

Final Grant Report

Due Date:

Grant No:

Organization: Bemidji State University and Minnesota State Colleges and Universities Foundation

This Final Grant Report is required when the grant project or purpose is completed or terminated and is to be submitted on the Due Date in your grant agreement. The report provides you, the Grantee, an opportunity to conduct a self-assessment of the progress you have made towards the goals you proposed in your application and to share this assessment with the Foundation. Please submit this cover page and accompanying narrative and budget worksheet electronically.

The Final Grant Report consists of two parts as follows:

1. **Narrative:** please refer to the instructions attached to the grant agreement when preparing your narrative report.

Narrative Prepared By: Derek Webb

Phone No:

E-Mail Address: dwebb@bemidjistate.edu

2. **Grant Revenue & Expense Worksheet:** This report is intended to provide the necessary financial information relative to the grant. Please follow the budget worksheet instructions.

Grant Revenue & Expense Worksheet Prepared By: Derek Webb

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Please submit both parts of your Final Grant Report on the Due Date listed in your grant agreement

Narrative

A. Progress Toward Project Goals

- 1. Please restate the goals of your grant.** The goal of the Northern Minnesota College Readiness Partnership is to implement and maintain an initiative that helps students, parents, educators, schools and institutions of higher education capitalize on shared resources to increase students' educational performance in the mathematical sciences and, ultimately, in their chosen area of study at institutions of higher education.
- 2. What progress have you made toward these goals?** The Northern Minnesota College Readiness Partnership (NMCRP) included participation from the following high schools and colleges - they are divided into current, future, and past partners.

Current Partners:

Bagley High School	Northwest Technical College
Cass Lake-Bena High School	Northland Community and Technical College
Clearbrook-Gonvick High School	Red Lake Nation College
Fairmont High School	White Earth Tribal and Community College
Floodwood High School	
Grand Rapids High School	
Thief River Falls High School	
Win-E-Mac High School	

Future Partners:

Nashwauk High School

Past Partners:

Red Lake Head Start instructors and pre-service instructors
Mahnomen High School
Bemidji High School
Fond du Lac Tribal and Community College

Note that with the addition of Fairmont High School in Fairmont, MN located in southern Minnesota near the Iowa border the partnership is now called the Minnesota College Readiness Partnership (MCRP). There is a summary discussion on all current, future, and past partners included in the appendix of this document.

At this point, all current partners have indicated a commitment to continue to offer the course in the future and commit to the teaching pedagogy that has made the course and the partnership successful. This success has been realized across diverse demographics and in a variety of physical classroom settings with technology ranging from minimal to excellent.

Even though grant funding is ending Glen Richgels and Derek Webb are committed to continuing to encourage school districts to adopt our curriculum and pedagogy. We also are committed to assist school districts adopting our materials in the future by supplying them with information and communicating through email and phone conversations.

The reasons why past partners are no longer part of MCRP are varied and are documented in the appendix with the exception of the Red Lake Head Start instructors and pre-service instructors. This was a one-time opportunity and the course was taught at the request of the Head Start program to help the individuals complete their liberal education requirements and gain knowledge in teaching mathematics and effective pedagogy.

The success stories related to our goal are too numerous to mention in this narrative and I urge the reader to consult the appendix for additional information. A few are given here:

- Our course has been taught twice at Win-E-Mac High School the last two years (there are plans to continue to offer our course at this institution) and both times the course was taught a student classified as Special Education – Learning Disabled took the course. Our course was the first math class these students ever took with their peers (mainstreamed). The students successfully completed the course and showed positive learning gains. More importantly, the students built confidence working with their peers. Confidence they had not had the opportunity to gain in their previous class. The first year, the Special Education – Learning Disabled student came up to the instructor, Jessica Strom, at a graduation party and personally thanked her for the opportunity to be in the class. He conveyed how hard he worked and his pride in taking part in a class with his peers and being successful.

Jessica had this to say of our grant work: *“I don’t know if it should be said, but one of the biggest aspects of this program that I am astonished with is that you guys (Glen and Derek) come to our school, give us a curriculum, work with us personally, and don’t ask for \$ in return. We don’t see much of that in this world and I still feel like it is too good to be true... It is definitely appreciated in this district!”* – written correspondence on 18 AUG 2009.

