

Bridging the Gap: Empowering Teachers, Preparing and Inspiring Students, and Supporting Parents through *iSTEM from Excellence* (Lakeland School District, Idaho)

Micron Innovation Grant STEM Education Innovations Final Report

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Executive Summary

During the 2013-2014 school year, the Lakeland School District piloted a holistic approach to overcoming barriers in STEM education, involving interventions for teachers, students and parents, and development of partnerships between STEM professionals and Lakeland School District staff. The program was made possible through a grant funded by the Micron STEM-Ed Research Initiative. This multi-pronged holistic approach, bringing students, teachers, parents, and professionals together to teach a watershed-based STEM curricular set, was accompanied by a research plan designed to test program efficacy. Data, both qualitative and quantitative, show promise in the model.

Interventions included week-long STEM pedagogy training, job-embedded practice in teaching STEM in the informal (after-school) setting with a future goal of incorporation into the classroom, bringing STEM professionals into the classroom, and development of robust online parent-student support mechanisms. Results from the pilot program showed statistically significant increases in teacher proficiency and confidence in content depth of knowledge (DOK) and in hands-on investigative and guided inquiry pedagogies, effectiveness and practicality of integrated curriculum, student achievement related to increases in effective hands-on learning and use of 21st Century competencies, and increases in parent STEM literacy confidence for support of their student's learning.

Introduction

Lakeland School District is a Local Education Agency (LEA) much like many rural districts across the nation. Located in northern Idaho, with approximately 4,400 students, the district incorporates four towns and cities, Rathdrum, Spirit Lake, Athol and Hauser, which cover 384 square miles of land area. Over 52% the student population is eligible for free and reduced lunch program, and all of the elementary schools are Title I qualified. District students are among the highest scoring in the state in math and reading, as measured by the state ISAT assessment. In spite of high student achievement there is a significant gap in utilizing these skills to pursue a higher education, and very rarely in STEM fields. Of the 98% of students who graduate, only 45.3% start college, an associate's degree, or technical certification. Of those who have gone on to

a two- or four-year college, only 15-20% of the average graduating class completes a degree. Graduating seniors are literate, but they are still being left behind; part of the underrepresented rural population significantly absent from STEM professions.

Current research on effective STEM education suggests that there is a significant need to inspire as much as equip students to pursue STEM degrees (President's Council of Advisors on Science and Technology, 2010). According to Maltese and Tai (2010), many graduates in STEM fields commented that if it weren't for early impactful experiences, in elementary and middle school, they may have lost interest in STEM subjects by high school.¹ It is apparent this excitement needs to be engaged early, and sustained rigorously throughout the entire K-12 experience, in the formal classroom environment and in an abundance of after school informal offerings that enrich the formal curriculum. Educators must be equipped with the level of knowledge, adaptive expertise and confidence in STEM innovative pedagogy to create learning environments where these experiences are possible (Maltese and Tai, 2010; Penuel and Fishman, 2012). Many elementary educators lack cohesive coursework and experiences related to science, and science education, compromising teachers' confidence and credibility in teaching STEM subjects. (Bayer Facts, 2004) This concern over the lack of science/STEM training is compounded by the release and likely adoption (in part or whole) of the Next Gen Science Standards in the state of Idaho and nationwide.

The need to create impactful professional learning STEM pathways for in-service teachers, bridging the gap between theory and practice, university and K-12 environments, transcends all state boundaries. Some universities have developed pre-service models that have proven effective for increasing teacher confidences in creating hands-on investigative STEM learning environments for their future students (Heaston and Marcum, 2011). There is a recognized need to extend use of these models to in-service teachers nationally. Traditionally, professional development for in-service teachers has focused mainly on conferences, conventions, and short-term immersions which provide many excellent ideas and increases in content understanding, but do not typically provide follow through and support after the training. In a study done by the University of California, teachers lost over 50% of content they had gained in short professional development experiences within 6 months of training (Goldschmidt and Phelps, 2007).

