Project Narrative

Section A. Significance

A.1. Innovating to Improve Middle-Schoolers' STEM+CS Success: This **early-stage** proposal **STEM-Language Arts Teaching/learning Ecosystems (SLATE)** responds to **Absolute Priority 1 [AP1]: Demonstrates a Rationale**, and **Absolute Priority 3 [AP3]: Field-Initiated Innovations – Science, Technology, Engineering, or Mathematics (STEM)**, and addresses the three **Competitive Preference Priorities: Computer Science, Innovative Approaches to Addressing the Impact of COVID-19 on Underserved Students and Educators, and Promoting Equity and Adequacy in Student Access to Educational Resources and Opportunities**. The project is a multi-level intervention that includes (1) near-peer mentoring opportunities, realized through Extended Learning Opportunities (ELOs) that leverage high school students as just-in-time tutors; (2) professional development for teacher teams to deepen knowledge and foster team-led curricula development in science communication/writing, with a focus on the integration of state-level computer science (CS) standards into STEM and the language arts (both LA and EL).

The SLATE project aims to address inequities and issues of access for English learners (ELs) at the middle levels with a focus on STEM+CS and language arts development. The University of New Hampshire's Leitzel Center (LC), NH Literacy Institutes (NHLI), and Community Literacy Center (CLC) propose an innovative multi-tiered intervention program that brings together teacher training in EL and STEM+CS, cross-disciplinary teacher collaboration, academic year support for teachers, near-peer tutor development (high schoolers), the GLOBE program for environmental science, and summer support for middle schoolers; in short, our team seeks to build a learning ecosystem to support and aid middle students and their teachers in order to increase high-needs students' exposure to, positive attitude towards, and success in rigorous

STEM + CS courses. ‘High-needs students’ are defined as ELs, former ELs and multilingual students who may still find themselves unable to access rigorous courses, and low-SES students.

We propose to accomplish this through the refinement and implementation of a learning ecosystem that includes near-peer tutoring, extended learning opportunities (ELOs) for students, and the building of educator capacity/knowledge. Project impacts will be measured by attitudinal surveys, participation in STEM classes at the HS level, scores on state and national tests, and the production of vetted, tested and refined curricular units. The project’s specific goals are: (1) improve underrepresented grade 5-8 students' scores in STEM-related attitudes and achievements; (2) test the added value of combining interventions with a near-peer tutoring program using a quasi-experimental, multi-level intervention that meets What Works Clearinghouse (WWC) evidence standards; (3) collaboratively hone the SLATE framework for development of learning ecosystems for HS and MS students including teacher professional development with participating middle-level teachers and administrators to increase STEM and language achievement among multilingual and high needs students; (4) develop STEM and ELA teacher capacity and knowledge through PD training and the collaborative building cross-disciplinary units of curricula; (5) develop sustained interest and positive attitudes across middle-level ELA, ELL, STEM, and CS teachers through SLaTE framework for teacher development; (6) increase content-area teachers' confidence and pedagogical knowledge to teach multilingual learners with a particular emphasis on science vocabulary and concepts, writing, and reading; (7) ensure longevity of project through dissemination of findings and resources and through securing future funding.

A.2. Project Dissemination: Project success will be assessed independently and widely disseminated. A multi-pronged plan where all project members contribute to dissemination of

results will be implemented to disseminate project derivatives. To reach the ***scientific community,*** once data have been collected, the data will be promptly prepared and submitted for publication. Findings from this project will be presented as talks and posters at conferences and prepared for submission to relevant journals. This team has a strong record of presenting and disseminating research at conferences. To reach the ***education community,*** results of the project will be disseminated through state-wide Teacher Development Programs, including the annual STEM Educators' Summit, sponsored by the LC. In year 3 of the program, SLATE initiative teacher teams will be invited to lead Summit workshops highlighting the integrated approach to teaching. In addition, SLATE collaborative teams, as well as near-peer tutors and their teaching advisors, will be invited to share their experiences and teaching approaches at the summer NH Literacy Institutes and work with other teacher-authors to write about their work and disseminate the curriculum projects to fellow teachers. The ELOs involved in this project will be supported in discussing their roles at NH ELO meetings. We would also support teachers' presentation of their curricula at the yearly New England regional CSTA meeting. Additionally, educators will share their lesson plans in an online repository, co-hosted by the LC, CLC, and NHLI. Through the Global Learning and Observations to Benefit the Environment (GLOBE) Program (www.globe.gov), this network, products, including the posted training modules, will reach the community of 126 GLOBE Partners throughout across the country who provide professional development to the teachers in their service areas, along with teachers using the site for support materials. We will highlight the SLATE project in the GLOBE annual meetings (international and North American) and in weekly meet-ups, "Watercoolers," where GLOBE Partners gather (virtually) to hear about new ideas and implementation methods from each other. Watercoolers are recorded and archived in the globally accessible GLOBE Program YouTube channel.

Section B. Project Design

B. 1. Conceptual Framework: Language demands in both science, mathematics, and CS content areas can be substantial, and learning STEM content requires EL students to understand and meet linguistic expectations, as well as discourse practices for these content areas (Snow, 2010; Lee & Buxton, 2013). This challenge for ELs is impacted further by STEM+CS educators who often have limited formal training in teaching ELs and in language development (Santos et al., 2012). These challenges are more apparent as students advance into and beyond secondary levels. ELs are less likely to take and thrive in advanced-content STEM + CS and language arts classes (Callahan et al., 2010; Kanno & Kangas, 2014; Dabach, 2015). Success and interest of ELs requires and is dependent upon content-area teachers' capacity to address ELs' language and academic needs *with* engaging, rigorous STEM content and *through* approaches that build upon EL students' competencies and linguistic/cultural resources (Cook, 2003, Cimpian et. al., 2017).

The SLATE initiative begins with the idea that blending of computational thinking and science writing/communication into middle school science through cross-disciplinary curricula has the potential to benefit STEM learning environments in several ways. First, this approach may help abate waning interests in STEM (particularly notable in women, ELs, and other under-represented groups) thought to begin in middle school years (e.g., George, 2002). Secondly, this blended approach serves as a more effective representation of skills important in critical thinking and the development of scientific arguments. Current literature on the intersections between science and language arts has found STEM teachers support the idea of integrating text and literacy instructional practices into their lessons but perceive a wide range of barriers to implementation (Wexler et al., 2017). Next Generation Science Standards (NGSS), written to align with the Common Core State Standards (CCSS, 2010), affirm that

communicating in science is an important skill that requires, for example, the ability to read and write, in ways that synthesize complex information, communicate those understandings, and use evidence to explain findings to a variety of audiences. In addition, increasing demands for students to become savvier with digital literacies, to understand and communicate scientific information, are being driven by states' adoption of CS standards (e.g., NH DOE, 2018).

