WPR, Ed Week and others).
- Action Item 2: Enhance Educational Effectiveness and Cross-Discipline Integration
  - *Develop a capstone course* as an alternative to the Plan B requirement: a course has been developed and piloted and a CARF is being prepared for submission.
  - *Develop new and creative recruitment efforts* to reach teachers inside and outside of Wyoming and increase diversity: efforts have begun with initial funding from Academic Affairs but continued effort and a long-term plan in conjunction with other UW entities are needed.
  - *Develop certificate programs* to meet needs of teachers and schools (i.e., Teaching STEM, Incorporating Engineering and Design, Implementing the New Science Standards, Elementary Mathematics, Place-based Learning, Education for Sustainable Development): it will be necessary to

work with the College of Education to develop and offer any of these programs.

- *Develop interdisciplinary courses and collaborate with faculty in other departments:* the MS programs in Natural Science are interdisciplinary and we will renew our commitment to make sure that courses are taught by faculty from the designated department to ensure content-rich instruction.
- Action Item 3: Create New Research Opportunities
  - *Collaborate with and support the work of others engaged in STEM:* The SMTC collaborates with faculty throughout the university on Broader Impacts by helping them conceptualize timely and appropriate approaches for impacting broader audiences with their research work; assisting them in writing and budgeting for their proposals; writing letters of support/commitment; finding partners and recruiting participants; collaborating to develop and deliver professional development to teachers and programs to other audiences; assisting with evaluation and assessment; publishing articles together and publicizing efforts; making joint presentations. We also invite faculty from other departments to collaborate on projects the SMTC is proposing. Recent interactions have been with faculty in the following departments: Molecular Biology, Philosophy, Secondary Education, Literacy Education, Math, Computer Science, Botany, Mechanical Engineering, Electrical Engineering; and the College of Agriculture, College of Engineering, the Biodiversity Institute, WSGS, and SER.

### **3. Mission Centrality: Does the program advance the mission of UW including institutional strategy?**

- a. The SMTC plays a distinct role at UW as a long-term unit committed to interdisciplinary collaborations that support the teaching and learning of science and mathematics, and more recently engineering, technology and the arts. Supported by both the Colleges of Education and Arts and Science, the SMTC plays a leadership role in providing high quality, timely professional development that is research-based and culturally relevant to teachers in Wyoming and across the western United States. That means that the SMTC does not engage in one-shot workshops but works to provide professional development and ongoing follow up support increasing the likelihood of successful implementation. SMTC is both a resource center for educators and a center for developing projects and grant proposals to fund collaborations between K-12 schools, the Wyoming Department of Education, community colleges and University of Wyoming faculty. The SMTC offers master's degree programs to experienced teachers; facilitates collaborations on campus and around the state with organizations such as the WY After School Alliance, the Wyoming Environmental Education Association, and the Teton Science Schools. The SMTC is a national leader in place-based education, culturally relevant pedagogy, and increasing diversity in mathematics education.
- b. Describe how the program contributes to other programs across campus. The SMTC works hard to build relationships within UW: we jointly sponsor and/or participate in planning and conducting events such as the SciArt Symposium this week with the Art



Museum, Biodiversity Institute, the Haub School, and the Visual Arts Department; the Saturday STEM Days and Women in Science with WY STEM and the NASA Space grant. We sponsor speakers and invite the entire campus and local educators (a good example is Chris Emden, a well-known science educator at Columbia University who uses hip hop to get kids to love science). We sit on boards and committees such as the NASA Space Grant Advisory Board, the Biodiversity Institute's Faculty Advisory Committee, the Committee on Women and People of Color, the Haub School's Innovation Grants selection committee. We are actively involved with WY STEM, the Engineering Initiative and SER. We show up, participate, collaborate and support the work of faculty and their students. We place graduate students with faculty and programs across campus and build relationships through them.