In response to the immediate need for overcoming barriers to STEM education in Idaho and in the nation, Lakeland School District and the University of Idaho, with the grant funding support of Micron, are partnering to develop a model, *iSTEM from Excellence*, that increases STEM literacy for teachers, students, parents and the community. The model includes creating STEM learning environments, informal and formal, where students habitually use 21st Century skills; this is in step with the trends for global economic competition (President's Council of Advisors on Science and Technology, 2010; Idaho Department of Labor, 2011).

The first prong involved teachers and incorporated focused professional development in STEM content and pedagogy involving integrated curriculum, inquiry based learning, cultivating creative and critical thinking skills, and facilitating scientific skills and processes. This professional

¹ In 2010, Nobel Laureates in physics and chemistry were asked by Maltese and Tai about the moment they knew they wanted to pursue a career in STEM; 67% described a pivotal experience in elementary or in middle school.

development piece began with 20 hours of collaborative learning within the topic of Watersheds. This curriculum was developed by the project director for the NIC iSTEM Summer Institute 2013, and is a collection of some of the best curricula in the nation regarding watershed education. Lesson plans, and links to other resources and videos were (and are still) available to all teachers via a website dedicated to the strand. Teachers will continually have the open opportunity to contribute their lesson plans to the site, as well as new links to high caliber resources for teacher, student and parent education. The lesson plans are individually tied to the NextGen Science Standards within the 3rd-5th grade band benchmarks, and integrated with 4th grade benchmarks from the Common Core State Standards for Mathematics.

University of Idaho Extension Faculty Member, Jim Ekins, and Program Coordinator, Marie Pengilly, from the IDAH₂O Master Water Stewards citizen-science program taught the certification training for becoming a Master Water Steward, and the water quality testing skills this involves. This training was an invaluable component toward equipping and empowering both mentor teachers and students in the cohort. As trained stewards, the data that teachers and students collected at various lakes and streams in the area, then uploaded to a national data base, adding to the depth of knowledge regarding our country's fresh water quality, and affirming the cohort's role as citizen scientists. Continued professional development took place throughout the year during web conferences with STEM professionals, specific times for collaboration among mentor teachers, and ongoing support from university level faculty, the project director, and STEM professional partners from within the community. Through this combination, teachers were taught an engaging, integrated curriculum that unifies science, English Language Arts, and Math within the Common Core, therefore leveraging valuable classroom time. Teachers were continually empowered through job-embedded, sustained, year-long professional development in content and pedagogy. Teachers were also equipped for bringing the curriculum into the formal learning environment through utilizing the less-pressured after-school enrichment environment to practice their newly found guided inquiry and investigatory skills. Teachers were also provided a formalized, reflexive space in which to utilize collaboration, team teaching, and peer coaching through regular open meetings.

The second prong creates an informal education and STEM enrichment experience for students within cohorts at each grade school. The curriculum revolved around the place-based theme of Watersheds and is designed to increase student achievement in STEM and Common Core benchmarks, develop higher order thinking skills, promote increased proficiency in scientific process skills, encourage collaboration, and ignite a passion for STEM learning. The pilot for this program was designed to be held once per week at each grade school for two hours after school. The program involved between 16 and 32 students per grade school from grades 4-6, and one to two mentor teachers, with cohort size capped at 16 students per mentor teacher. The first 30 minutes was devoted to homework help, and the next 90 minutes involved hands-on investigations.

The students in each grade school cohort delved into inquiry based, hands-on, collaborative, real world investigative learning within the place-based theme of Watersheds. Students were provided with multiple opportunities for catalyst moments through experiencing real-world connections within STEM. These moments came outside the classroom through after-school projects and formal field excursions to take scientific measurements of local lakes or streams. These

opportunities for inspiration and engagement were also fostered in the classroom through guest presentations and problem-based activities led by outside scientists and university instructors, fueled with real data and Socratic discussion. By building on prior knowledge and investigative experiences, students built deeper understanding of science processes and formed foundational 21st century skills for success in life and work.