For example, in addition to written and digital communication serving to allow students to synthesize and sharpen their scientific thinking, students are expected to meet key performance expectations in (1) obtaining, evaluating and communicating information and (2) engaging in argument using evidence (NGSS). Yet, national data indicate middle-school students, particularly ELs, still struggle with writing and communication. According to NAEP (NCES, 2012) assessments, fewer than 3% of students at both grades 8 and 12 performed at the advanced level for writing. Only about a quarter (24%) were at the proficient level. For ELs, their national performance on NAEP assessments in the STEM content areas have been substantially lower than that of their non-EL counterparts (NASEM, 2018). Both EL and non-EL students often incorrectly assume that effective communication/writing is not important in STEM fields. Notable disconnects students experience in how writing is stressed in STEM vs. language arts classrooms regrettably reinforce these misconceptions.

Although the responsibility for teaching students these skills lies at the intersection between language arts and STEM classrooms, often, these subject-area teachers do not have opportunities to collaborate on curricula and work together to address intersections between science and writing. ELA and EL teachers are often uncertain of STEM teachers' goals in the classroom or the importance of science communication, including writing, for their students. This uncertainty, coupled with what students can interpret as a perceived lack of interest in

STEM fields, can impact the interest in science among their students. Similarly, as noted above, STEM teachers are often unsure how to use best practices to help EL students increase their writing and academic reading proficiency levels, despite knowing how important communicating science to a range of audience types is for future STEM professionals. Today's students require EL, language arts, and STEM teachers to become better equipped to incorporate computational thinking, as well as effective science communication, into their curricula. However, since LA and STEM teachers do not often have a shared vocabulary, given their different disciplinary backgrounds, this exploratory project aims to aid teachers in developing shared vocabulary and interest through a collaborative experience, focused on building and implementing cross-disciplinary project-based curriculum units for their students.

The SLATE project is guided by two frameworks: (1) the development of a multi-tiered learning ecosystem with support systems created among trained high school tutors, extended learning opportunities, families, and well-prepared, innovative teacher teams (See Exhibit 1); and (2) the development and implementation of the SLATE professional development institute for teachers which supports STEM and language arts curricular innovation, team collaboration, and responsive teaching practices (See Exhibit 1).

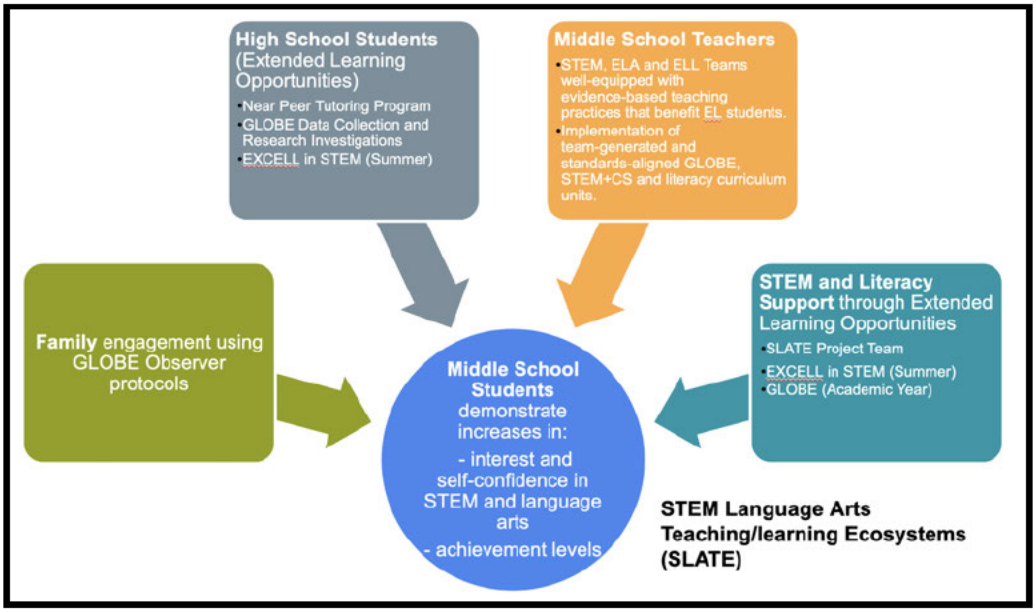

Exhibit 1. Multi-level interventions with middle school English Learners

Extended Learning Opportunities for Middle School Students (Summers): In the summers of 2022, 2023, and 2024, EL students will have tuition-free access and free transportation to *EXCELL-in-STEM*, a five-week summer middle-level academic support program at UNH Manchester campus, in order to provide a rapid response to the impact of COVID-19 on underserved students in the areas of STEM, reading, and writing. Through hands-on biology labs, engineering projects, and 3D printing and coding workshops, as well as presentations from faculty and students, EXCELL introduces students to diverse STEM fields, careers, and college opportunities. This long-standing program is aligned with WWC recommendations for structuring out of school time for academic achievement (Beckett et al., 2009).

Near-Peer Tutors: The WWC has identified that evidence-based peer tutoring models, like PALS, have been demonstrated to positively affect students' reading fluency and comprehension (Saenz, Fuchs, & Fuchs, 2005). Given this evidence, and building on these models, SLATE, beginning in AY 2022, will recruit high school students, along with

undergraduate students, to be trained as tutors who help collect environmental data using the GLOBE Program protocols (described below). These near-peer tutors will work with middle school students, both in a tutoring capacity and as facilitators of GLOBE data collection. Near-peer tutors will be recruited with a high attention to diversity and inclusion, particularly with regard to fostering more multilingual students, students of color, and young women toward STEM + CS interests. Near-peer tutors' leadership will improve middle schoolers' attitudes towards STEM + CS while concurrently developing a cohort of multilingual/ELL students that both improve academic outcomes for younger students and serve as a STEM + CS pipeline for high school, college, and the workforce.