- MCRP positively impacts hundreds of students. The vast majority of student feedback both formally through evaluations and informally through direct student-to-instructor communication has been positive. Derek, Glen, and participating instructors have heard many comments with the following flavor: “Why weren’t all my other math classes taught this way?”; “Now I realize why mathematics is useful.”; “I wish I had this course before taking my science courses for nursing.”; “This math course is actually fun.”; “I like this course and I hate math.”; and “This is the first math class I did well in.”
- Valuable relationships between partnering institutions have been formed. Glen and Derek have formed valuable relationships with presidents, vice presidents, and deans at our two-year partnering institutions. They have also formed relationships with high school councilors, principals, and superintendents. These relationships have resulted in many good discussions about curriculum and student learning at our partnering institutions. They also have had the opportunity to attend academic affairs meetings at multiple two-year partnering institutions and participate in curricular discussions. In addition, we have been invited to take part in mathematics placement

exam discussions at one of our two-year partnering institutions. These relationships would not have been created without our grant work.

- The MCRP course is successful under a variety of situations. From a research perspective, it is very important to note that our course is successful (success documented through pre-test and post-test data) at institutions with very different classroom environments; technology infrastructures; and instructor skills, backgrounds, and teaching styles. We postulate that this is due to the unique and robust pedagogy we teach all instructors and the engaging and relevant course content.
- The first time the course was taught at Clearbrook-Gonvick High School the instructor had students in the course who had failed the Minnesota Comprehensive Assessments (MCAs) II test on their first attempt. The instructor used the course structure and pedagogy to help remediate these students. By the end of the course all but one student had successfully passed the MCA II. Teachers at other high schools have started to experiment with using our course to help students successfully pass the MAC II. By doing this, students not only learn many new mathematical topics and increase their chances of being successful later on in post-secondary education, but they also better understand many basic topics that appear on the MCA II.

In summary, the Northern Minnesota College Readiness Partnership has helped students, parents, educators, schools and institutions of higher education take advantage of shared resources to increase students' performance in mathematical sciences.

3. Have you made any significant revisions to these goals, and if so, why? While changes might have occurred in the participating schools, course lengths, or the way in which the course was taught, there was no diversion from the original goal of the Minnesota College Readiness Partnership. The most significant departure from our original plans is that the number of participating institutions has grown due to increased awareness of teachers in our region and our recruiting efforts. This is a positive departure and signals interest and acceptance in our curricular model.

It should be noted that one big challenge Drs. Webb and Richgels faced when implementing this grant work is the very real issue of high turnover at the administrative level and within the teaching ranks. This turnover makes the creation of long-lasting relationships challenging and required repeated work/conversations at many partnering institutions. This is a challenge that seems ubiquitous in K-12 education in the United States and something that needs to be addressed at a national level.

B. Social Capital: Developing and maintaining relationships that allow us to work together across our differences.

1. To what extent has working on this grant helped to develop new relationships/networks or strengthen existing ones? Project leaders, Drs. Derek Webb

and Glen Richgels report experiencing numerous positive results that are not easily quantifiable. There have been thoughtful discussions with instructors at partnering institutions that have resulted in the instructors seriously considering how they teach and how they can improve their teaching. College and high school instructors are being exposed to new pedagogy and course content, which positively impacts how they view mathematics instruction which will carry forward into the future for many years. These changes in perspectives and attitudes of the NMCRP partnering instructors will also carry forward into classes outside the scope of our project.

Working face-to-face with teachers at each partnering institution has been critical to the success of this grant. Many teachers are handed new technologies and new materials (textbooks, papers, physical manipulatives, etc...). But, few teachers have had the opportunity to work directly with mathematics education experts directly in the teachers' classrooms with their own students. This living laboratory is the perfect environment for educating teachers on new pedagogies because the teachers see how it impacts the students in real time and the teachers don't forget what they learn. Drs. Webb and Richgels realize this model is time consuming and expensive. But, they firmly believe it produces the greatest and most long lasting results.

2. Describe the types of community perspectives that were sought out and included in the preparation of your plan. The Minnesota College Readiness Partnership is based, in part, on curricular research both at the national and international levels. Drs. Webb and Richgels examined what mathematics students need to be more successful at post-secondary institutions in the U.S. and keep pace with what students world-wide are learning in mathematics at the high school level.