Figure 1. Students engaged in class dissecting owl pellets with Fish and Game specialist Beth Paragamian



Figure 2. Students assessing macroinvertebrates in the field



The third prong addressed increasing parent and community STEM literacy, as well as initiating support and resources for college planning and understanding the scholastic pathways to STEM degrees and professions via the program's student and parent web page. This is in direct response to the research in the University of Idaho-Micron parent surveys, as well as national research that calls for more support for parents in both STEM content literacy and knowledge of collegiate and professional pathways. Parents had access to the same *iSTEM from Excellence* website the students used to review concepts covered and learn more on each new topic via links to other education websites and videos. The web site design includes a parent resource area still in development, with support in understanding the benefits of a college education, options for STEM professions and types of education required, supporting student academic preparedness for college, filling in college applications and applying for financial aid. Although this type of support may be early for parents of 4th through 6th graders, it was invaluable to receive feedback from the parents in the cohort regarding the efficacy and usefulness of such a resource and ideas for improvement. Parents were strongly encouraged to volunteer in the weekly program and on days when field testing is being conducted, to promote awareness and encourage them in the role of co-investigators with their student. Numerous parents did take the time to join in with the field experiences, often learning side-by-side with their children.

Figure 2. *Kat Hall, Environmental Educator from Spokane Lands Council guiding students and parents during a field experience*



Parents were therefore provided web-based resources (also accessible to students) to increase opportunities to be co-learners with their students, and equipping them to be co-educators with teachers as they build their science literacy. The website can be found at the following URL: <https://sites.google.com/site/istemfromexcellencewatersheds/>. A mid-year Parent Night was

organized so that the students could demonstrate their new investigative knowledge and understanding of science processes. A Watershed Extravaganza was held at the end of the year to showcase student work, bring in the STEM professionals and agencies that had worked with the school district all year, and to provide additional hands-on learning opportunities.

Figure 3. Parents and students at Parent Night, Spirit Lake Elementary



Partnering scientists from area agencies and businesses came together to develop a strong relationship with the school district. Lessons incorporated the same real-time data used by agencies and scientists. This helped familiarize students with the importance of good data. Partnering agencies currently include the University of Idaho Extension IDAH2O Program, Community Water Resources Center at UI-Coeur d’Alene, Department of Environmental Quality, Bureau of Reclamation, and the Department of Fish and Game.

Figure 4. Department of Environmental Quality hydrogeologist, Gary Stevens, sharing information with students and teachers about the Rathdrum Prairie Aquifer



The Micron-funded pilot project enabled this model to be evaluated in Lakeland School District, and provided the capacity to continue the model, as well as to pursue additional research and program-support funding from sources such as NSF DRK-12 and AISL grants. Our next step is to develop an increasingly focused research-in-practice program, *STEP up to STEM* (Sustained Teacher Education and Preparedness). It will develop and evaluate a primary teacher professional learning model against two other models, with the goal of empowering teachers to create and sustain K-8 students' transformative moments through four co-developed strategies, three of which were studied in the pilot, iSTEM from Excellence. Future research will focus on whether, and the extent to which, each model leads to teacher increases in confidence, self-efficacy, self-perception of professionalism, and frequency of successful implementation. Results will also be evaluated for student increases in content DOK, science processing, and 21st Century Competencies, aligned with state and national standards.

Personnel and Community Partners/Participants

University Partners

Jim Ekins, Co-PI, University of Idaho Extension Faculty Member: Area Water Educator. Co-PI and Field Instructor for student field trips. Instructor, IDAH₂O master Water Stewards Program, from which many water science principles and teaching techniques are derived.

Marie Pengilly, University of Idaho Extension IDAH₂O Program Coordinator. Co-Instructor for field excursions and IDAH₂O.

Lakeland School District Partners

Sarah Halsted, Co-PI, Lakeland School District STEM Coordinator. Developed the Walk in the Watershed curriculum, taught the teacher professional development workshop components other than the IDAH₂O portion.

Agency and Community Partners

Jama Hamil, US Dept of Reclamation; engineering and weather/climate monitoring and modeling expert

Gary Stevens, Idaho Department of Environmental Quality; hydrogeology expert

Beth Paragamian, Idaho Department of Fish and Game; wildlife ecology expert

Kat Hall, Spokane Land Council; environmental education specialist

Participants

Seven teachers from six District schools were involved in the program. Due to the enthusiastic response by student applicants at Spirit Lake Elementary, another trained and qualified teacher who was not initially selected for inclusion in the program, was compensated with a full stipend by the Spirit Lake PTO, to accommodate the student numbers.