Teacher-developed, cross-disciplinary units, in-class support, and other academic year innovations: Throughout the academic years of the program, middle school students will take part in collaboratively-designed, cross-disciplinary standards-aligned STEM + CS units within their content-area classes (See descriptions of *Teacher Teams and the SLATE Institute* below) During AY 2022-23, 2023-24, 2024-25, 2025-26, middle schoolers will also receive tutoring in STEM + CS and literacy from near-peer high school and undergraduate students. We hypothesize that participation in engaging summer support and inquiry-based coursework, administered by educators trained in inclusive pedagogies, will increase middle school students' positive attitudes towards STEM + CS; this will, in turn, increase students' achievement in the STEM fields and language arts and increase their successful participation in STEM + CS courses in high school. In order to build enthusiasm for STEM, as well as computational skills, teachers and students will work closely with GLOBE, a vibrant community composed of youth, educators, scientists, partners and interested citizens, funded by NASA and supported by NSF, NOAA, and the U.S. Department of State. It is a broad international community spread throughout 126 countries with

over 37,000 K-12 schools and out-of-school providers, and 41,000 teachers around the world. Youth and teachers/adult facilitators use GLOBE protocols that have been designed by scientists and field-tested by classroom teachers to study the atmosphere (weather and climate), biosphere, hydrosphere (water) and pedosphere (soils). Youth enter data into the GLOBE database that has grown to over 204 million measurements since the program's inception in 1995. There are 126 United States Partnerships recruiting, training and mentoring teachers in inquiry and research investigations using GLOBE protocols. GLOBE partnerships are located at many types of organizations, including colleges and universities, state and local professional development centers, NASA education centers, informal science centers, and individual schools and school districts. Using the GLOBE Observer app, 4 of the protocol measurements (clouds, land cover, tree height and mosquito habitats) can also be reported by citizen scientists, including students' families. Through the GLOBE website and with the assistance of GLOBE Partners, teachers/adult facilitators and youth have the resources and tools to explore the local environment, ask questions, design investigations, carry out data collection, enter data into a publicly accessible repository and conduct analysis using satellite imagery along with the spatially-located data. The GLOBE website can be displayed in multiple languages and the Teacher's Guide for the program has been translated into ten languages. Youth communicate the results of their research virtually through the International Virtual Science Symposia and can submit posters and projects in English or in several other languages dependent on the languages of the volunteer reviewers. Since 2016, United States youth have had the opportunity to discuss their research in-person with STEM professionals at regional GLOBE Student Research Symposia offered annually (pre-COVID-19) at six locations across the country. At the 2019 events, 261 students presented 114 projects. Students use videos, posters and written reports to

share their research, all of which can be uploaded to the GLOBE website in the Student Research area where GLOBE students can comment on each other's projects or collaborate with other youth around the world on joint investigations. The International Virtual Science Symposia and the United States Regional Student Research Symposium both provide blog posts, webinars, links and downloadable templates to support teachers and youth in GLOBE investigations including tools on generating research questions, choosing the correct graph, writing CER (Claims-Evidence-Reasoning), and creating an informative poster.

GLOBE data also provide a useful facilitation for learning opportunities for computational thinking and computer science. Once data sets become large and unwieldy, programming and visualization tools become necessary to make sense of the data so student-scientists can make predictions, posit solutions to problems, and draw conclusions. Students need to learn and practice the skill of abstraction, so that they can make the connections between the data and models. The HS ELO students will be trained first in basic computer science concepts using the code.org curricula so they can practice all parts of the computational thinking practices (defining problems; developing abstractions; creating, testing and refining computational artifacts) in a fun and relevant environment in which communication about computing is expected, collaboration is required, and an inclusive culture is formed between the ELO cohort (K12 CS Framework, 2016).

Teacher Teams and the SLATE Institute: Professional learning that merges content learning, practical application, and coaching is necessary to improve practicing educators' application of new knowledge to the classroom (Thurlings & den Brok, 2017). To increase middle school teachers' capacity for teaching EL and high needs students across content areas, grade-level teacher teams—composed of EL, ELA, and STEM teachers— will attend an 8-12

day summer SLATE Institute, collaboratively designed and organized by UNH's LC, CLC, and NHLI. We will support middle-school STEM and LA teacher teams in collaboratively implementing computational thinking and science communications into project-based learning opportunities in their science and writing curricula. The goal is to aid teachers in identifying the misalignment between standards in science and writing, normally segregated into content area domains. Teachers will be given opportunities to establish commonalities across their domains and content-areas, as well as to develop a deeper interest and understanding of writing-across-the-curriculum concepts. Mechanisms for meeting these goals are found in the establishment of effective professional development programs supporting collaborative teams with time and PD training to work across their disciplinary knowledge domains. Institute instruction will include GLOBE Program protocols, an introduction to coding basics, interactions with STEM and Literacy university faculty for support and knowledge building, content-area teacher development for working with ELL/multilingual students, and opportunities to integrate new state-level CS standards in the content areas, per the NH state guidelines (See Exhibit 2).

Exhibit 2. Intervention with blended, cross-disciplinary middle school teacher teams

During the Institute, teacher teams will experience cross-disciplinary, inquiry-based, standards-aligned STEM + CS units for middle-level classroom implementation and have time to thoughtfully modify them based on their class structure and teaching style. This structure, based on STEM+CS teachers working on joint curricular activities with language arts teachers, will leverage all teachers' valuable content-area knowledge to improve students' reading/writing across content areas. During the institute, project team members will support teachers in the creation of these units, conducting follow-up implementation support during the academic year. Teacher teams will have the opportunity to return to subsequent institutes to present their units and lessons learned. Although this approach to cross-disciplinary teacher training across Science, ELL, and ELA is innovative, it draws upon evidence-based approaches (e.g.,Wang, et. al.,2018) in teacher education that suggest teachers working with one another at the building and grade level are more likely to impact student learning and implement innovation in schools.

B.2. Goals, Objectives, and Outcomes for SLATE

Goal 1: Improve underrepresented gr. 5-8 students' attitudes, participation, and success in STEM+C & ELA		
Objectives	**Measures**	**Outcomes**
1.A. Engage students in ELOs to support their STEM+C and ELA learning	1.A.1 Enrollment and attendance data; 1.A.2 Observational notes	264 of students participate in ELOs; 80% of students who attend ELOs complete full series.
1.B. Increase underrepresented students' positive attitudes toward STEM	1.B.1 Views About Science Survey (VASS) (VM)	20% increase in students' attitudes towards science.
1.C. Increase # of underrepresented students who take advanced STEM, CS, and ELA courses.	1.B.1 Enrollment data.	15% increase in students' participation in STEM, CS, and ELA courses.
1.D. Increase underrepresented students' achievement in science courses.	1.D.1 NHSAS science scores; 1.D.2 NHSAS ELA scores; 1.D.3 NHSAS Math scores; 1.D.4 ELL participants' WIDA ACCESS scores in reading and writing; 1.D.5 Administrative data.	10% increase in students' achievement on NHSAS across content areas; 10% increase in students' achievement on WIDA ACCESS; 10% increase in students' achievement on classroom measures.
1.E. Understand MS and NPT perspectives on intervention.	1.E.1 Survey data from MS students who work with a NPT; 1.E.2 Survey data from NPTs; 1.E.3 Attendance records	Findings regarding MS and NPT perspectives on intervention.