Drs. Webb and Richgels also incorporated pedagogical techniques and project oriented activities into the course in order to engage students and improve their view of mathematics, in general. Many students come to this class holding negative views of mathematics. Their views have been shaped, in large part, from negative experiences in a past mathematics class(es). In the MCRP math classes, these students become engaged and participate. They discuss problems with their peers, feel less isolated, and find that they can succeed in a math class. While test scores showing improvement remains an important measure of success, witnessing first-hand the changed attitudes of students has had a strong impact on Drs. Webb and Richgels and on the partnering instructors.

3. How have these perspectives and researched influenced the effectiveness of your plan?

Meeting regularly with students, instructors and school administrators help the project leaders to identify ways in which current-day learning could better occur and how the pedagogy of the MCRP-related classes increases the students' ability to succeed in advanced subjects in the later grades. Moreover, what might occur at one partnering high school or college could yield methods in which other participants could better provide individual attention to challenged students, customize instruction, and cover more material effectively. The project leaders have also been able to identify areas that will need to be rethought or revised; concurrent enrollment is such an area.

Concurrent enrollment is not a major component of the MCRP. In the design phase of the MCRP, concurrent enrollment was considered to be a valuable relationship between high schools and Bemidji State University that high schools would pursue. This has turned out not to be the case. High schools value the course and are offering the course in their schools because of the success the high school's mid to lower level students have. Because the course is typically populated with mid to lower level high school students, the state requirements on classroom populations for offering a concurrent enrollment class are not met. Therefore, high schools are not offering our course as a concurrent enrollment course. A benefit to the high schools of not having the course offered as concurrent enrollment is that the school has more control and choice over the content and hiring of instructors.

C. Framing: Crafting an effective action plan based on research and the inclusion of a variety of perspectives.

- 1. What research was performed to help put your plan together?**
- 2. How have these perspectives and research informed the effectiveness of your plan?**

The MCRP course is research based and pedagogically sound. The class was developed through a formal research process and driven by real data and input from faculty in multiple disciplines. The course being offered at each partnering institution is assessed for quality and student learning each time it is offered. There is a growing body of research evidence of the successfulness of this course and the course development, content and success has been presented and published at an international mathematics education conference:

- Improving Student Interest, Mathematical Skills, and Future Success Through Implementation of a Novel Mathematics bridge Course for High School Seniors and Post-secondary Students, 10th International Models in Developing Mathematics Education Conference, Dresden, Germany, September 11-17, 2009. Joint talk given by Dr. Derek Webb and Dr. Glen Richgels of Bemidji State University.
- Webb, D. F., Richgels, G, Wolf, M. J., Frauenholtz, T, and Hougen, Ann (2009) Improving Student Interest, Mathematical Skills, and Future Success Through Implementation of a Novel Mathematics bridge Course for High School Seniors and Post-secondary Students, Proceedings of the 10th International Conference - Models in Developing Mathematics Education, 575-578. (A copy of this publication can be found in the appendix)

Major national mathematics organizations recommend courses with content and pedagogy that matches the MCRP course.

The article A collective Vision – Voices of the Partner Disciplines (Ganter, Susan L. and Barker, William, Mathematical Association of America, 2004, <http://www.maa.org/cupm/crafty/Chapt1.pdf>) gives recommendations for mathematics course content and pedagogy based on “an unprecedented amount of information on the mathematical needs of partner disciplines, obtained through a series of disciplinary-based

workshops known as the *Curriculum Foundations Project*.” These workshops were held nationwide from November 1999 to February 2001. The summary recommendations the article gives for mathematics classes are in alignment with the MCRP course model.

The article [Beyond Crossroads – Implementing Mathematics Standards in the First Two Years of College](http://www.beyondcrossroads.com/doc/PDFs/BCAll.pdf) (Blair, Richelle – Editor, American Mathematical Association of Two-Year Colleges, 2006, <http://www.beyondcrossroads.com/doc/PDFs/BCAll.pdf>) very thoroughly discusses and recommends what mathematics curriculum should look like at two-year institutions. Recommendations are given on all aspects of curriculum from content to appropriate learning environments for different types of student learners. The MCRP course complements the recommendations given in this article.