Corey Friis, Betty Keifer Elementary, 4th grade

Colleen Pelloquin and Kim Hill, Spirit Lake Elementary, 4th grade

Laura Spurway, STRIVE, gifted and talented specialist for grades 4-6, worked with students at Garwood Elementary for iSTEM

Susan Walker, Athol Elementary, 4th grade

Shannon Rider, Twin Lakes Elementary, 1st grade

Kelly Chaney, John Brown Elementary, 4th grade

Total number of students enrolled in Walk in the Watershed/iSTEM from Excellence: 120. Over 100 students in the program responded to the fall Micron survey, and seventy five students responded to the anonymous iSTEM from Excellence Student Survey in the spring.

A total of 34 parents/guardians responded to the Parent Feedback for iSTEM From Excellence Survey about the efficacy of the program. Students from many more households were involved in the program.

Budget Summary

Lakeland School District Sub award Budget: Lakeland School District administered the larger portion of the Micron grant.

Six Teacher stipends @ \$2000 each	\$12,000
U of I credits (not including the \$20 for IdaH ₂ O Master Water Steward Cert)	\$690
Total	\$12,690.00

IDA_H20/ UI Extension administered a smaller sub-award of the Micron grant:

Stipend for IdaH ₂ O Project Assistant @ \$22.10/hr x 53 hours (includes hourly pay plus fringe)	\$1173.25
Travel to Rathdrum Reimburse .55 /mi x mi x days x 2 trips =13.4 mi X 0.55 X 2 X 5 days	\$73.70
Fee for IdaH ₂ O Workshop: \$20 per person x 6 teachers	\$120
Teacher water quality test kits: @ 4 x \$225	\$900

Total	\$2266.95
<i>Micron Grant Budget total</i>	<i>\$14,956.95 = (2266.95 + 12,690.00)</i>

IDAHO20, as a part of the UI Extension Service, Northern District Office, administered this portion of the Micron grant.

Programmatic Evaluation Methods

The purpose of the research was to test a model of improving STEM content delivery and pedagogy throughout a school district, focusing on the 3-6th grade band. The end goal is to increase student capability and desire to complete STEM degrees or certifications and to become engaged thinkers, invested citizens and holistic problem solvers. The parent support provided on the student/parent website engages them with links to animations, videos, interactive websites, and content taught in class, so that parents are co-learners with their students.

Each prong of the three-prong approach was tested through a combination of qualitative (teacher, parent, and student survey data and student artifacts) and quantitative (student and teacher test scores) data analysis.

This academic-year-length longitudinal survey design consisted of three teacher survey instruments; two online, and one pen-and-paper. It also consisted of one student survey and one parent feedback survey.

The first teacher survey was given anonymously to elementary teachers District-wide, of which two elementary schools of six submitted teacher responses. A portion of this survey was also given specifically to the Course participants in addition to the pre-post assessment, to track changes in attitudes over the course of the year. An assessment of the iSTEM From Excellence Professional Development Course, was given only to course participants.

The “District-Wide Micron General Teacher Survey” focused specifically on teachers’ perceptions of inquiry-based learning environments. This survey was almost identical to that distributed to teachers around the state by the Micron STEM Education Research Initiative Program. The project team was able to compare Lakeland School District teachers’ aggregate responses with those from the larger statewide Micron survey. Specifically, this survey instrument explored teacher support, attitudes, and opportunities in the following areas:

- Teacher overall experience in community,
- Teacher training and knowledge in math/science,
- Teacher science attitudes,
- Teacher preference for professional development,
- Teacher knowledge and preparation of Common Core Standards, and
- Teacher attitudes and experiences with students and Parents

A version of this survey was given to iSTEM From Excellence Professional Development Course participants. Titled, “Mentor Teacher Only Survey Winter 2013”, and “Mentor Teacher Only Survey Spring 2013”, it was modified only to add a space to record the teachers’ names so that we could capture individual teachers’ progress during and after the professional development training. Our objective with this survey was to formatively establish progression of confidence in content knowledge and skills related to inquiry-based learning, NextGen and New Common Core grade-level standards and integration at mid-year, and continuing progress throughout the academic year. The survey was included with the pre-post assessment for content throughout the year.