Goal 2: Test the added value of combining interventions with a near-peer tutoring program using a quasi-experimental, multi-level intervention that meets What Works Clearinghouse (WWC) evidence standards.		
Objectives	**Measures**	**Outcomes**
2.A. Randomly assign students to PD or PD + NPT groups	2.A.1 Records of participants; 2.A.2 Demographic information	Baseline equivalence between PD and PD +NPT groups.
2.B. Collect and analyze impact data	2.B.1 Lists of participating MS students and NPTs; 2.B.2 VASS survey (VM); 2.B.3 Measures from 1.D.	Findings regarding differences in attitude, participation, and success betwen PD and PD + NPT. Understandings about learning ecosystems and their impact on learners.
Goal 3: With participating teachers, collaboratively hone the SLATE framework of ecosystems for increasing STEM+CS and ELA achievement among multlingual and high needs students.		
Objectives	**Measures**	**Outcomes**
3.A. Improve the SLATE Institute framework for building teacher capacity by engaging in iterative improvement cycles (pilot, field-test, impact).	3.A.1 Post-institute evaluations; 3.A.2 Post-institute semi-structured interviews with teacher teams; 3.A.3 Institute lessons; 3.A.4 Teacher team-developed lesson plans	Iterative improvements to SLATE PD Framework.
Goal 4: Develop STEM+CS and ELA teacher capacity and knowledge through PD training and the collaborative building of cross-disciplinary units of curricula.		
Objectives	**Measures**	**Outcomes**
4.A. Teachers teams take part in professional learning through summer institute and follow-up coaching.	4.A.1 Attendance records; 4.A.2 Post-institute evaluations; 4.A.3 institute observational notes	136 teachers receive professional learning and follow-up coaching.
4.B. Teacher teams develop and implement collaboratively-planned units.	4.B.1. Curricular materials	Creation of an online repository of vetted cross-disciplinary units.
4.C. Increase teachers collaboration across middle-level ELA, ELL, STEM, and CS teachers	4.C.1. Attendance of team members; 4.C.2 Self-reporting from individual teachers and teacher teams; 4.C.3. Online learning platform analytics	20% increase in teachers' reporting of implementing collaborative units. Achieve 70% of teachers in SLATE who use online platform a minimum of 1 time a month.
Goal 5: Develop sustained interest and positive attitudes across middle-level ELA, ELL, STEM, and CS teachers.		
Objectives	**Measures**	**Outcomes**
5.A. Increase teachers' positive attitude toward ELA, ELL, STEM, and CS learning	5.A.1 Teacher Efficacy and Attitudes Toward STEM Survey (VM); 5.A.2 Measure of CS attitudes TBD; 5.A.3 Measure of ELL attitudes TBD; 5.A.4 Measure of ELA attitudes TBD	20% net increase in teachers' responses to the Teacher Efficacy and Attitudes Toward STEM Survey
Goal 6: Increase content-area teachers' confidence and pedagogical knowledge to teach multilingual learners with a particular emphasis on science vocabulary and concepts, writing, and reading.		
Objectives	**Measures**	**Outcomes**

6.A. Increase teachers' knowledge of systemic functional linguistics (SFL) in the teaching of writing as an intervention for EL writers.	6.A.1 Semi-structured interviews with teachers; 6.A.2 Lesson plans; 6.A.3 Curricular units	Teachers include understanding of SFL in creation of curricular units.
6.B. Increase teachers' knowledge of best practices in teaching academic, content-based vocabulary.	6.B.1 Semi-structured interviews with teachers; 6.B.2 Lesson plans; 6.B.3 Curricular units	Teachers include understandings of best practices in teaching academic, content-based vocabulary in creation of curricular units.
6.C. Increase teacher understanding of reading processes and comprehension skills for scientific texts, specifically identifying claims, identifying and evaluating evidence, and synthesizing information.	6.C.1 Semi-structured interviews with teachers; 6.C.2 Lesson plans; 6.C.3 Curricular units	Teachers embed practices for developing reading processes and comprehension skills within curricular unit lesson plans.
6.D. Develop teachers' ability to incorporate inclusive pedagogy	6.D.1 Semi-structured interviews with teachers; 6.D.2 Lesson plans; 6.D.3 Curricular units; 6.D.4 Classroom observations	75% of teachers demonstrate incorporation of inclusive pedagogy when implementing curricular units.
Goal 7: Ensure longevity of project through dissemination of findings and resources and through securing future funding.		
Objectives	**Measures**	**Outcomes**
7.A. Develop a library of vetted collaborative units of lesson plans available online	7.A.1 Number of collaborative units; 7.A.2 page views of online spaces.	Creation of an online library of vetted standards-aligned, STEM+CS units available to educators throughout the country.
7.B. Promote the use of the online library at local, national, and international conferences and workshops	7.B.1 Number of conferences and workshops	Increased awareness of SLATE resources and importance of embedding STEM+CS throughout content areas while meeting needs of underrepresented students.
7.C Identify and apply for appropriate fundings and submit application in Year 4	7.C.1 Proposal submission	Ability to expand support throughout New Hampshire.
7.D. Share project findings through conference presentations and publications	7.D.1 Number of conference proposals accepted; 7.D.2 Number of publications	Increased awareness of SLATE resources and findings.

Exhibit 3. Goals, measures and outcomes of the SLaTE project

B.3. Needs of Target Population: NH, in particular, is a state whose economy relies heavily on technology and computing. The NH technology ecosystem is composed of a wide variety of fields from information technology and support services to energy technology, from enterprise software and advanced manufacturing to biotechnology and robotics. The demand for NH computing jobs is nearly twice the average demand for jobs in the state; likewise, the average

salary for those NH computing jobs is nearly twice the salary of the average NH job (BLS, 2017). CS education, however, is much more than just computations, coding, and good jobs; it produces computationally literate students empowered to create their own technologies and solutions to problems and who can express themselves in new and creative ways through computing. However, many NH students have traditionally not had access to CS. In the past 6 years, NH had < 20 high schools statewide who offered advanced placement courses in computer science; nearly all such schools were located in wealthier districts(College Board, 2018).