- c. The SMTC also conducts research – on effective practices in education; learning progressions; effective professional development for teachers; culturally relevant place-based education; and diversity especially as related to STEM areas. We have a special interest in collaborations, partnerships and relationships with community. We share our research and that of our students through publications, presentations, social media and the Wyoming Scholars Repository. We collaborate on major research projects both within UW and with other partners around the country.
- d. An informal survey of graduates of the NED program brought to our attention that all but 4 of the 39 graduates are gainfully employed in areas related to their degree. Three of the four are new mothers and one had no forwarding information. All of the students in the MSC and MMA programs are employed teachers so few of them change jobs although some take on leadership roles within their districts.
- e. The SMTC programs are unique at UW. The synergy between the academic programs, the outreach efforts, relationships with faculty and other UW interdisciplinary programs, and institutional support should not be underestimated. For example, last year a graduate student in the NED program worked as a halftime graduate assistant in the Biodiversity Institute. At their request, she developed a curricular unit on Sage Grouse ecosystems and piloted it in a fifth grade class in Baggs with a teacher in our MSC graduate program. Working with scientists (who are also SMTC affiliate faculty members) at the Berry Center to incorporate accurate science content, the graduate student based the unit on solid academic research she was doing for her Plan B project and grounded the activities in place-based education (an emphasis in the SMTC). Furthermore, our emphasis on social justice and her personal commitments from teaching in Latin America in the Peace Corps prompted her to minor in teaching English language learners (ELL). She incorporated ELL teaching principles in the unit in order to better serve all students and invited her ELL professor to serve on her graduate committee. Working closely with the Baggs teacher to make sure the unit addressed important science standards and that it was appropriate for 5<sup>th</sup> graders in her community, the graduate student also received valuable feedback from her during the pilot enabling her to revise, improve and finalize it before making it available to all teachers in Wyoming through the Biodiversity Institute. Her plan B paper and the curriculum (with a link from the Berry Center) reside on the UW libraries WySR site and have been downloaded 41 times since July. The impact of this graduate student's work extends well beyond a

single classroom. She has a full-time job teaching in Wyoming this fall. This single case study exemplifies the experience of many SMTC graduate students.

4. **Cost: Is the program financially viable?**

a. Ratio of student credit hours per FTE

The total program FTE is based on the assigned teaching load for the 3 SMTC faculty (Leonard: 25%; Houseal: 40%; and Parker: 30%).

	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	Total
Grad	589	844	713	877	698	751	4472
PD 5959 <sup>6</sup>	553	495	429	311	360	433	2581
<b>Total</b>	1142	1339	1142	1188	1058	1184	7053
FTE	.95	.95	.95	.95	.95	.95	
<b>Credit Hrs/FTE</b>	1202	1409	1202	1114	1114	1246	Average 1214.5

b. Direct instructional expenditures:

- i. The state support budget does not include faculty pay; expenditures are not tracked to specific programs or individuals. SMTC faculty typically teach NASC courses on-load and receive no extra pay. Faculty from other departments who teach courses for SMTC students particularly during the summer are paid as instructors. This table shows the income as well as summer school and course fee inputs.

Year	State support budget*	Summer School & Course Fees	Summer Salaries Faculty Teaching
2010	\$11,403	\$29,472	\$21,224
2011	\$10,833	30,530	12,611
2012	\$11,403	25,594	14,123
2013	\$15,000	No distribution from College of Ed	17,639
2014	\$15,168	29,818	9,750
2015	\$14,423	14,149	11,100

\*Does not include \$75,000 provided for WSSF Coordinator and fair or for faculty and support staff

c. Course enrollment

- i. Because the MMA and MSC programs each include 24 credits of mandatory courses that are offered on a rotating basis, it is our responsibility to offer the courses even if there is low enrollment so students don't have to wait 2 or 3 years until those particular classes are offered again. The only courses that appear to be under-enrolled are NASC 5959 professional development workshops – some participants might sign up for PTSB credit or none at all. A workshop might have 15 participants but if only 4 decided to take it for credit that class would show up on the report with an enrollment of only 4. All of our classes required for the degrees appear to have adequate enrollment numbers.

d. Other instructional cost drivers, N/A

<sup>6</sup> NASC 5959 courses provide professional development for teachers. They are recorded on UW transcripts to indicate successful participation but can't be used towards a graduate degree. Instructors are not paid by UW but are typically covered by grants. SMTC reached 1393 teachers through 122 offerings between 2011 and 2016.