This “Pre-Post Test: Mentor Teacher Only IDAH20 Workshop 2013,” was a program assessment tool specifically tailored to the learning objectives of the iSTEM From Excellence Professional Development Course. The assessment focused on summative content knowledge increase in science principles learned in the professional development trainings and on application of those principles within an inquiry-based learning environment. It was given as a pre-test at or immediately before the beginning of the training; as a post-test, immediately after the training; a delayed-post-test at mid-2013-2014 academic year; and a second delayed-post-test at the end of the 2013-2014 AY.

Students were surveyed about their experiences, focusing on gathering data on the parts of the program they enjoyed, those that sparked future interest in STEM fields, and those from which they learned the most. Other parts of the program, including the importance of the meal that was provided, and the importance of homework help, were also documented.

Parents were surveyed to understand the benefits they received from the program, and to understand the perceived benefits to their children who were students in the program. Questions were also included to critique the current program and to gather ideas about the future structure and direction of the program.

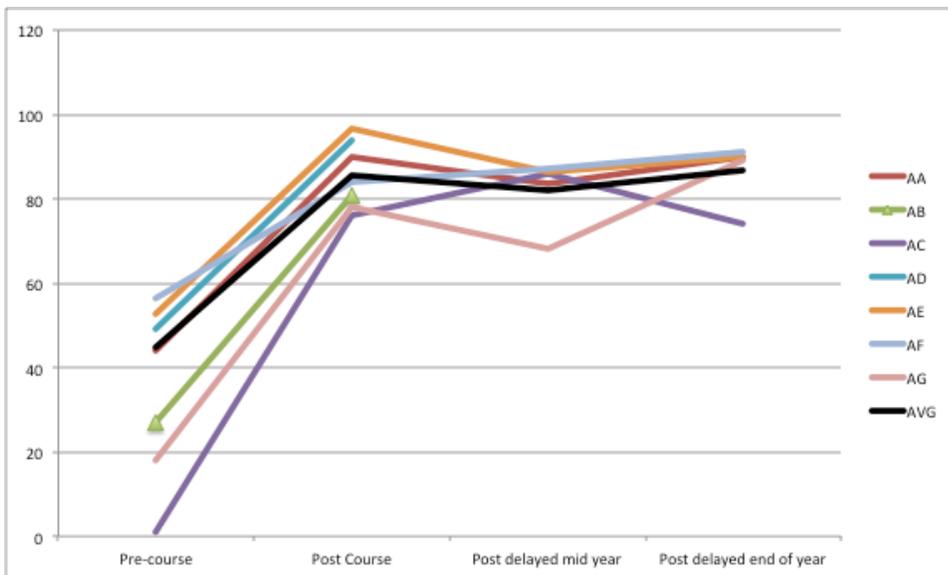
Results

Preliminary data indicate increased confidence in teacher content depth of knowledge and hands-on guided inquiry investigations, and increases in student achievement based on qualitative and quantitative analysis of artifacts and surveys from 7 teachers and 120 students.

Survey results demonstrate that the majority of teachers agreed or strongly agreed that sustained yearlong support increased their confidence and effectiveness in planning for and implementing the lessons. Eighty-seven percent of the teachers strongly agreed that yearlong practice in the informal environment increased their confidence in content depth of knowledge and in guiding hands-on investigations. All teachers agreed or strongly agreed they preferred teaching with an integrated approach, and that creating hands-on investigative learning environments was worth the effort because of the resultant student growth. As one teacher stated, “We need to integrate more because there is not enough time in the day to meet all the standards and the needs of the different learning styles and levels of understanding.” The majority of teachers agreed or strongly agreed that throughout the year it became more intuitive and easier to recognize opportunities in the curriculum to be intentional in integrating Common Core ELA and math concepts with science, through a variety of activities and methods. In addition, the majority of teachers began using their

newfound pedagogical skills in other areas of teaching, and looking for opportunities to integrate subject matter.