Acknowledging this access gap, the NH legislature passed a bill in 2018 that requires CS be taught as a core subject in grades K-12. NH guidelines specifically recommend that K-8 teachers integrate CS into existing core curriculum (NH DOE, 2018), based on recommendations in the national Framework (K12 CS Framework, 2016). Recognizing the importance of computer science education in K12 schools, the K12 CS Frameworks were developed by states, districts, and the CS education community as organized by a coalition from the Association for Computing Machinery, the nonprofit Code.org, the Computer Science Teachers Association and others. The Frameworks consist of 5 Computing Concepts with 7 Practices; many of these practices overlap with science and engineering practices of the NGSS and math practices of the Common Core State Standards in Mathematics.

As a group, EL/multilingual students (including students who have exited EL programs) continue to be underrepresented in STEM fields in college and in the workforce, despite the fact that the demand for employees in STEM fields is unmet and increasing. In 2018, the report *English Learners in STEM Subjects:Transforming Classrooms, Schools, and Lives,* (NASEM) identified three emerging forces that are shaping the landscape of K–12 science education: (1) the changing demographics of the nation's student population including the fast-growing

subpopulation of ELs (National Center for Education Statistics, 2018); (2) STEM subjects, especially disciplinary practices (e.g., developing models, arguing from evidence, constructing explanations), are both academically rigorous and language intensive; and (3) computer science, including computational thinking, is becoming increasingly important for all students. These emerging forces have become further complicated by the educational changes that impacted students during the COVID-19 pandemic.

Our initial school district partner for developing the SLATE initiative is the Manchester School District in New Hampshire. Manchester district enrollment is 12,380 total with 2,300 (i.e. 18.6%) designated as Limited English Proficient (LEP) or LEP-eligible. Demographically, Manchester is one of the most diverse school districts in NH: 24.7% Black, 29.7% Hispanic, 34.1 % White, and 8.4% Asian. Over 66.7% of the students in the district qualify for free and reduced lunch. (NCES, 2018. See Appendix J, Demographic and School Data, which provides more detailed demographics and proficiency percentages for the four district middle schools that will be part of this initiative.) Of note, students in the selected middle schools have had science proficiency levels consistently under 22%, with two schools falling <10% and 12%, respectively. These downward-trending proficiency levels are also evident in ELA and Math scores and were documented, even prior to the COVID-19 educational disruptions which have created further challenges for students and teachers (NCES, 2018). We aim to target our interventions in STEM, ELA, and EL classrooms and with teachers, working with high numbers of EL/multilingual and high-needs students. The program goal is to begin efforts with these schools in Years 1-4. Additional teacher teams and NH school districts, with high-need student populations, will be able to apply into the SLATE Institute and initiative beginning in Years 4 and 5.

Exhibit 4 (next page): Integrated Timeline of SLATE project activities.

Activity	Goal	Lead	Support	Timeline													
				Spring Semester	Summer	Fall Semester	Spring Semester	Summer	Fall Semester	Spring Semester	Summer	Fall Semester	Spring Semester	Summer	Fall Semester	Spring Semester	Summer	Fall Semester
Project Management				2022			2023			2024			2025			2026		
Weekly project meetings		JGB	ln, bs, coh															
Monthly and annual reporting to EIR		JGB, COH, BS	jc, ln, ek, jlb															
Solidify and implement SLATE Framework for Teaching and SLATE Summer Institute				2022			2023			2024			2025			2026		
Planning for SLATE ELL classroom implementation		COH, LN, BS	tt, jgb, jlb, hw															
Recruit PhD students		JGB, COH, BS																
Pilot and refine SLATE with 2-3 teacher teams	3-6	COH, LN, BS	tt, jgb, ds, jlb, mff, hw															
Refine SLATE with Cohort feedback (iterative)	3-6	LN, COH, JLB	ds, jgb, bs, mff, hw															
Recruit and prepare teachers teams from cooperating districts	3-6	COH, JGB	ds, tt, ln, bs, ek, jlb, hw															
8-12-day SLATE Summer Summit	3-6	Project Team	ds															
Implement SLATE AY Support Network	3-6	JLB,COH,LN,BS	jlb, mff, ds, hs, hw															
Youth Programming to support 5-8 ELL STEM Learners: Near-peer Tutors and Summer Opportunities				2022			2023			2024			2025			2026		
Plan, recruit tutors, pilot and refine tutoring program	1,2	BS, ELO	jlb, coh, ln, tt, ELO															
Implement tutoring program with ongoing support for tutors	1,2	BS	coh, ln, tt, hw, hs, ug, ds, ELO															
Plan ELO school-based GLOBE data observatories (carbon)	1,2	JGB,JLB,MFF,HW	ds, hs, elo															
Train ELO participants in GLOBE Protocols	1	JB, HW	ds, mff															
Create framework for computational opportunities within the studen	1	LN	jlb, hw, mff, jgb, ds															
Recruit students for summer extended learning: EXCELL-STEM su	1,2	EK	tt, EXCL, ds															
Summer opportunities: EXCELL-STEM Summer program	1	EK	tt, EXCL, ds											*			*	
Collect and Analyze Evaluation Data				2022			2023			2024			2025			2026		
IRB Submission and Review	1-6	JC	coh, bs															
Collect surveys, obtain administrative data	1-6	JC	tt, ELO															
Analyze data/Share results with team	1-7	JC																
Evaluation of tutoring program (quasi-experimental)	2	JC	bs, tt															
Evaluation of SlaTE framework and implementation with teachers	2-4	JC																
Evaluation of student achievement and STEM interests	1	JC																
Dissemination and Future Funding				2022			2023			2024			2025			2026		
Present at conferences and develop publications	7	BS, COH, LN	ds, ug, hs, tt															
Apply for other funding	7	JGB,COH, BS, LN																
Present to GLOBE Network and at Student Symposia	1,7	JLB, HW	ms, hs															

[redacted]

Section C. Adequacy of Resources and Management Plan

C.1. Management Plan - Tasks, and Timeline: The management plan and timeline (See Exhibit 4, SLATE Management Plan and Timeline on previous page) aims to achieve the objectives of the SLATE initiative on time and within the budget. Individuals from the key personnel have clearly defined responsibilities and milestones are identified for various goals and stages of the five-year project. Project personnel already work collaboratively across UNH institutions, have the ability to leverage those experiences as needed to meet program goals, and have the expertise required for successfully meeting project objectives and benchmarks.