Longitudinal results include that teacher depth of knowledge increased by an average of 48% overall. Scores on a test of science knowledge jumped from an average of 45 points to an average of 86 points immediately after a week-long intensive Walk in the Watershed STEM content and pedagogy training. At mid year, after teaching content with sustained assistance from a STEM Coordinator, plus monthly collaborative work sessions with peers, the teachers were tested again, with an average test score of 82 points. At the end of the year, with the same STEM Coordinator and collaborative support, teachers tested once again averaged 87 points. A small dip in most teacher scores was noted at the mid-year delayed posttest as compared with the post-test. End-of-year (second) delayed posttest indicated an increase more or less to levels of content knowledge immediately after the workshop in most teacher scores from the mid-year posttest. This demonstrates potential benefits of sustained STEM Coordination and support for teachers.



All teachers saw gains in over half to the strong majority of their students in their abilities to communicate using written and oral language, think creatively and critically, communicate higher order thinking and greater depth of knowledge for the ISSS, use science processes, make claims and user evidence to back them, and utilize higher order thinking in areas other than science. One hundred percent of the teachers strongly agreed that the hands-on integrated approach was a more engaging experience for students than utilizing text alone. All teachers agreed or strongly agreed that integrated curriculum was more effective for student comprehension of the content, on the whole, as compared to teaching each standard as separate and unrelated.

All 20 of the fifth-grade students in the program received proficient or advanced scores on the 2014 science ISAT. One hundred percent of these students self-reported that their success on the science ISAT was due to their experience in the iSTEM program. Teachers reported that there were fifth-grade students whose academic performance in other areas caused concern that these

students may not achieve proficiency on the ISAT, but were pleasantly surprised when each of these students passed with proficient scores.

Sixty-seven percent of the students involved at the beginning of the year claimed an interest in being a scientist and by the end of the year, 33% of those students had an increase in becoming a scientist or working in a science field due to being involved in the program. Students went as far as naming the scientist they would like to be, including hydrologist, hydrogeologist, wildlife biologist, ecologist, water scientist, chemist, geologist, and entomologist among many others. Sixty-eight percent of the students had an increase in their interest in science overall, and forty-seven percent of these students said their interest increased more than they expected it would! Eighty-two percent of the students planned to return if the program was offered in the 2014-2015 school year. That number neglected to eliminate for the sixth-grade students not able to enroll in an iSTEM program in junior high as they are not yet offered there. Given the option of enrolling by quarter, the majority of students said they would enroll all four quarters, strongly suggesting this is a much needed opportunity. The top three most rewarding aspects of the programming for all students were field experiences, hands-on investigations and working with authentic science tools like microscopes and water quality test kits.

Of the parents surveyed, one hundred percent supported iSTEM from Excellence and its expansion into other grades. Parents were highly supportive of the field experiences and ranked them as valuable and engaging. Parents commented on the Watershed Extravaganza as a powerful community event that was highly informative, educational and fun! About 50% used the student/parent website and about 85% of those parents found the site useful. The site was under development for part of the year, and the investigators believe with increased awareness about the site's availability, more parents would use it with their student. Interestingly, the majority of the parents stated they would be willing to pay a nominal fee of \$10 per quarter for their student to participate in the program again, and only two families stated they would need the fee gifted or waived. Also, parents were much more inclined to state they'd likely support a levy in favor of increasing STEM education specifically, whereas many would not likely support a levy for general education.

Overall, the investigators are encouraged by the success of the program and are pursuing ways to leverage this success to expand programming across the district in grades 3-8, and eventually in the high schools as well. We are passionate about this model's role in building capacity in Lakeland and in districts across the state as we develop a more STEM literate citizenry, practiced in holistic thinking and problem solving, and grounded in the 21st Century competencies that are necessary for success in life and work.

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Conceptual Framework:

John Dewey (1910, 1936, 1958), L.S. Vygotsky (1968), and B. S. Bloom (1956), Bodrova and Leong (1996), Piaget (1970), M. Scriven and R. Paul (1992), and V.R. Ruggiero (1988),