C.1.2 Institutions Leveraged by SLATE Framework: We will leverage successful institutions to accomplish project goals, including the following: (1) **The Joan and James Leitzel Center for Mathematics, Science and Engineering (LC)** will provide project logistical and administrative support. The LC, based within the Office of the Senior Vice-Provost for Research, Engagement and Economic Outreach, works with faculty across UNH colleges and departments and has been home to many multi-institutional partnerships, including GLOBE as well as several collaborative partnerships fostering inclusive recruiting into STEM**.** The LC sponsors conferences and regular communication to > 500 NH STEM educators. (2) **New Hampshire Literacy Institutes.** Founded 30 years ago, the UNH NH Literacy Institutes' mission is to provide ELA teachers, teacher educators, and literacy specialists in all grades with professional development, research, and coursework that places students at the center of their teaching. The Institutes emphasize literacy across the curriculum/writing across the curriculum. (3) **UNH Community Literacy Center (Education):** A grant-funded resource for preK-12 learners and families that supports the literacy learning/tutoring of area children through collaboration with schools, families, and community organizations; and (4) **GLOBE** - The Global Learning and Observations to Benefit

the Environment (GLOBE) Program has a quarter-century track record of global engagement (both informal and informal) of educators and students both in informal and formal venues in the Earth and environmental sciences. Since 2016, [redacted] has led the implementation of GLOBE Student Research Symposia (SRS), in-person and virtual celebrations of student-led place-based projects carried out with GLOBE protocols that exemplify the approach we wish to expand with SLATE - deepening sense of belonging for students through rich experiences carrying out research and reporting the results.

C. 2. Qualifications of Key Project Personnel: Project personnel have worked collaboratively across UNH Institutions and with various school districts. They have the expertise required for successfully meeting project goals.

[redacted]**, Ph.D., UNH, PI**, is a Professor of Geochemistry in the Department of Earth Sciences and is the Interim Director of the Joan and James Leitzel Center (LC) for Mathematics, Science and Engineering, where she works with staff who support programs for teachers, undergraduates, and graduate students engaged in STEM Education initiatives. A key focus of LC projects is to expand access to STEM for under-represented communities. [redacted] has served as PI or co-PI on several teacher professional development programs for STEM, integrating inquiry and a systems approaches to teaching Earth and environmental sciences. As PI, she will provide executive leadership for the SLATE initiative and will be responsible for overall project management and other activities denoted above on the project timeline.

[redacted]**, Ph.D., UNH, Co-PI** is an Associate Professor of Composition and Director of the New Hampshire Literacy Institutes (NHLI). She has expertise in ELL/multilingual literacy and pedagogy, writing-across-the-curriculum, and teacher education. She brings expertise in systemic functional linguistics (SFL) approaches to

writing/reading, SIOP training, and culturally responsive teaching practices. She conducts research on adolescent ELL/multilingual literacy practices, writing development, and teacher education. She directs the NHLI, a research and teacher engagement center focused on writing and literacy. She has extensive experience developing collaborative teacher professional development programs. [redacted] will co-direct SLATE with PI [redacted].

[redacted]**, Ed.D., UNH, Co-PI,** is an Assistant Research Professor of Education and Director of the UNH Community Literacy Center (CLC), which, among other literacy activities, provides tutoring opportunities for pre-service teachers. She is an expert in digital learning and digital literacy curricula and has conducted partnership research with multiple institutions. She has expertise in teacher professional development and teacher-research partnerships, regularly collaborating on grant-funded projects focused on literacy needs. [redacted] has more than 14 years experience facilitating tutoring programs in a variety of settings.

[redacted]**, MS, UNH**, **Co-PI**, taught high school physics, engineering and computer science for 17 years. As an LC affiliate, she served as the Director of the STEM Teachers' Collaborative, with the primary goal of increasing K-12 teachers' expertise in computing, engineering and technology, and extending the impact of excellent STEM teachers to more students throughout the state. As the NH Regional Partner for Code.org, she trained nearly 200 NH K-12 teachers in computer science.

[redacted]**, UNH, M.A., Co-PI,** has been the U.S. Country Coordinator of the U.S. GLOBE Program since 2013. She has served as the coordinator of the NH Partnership and as a member of two NSF-funded GLOBE science teams (Land Cover/Biology and Carbon Cycle) based at UNH. In her role as U.S. Country Coordinator for the past 7 years, [redacted] has focused on GLOBE capacity building and the development and coordination of the 6

regional Student Research Symposia (SRS) annually since 2016. [redacted] will be responsible for leading the workshop demonstration of how GLOBE protocols can be implemented into school observatories and place-based lessons and will work with [redacted], [redacted] and other team members to leverage data analytics and opportunities for integrating coding into GLOBE-linked projects to meet the new NH Department of Education computer science and NGSS standards. Further, she will also work with the Project team to adapt the GLOBE SRS student instrument into a SLATE collaborative student instrument for assessing how experience in carrying out research and presenting research has enhanced student self-confidence in science.

[redacted] is a research scientist and Ph.D. candidate (expected to complete her Ph.D. in early 2022). [redacted] will support students in the development of GLOBE long-term environmental observatories (i.e. carbon) at the schools participating in the project. As a native Spanish speaker equally fluent in English, she will ensure training materials (e.g., explanations of background information and videos of sampling protocols) are available in both English and Spanish and can also assist with other translation duties or outreach to Spanish-speaking families. [redacted] has a demonstrated commitment working with students under-represented in STEM with several NSF-funded research mentorship programs. Feedback from students participating in these programs clearly identify that the participating students value the mentorship of an early-career Latina scientist.

[redacted] **UNH-Manchester, M.Ed. (SP)** is the Multilingual Learner Support Coordinator at the Manchester campus of UNH. She has also served as the STEM Discovery Lab Coordinator where she coordinated programs for youth and educators, including ones for English learners. Emily was an English as a Second Language and English Language Learner educator for youth and adults in the greater Manchester and Seacoast areas for over 8 years and was the

project assistant for the GATE CITY Project (Getting All Teachers ESOL Certified in Two Years) in Manchester from 2012 to 2015. Together with [redacted] with support of student instructors, [redacted] will lead *EXCELL-in-STEM*.

[redacted]**, U.S. GLOBE Project Assistant,** provides coordination, administrative support and teacher outreach for the U.S. GLOBE Office, with a particular focus on the U.S. GLOBE SRS. She is a former STEM specialist with the Concord, NH school district, has experience with curricular development and teacher training and outreach through her work with the Student Climate Data Project (a NASA Innovations in Climate Education project), and was a collaborator on the GLOBE Carbon Cycle Project.

External evaluation will be led by [redacted], Ph.D., [redacted] and Principal at the [redacted] and an Evaluation Consultant. [redacted] is a former K-12 public school teacher and is an expert in educational assessment and evaluation. [redacted] has served previously as an evaluator for NSF programs led by members of the project team.

C.3. Project Costs: The LC, NHLI, and CLC have collectively a half century of experience providing learning opportunities to the K12 community. In that time, they have established a track record of completing projects on-time and within budget. The UNH Sponsored Programs Office adheres to the procedures outlined in 2 CFR 200.317-200.326. A detailed outline of the budget of the personnel and support of the K12 partners can be found in the Budget documents and Narrative. During its five-year span, the proposed EIR project has the potential of impacting approximately 5000 students in grades 5-8 in the Manchester School District and other districts in the State of New Hampshire (in years 4 and 5). Since teacher teams will be working with EL students who learn alongside non-EL students, the benefits of many aspects of the SLATE

initiative (teacher training in STEM, the GLOBE program, classroom near-peer tutors) will impact the learning of those students as well. This translates to approximately $800 per student impacted during the project period, a conservative estimate as it is well established that teacher PD has a longer-lasting impact than the project period. SLATE impacts will be transformative within teacher teams at a given grade level and impactful in participating middle schools for years to come.

C.4. Procedures for Feedback and Improvement: We have included procedures to ensure timely feedback and improvement, to facilitate the completion and continual improvement of the SLATE project. The project team will meet weekly throughout the project, both for project administration purposes and to improve the program. Participants in all components of the project (NPT, educators, and teachers) will complete exit surveys upon completion of activities. We will also collect usage data from online platforms used during summer institutes. The team will review these data bi-monthly to inform future work. Our process evaluation will provide data on movement towards goals that we will use to iteratively improve the project operations.

Section D. Project Evaluation

Our evaluation plan has two components: an impact evaluation and a process evaluation. Evaluation data will include survey data from students and teachers; interview data from teachers; and administrative data, such as enrollment data and test score data.

D.1. Evaluation Will Produce Evidence That Meets WWC Standards: In order to make causal inferences, we will determine the impacts of our project by utilizing a multiple baseline design (interrupted time series) to evaluate student attitudes towards STEM and a cluster RCT model during Years 3-5 to evaluate the addition of the Near-Peer Tutoring (NPT) to the PD model to examine its potential value added. According to the WWC Standards Handbook, Version 4.1,

this quasi-experimental, single-case design will allow us to gather baseline data, and analyze data at each phase of the intervention while observing patterns over time and across conditions and cases (i.e., teacher teams). We will collect and analyze four years of administrative data prior to the intervention and up to four years after the start of the intervention phase (Exhibit 6). We will also collect attitudinal data beginning in 2022.

	2018	2019	2020	2021	2022	2023	2024	2025	2026
Administrative Outcomes									
Pilot (n=2)	O_1	O_2	O_3	O_4	X_P	O_5	O_6	O_7	O_8
Field Test (n=6)		O_1	O_2	O_3	O_4	X_{FT}	O_5	O_6	O_7
PD-Only (n=6)		O_1	O_2	O_3	O_4	X_{PD}	O_5	O_6	O_7
PD + NPT (n=12)			O_1	O_2	O_3	O_4	X_{PD+NPM}	O_5	O_6
Attitudinal Outcomes									
Field Test (n=3)					O_1	X_{FT}	O_2	O_3	O_4
PD-only (n=12)					O_1	X_{PD}	O_2	O_3	O_4
PD + NPT (n=12)					O_1	O_2	X_{PD+NPM}	O_3	O_4

Exhibit 5. Multiple Baseline Design for Administrative and Attitudinal Outcomes

Note. "Ns" refer to numbers of teacher teams in a group. "X" represents the baseline phase, the onset of condition 1 (PD) or condition 2 (PD +NPM), and the post-intervention phase. "Os" represent the phases within a data series.

Cluster RCT: As Year 1 is largely a planning year, the impact evaluation will take place in subsequent project years. Each year will have a new cohort of teacher teams of 4 teachers (± Tech professional) with: 6, 8, and 10 teams, respectively, per cohort. This timeline and cohort design allows us to experimentally investigate our research question, as well as maximize the capacity of our team's experiences and skill sets.

Students within the 6 teacher teams will be randomly assigned in 2023 to the PD only group (the comparison group) or the PD + NPT group (the treatment group). The treatment group will receive the same PD intervention as the comparison group, but they will also receive the NPT addition. Three-level multilevel modeling, where students are nested within teachers nested within schools, will be used to evaluate potential treatment effects. As this is an early- phase

project with smaller sample sizes, we plan cautious interpretation of effect sizes and will calculate overall and differential attrition according to the WWC standards (with the intention of performing multiple imputation if attrition rates exceed the necessary thresholds).

Outcomes. Student outcomes will be measured by enrollment and attendance data, scores on standardized tests, pre- and post-attitudinal surveys as well as surveys about the near-peer tutor program (see exhibit 3).

Teacher outcomes will be measured through annual interviews. The protocols will be developed within Year 1 and will include items that investigate their (1) perceptions of the current state of teacher and student engagement in CS; (2) commitment to increasing student's positive attitude toward STEM and to the project's implementation; and (3) satisfaction with project components and implementation. Teachers will also take pre- and post-summer institute attitudinal surveys to measure their interest in and attitudes toward ELA, ELL, STEM, and CS. We will also administer surveys to all teachers measuring several key domains, including their knowledge of and implementation of pedagogies to support STEM+CS throughout the content areas using inclusive pedagogies.

Semi-structured interviews of teachers will be conducted with each new cohort of teacher teams both before and after the summer institute. The purpose of these interviews is to elicit details of the teachers' knowledge of (1) systemic functional linguistics, (2) best practices in teaching academic, content-based vocabulary, (3) reading processes and comprehension, and (4) the role that the PD and the team-collaboration played in their development of curricular units.

D.2. Performance Feedback and Assessment of Progress: We will use evaluative reports (testing data, #s of participants and participant demographics, and teacher feedback), together with inspection of our progress towards meeting program goals (Section B.2., Exhibit 3) to ensure we

stay on track towards achieving the anticipated outcomes on short-, medium- and long-timescales we articulate int eh SLATE program logic model (Appendix G). These regular (at least quarterly) inspections will serve as a means to update program progress and serve as opportunities to reassess recruiting opportunities and curricular development.

D.3. Project's Contributions: Fostering the success and interest of high-needs students requires increasing content-area teachers' capacity to address language and academic needs with engaging, rigorous STEM content presented through approaches that build upon EL students' competencies and linguistic/cultural resources (Cook, 2003; Cimpian et. al, 2017). It also requires an ecosystem of learning that extends beyond the classroom. By attending to multiple aspects of learning ecosystems including tutoring from peers, ELOs, and improved quality of in-school STEM+CS instruction, the SLATE initiative has the potential to increase and expand access, interest, and success in middle school STEM+CS learning. By doing so, this project aims to make advanced STEM+CS high school coursework attainable to these students, which will in turn help to increase representation of high-needs students throughout the field. Additionally, our quasi-experimental design will provide rich data on the impact of NPT, a culturally relevant teaching practice, providing efficacy findings that will benefit all schools as they seek to create teaching environments that benefit all learners.

References

Bailey, A. L., Maher, C. A., & Wilkinson, L. C. (Eds.). (2018). *Language, literacy, and learning in the STEM disciplines: How language counts for English learners*. Routledge.

Bang, M. (2015). Culture, learning, and development about the natural world: Advances facilitated by situative perspectives. Educational Psychologist, 50(3), 220–233.

Beckett, M., Borman, G., Capizzano, J., Parsley, D., Ross, S., Schirm, A., & Taylor, J. (2009). Structuring out-of-school time to improve academic achievement: A practice guide (NCEE #2009-012). Washington, DC: National Center for Education Evaluation and Regional Assistance, Institute of Education Sciences, U.S. Department of Education. Retrieved from http://ies.ed.gov/ncee/wwc/publications/practiceguides.

Bureau of Labor Statistics' State Occupational Employment and Wage Survey 2017, Retrieved from: https://code.org/promote/nh.

Cimpian, Joseph R., Thompson, Karen D., Makowski, Martha B. (2017). Evaluating English Learner Reclassification Policy Effects across Districts. American Educational Research Journal, 54(1), p255S-278S.

The College Board. NH Advanced Placement Computer Science Scores, 2018.

Cook, V.J. (2003). Effects of the L2 on the L1. Clevedon, UK: Multilingual Matters.

Dabach, D.B. (2015). Teacher placement into immigrant English learner classrooms: Limiting access in comprehensive high schools. American Educational Research Journal, 52(2), 243–274.

Darling-Hammond, L., and Berry, B. (2006). Highly qualified teachers for all. Educational Leadership, 64(3), 14–20.

K–12 Computer Science Framework. (2016). Retrieved from http://www.k12cs.org.

Kanno, Y., & Kangas, S. E. (2014). "I'm not going to be, like, for the AP" English language learners' limited access to advanced college-preparatory courses in high school. *American Educational Research Journal*, *51*(5), 848-878.

Kricorian, K., Seu, M., Lopez, D. et al. Factors influencing participation of underrepresented students in STEM fields: matched mentors and mindsets. IJ STEM Ed 7, 16 (2020). https://doi.org/10.1186/s40594-020-00219-2

Lee, O., & Buxton, C. A. (2013). Teacher professional development to improve science and literacy achievement of English language learners. *Theory Into Practice*, *52*(2), 110-117.

National Academies of Sciences, Engineering, and Medicine (NASEM). 2018. *English Learners in STEM Subjects: Transforming Classrooms, Schools, and Lives*. Washington, DC: The National Academies Press. https://doi.org/10.17226/25182.

National Center for Education Statistics (2012). *The Nation's Report Card: Writing 2011* (NCES 2012–470). Institute of Education Sciences, U.S. Department of Education, Washington, D.C.

National Governors Association Center for Best Practices & Council of Chief State School Officers. (2010). *Common Core State Standards*. Washington, DC: Authors.

New Hampshire Computer Science Standards. (2018). Retrieved from https://www.education.nh.gov/who-we-are/division-of-learner-support/bureau-of-instructional-support/office-of-science-technology-engineering-and-mathematics-education

Saenz, L., Fuchs, L. S., & Fuchs, D. (2005). Peer-Assisted Learning Strategies for English language learners with learning disabilities. Exceptional Children, 71(3), 231–247.

Santos, M., Darling-Hammond, L., & Cheuk, T. (2012). Teacher development to support English language learners in the context of common core state standards. In Understanding Language Conference, Stanford University, California. Available at: http://ell.stanford.edu/sites/default/files/pdf/academic-papers/10-Santos%20LDH%20Teacher%20Development%20FINAL.pdf

Snow, C. E. (2010). Academic language and the challenge of reading for learning about science. *Science*, *328*(5977), 450-452.Thurlings, M., & den Brok, P. (2017). Learning outcomes of teacher professional development activities: a meta-study. *Educational review*, *69*(5), 554-576.

U.S. Department of Education, Institute of Education Sciences, National Center for Education Statistics. (2018). English Language Learners in Public Schools. Retrieved from: https://nces.ed.gov/programs/coe/indicator/cgf [August 2018].

Wang, J., Herman, J. L., Epstein, S., Leon, S., Haubner, J., LaTorre, D., & Bozeman, V. (2018). Literacy Design Collaborative 2016–2017 evaluation report for the New York City Departmentof Education (CRESST Report 856). Los Angeles, CA:University of California, National Center for Research on Evaluation, Standards, and Student Testing (CRESST). Retrieved from https://eric.ed.gov/?id=ED600125

Wexler, Jade & Mitchell, Marisa & Clancy, Erin & Silverman, Rebecca. (2016). An Investigation of Literacy Practices in High School Science Classrooms. Reading & Writing Quarterly. 33. 1-20. 10.1080/10573569.2016.1193832.

Cimpian, Joseph R.; Thompson, Karen D.; Makowski, Martha B. Evaluating English Learner Reclassification Policy Effects across DistrictsAmerican Educational Research Journal, v54 n1 suppl p255S-278S Apr 2017