There is variability between high schools in the following aspects of the course: ability of students, prior knowledge of students in the class, length of class time, number of days per week class is offered, total number of hours class is offered during the semester, topics covered and emphasized in class, and additional topics added to the class.

From a research perspective, this is both good and bad news. Good in that Drs. Webb and Richgels are able to assess the effectiveness of different renditions of the class; bad in that they are not able to make detailed class-to-class comparisons because the classes are different in many ways. In the end, though, the important question to ask and assess is whether or not the needs of students at particular partnering institutions are being met. Based on pre and post test assessment data and extensive discussions with instructors, guidance counselors, and administrators, Drs. Webb and Richgels do believe students’ need are being met much more effectively than prior to the course implementation. Schools are reporting that the MCRP course is a far better fit for their students learning needs than what the students’ historically would have taken, if they took even took a math class their senior year.

D. Mobilization

1. In addition to Blandin Foundation funding, what other financial and non-financial resources have been contributed to advance the project’s work? The project leaders were awarded a matching grant of \$100,000 in May 2009 from the Minnesota State Colleges and Universities Office of the Chancellor. This additional grant greatly aided the MCRP in that Drs. Webb and Richgels were able to focus on the MCRP work for the entire 2009-2010 academic year and recruit and work with more partnering institutions than was originally proposed.

In May 2009 the project leaders were also awarded a grant of \$2,400 from the Minnesota State Colleges and Universities Foundation to support partnering institution instructor travel costs so that the instructors could attend and present at the Minnesota Council of Teachers of Mathematics and Minnesota Mathematics Association of Two-Year Colleges annual Minnesota Spring Mathematics Conference in both 2009 and 2010. At the conference each year the instructors gave a brief presentation on the MCRP, the class, and their experiences. Then the discussion was opened up to the floor for a question and answer session. The instructors were also able to meet as a group outside of the panel discussion and talk about their personal experiences teaching our course through the MCRP grant work. They had

never met each other before, so having this opportunity was very rewarding. Many of the instructors had also never had the opportunity to attend this conference. They all found the conference professionally valuable

2. Are these resources sufficient to achieve the desired outcome? Because the original project was scaled back to work within the Blandin Foundation’s award, the project goal has been achieved. However, given the additional grants awarded from the Minnesota State Colleges and Universities Foundation and Chancellor’s Office expansion of the original proposal has been possible. However, even though funding had a distinct endpoint, instructor and student needs continue and Drs. Webb and Richgels realize this. They are committed to offer limited support via phone and email to all partners of the MCRP.

E. Healthy Communities Indicators

Strategy	Impact Indicator
Increased educational attainment for disadvantaged students	<ul style="list-style-type: none"> • Teachers will be able to teach the activities-based course, Introduction to Mathematical Sciences. • Pedagogical and policy changes to better serve American Indian and other underrepresented populations will be driven by the project’s research-based best practices and adaptable theoretical applications. • Enhanced professional development opportunities will be provided to American Indian secondary and post-secondary and non-Native educators.
Strengthen inter-cultural competencies.	Area high schools, tribal, community and technical colleges have the capacity to implement a culturally-conscious mathematics course.

Appendix

Pedagogy Discussion

Glen Richgels and Derek Webb have been actively conducting MCRP grant work the past year and a half and have a set of pedagogical teaching skills that they believe are optimally suited for the mathematics classroom. Many of these pedagogical teaching skills originated through research-based grant work under the Initiative to Promote Excellence in Student Learning (IPESL) MnSCU grant program in 2006. A summary of that grant work can be found in the research article at the end of this document. Drs. Webb and Richgels have found these changes take time and need to be developed through mentorship in the classroom and not through lecture or summer workshops. They have empirical evidence of success with mathematics teachers and students at multiple high schools and colleges in Minnesota. The pedagogical ideas are summarized in the following bullets:

- Teachers can be convinced that teaching the way students learn, rather than the way math was taught in traditional textbooks and curricula, works better. This may sound obvious to the reader, but is not the way mathematics is taught at most institutions.
- Teachers need good instruction modeled for them and need long-term support in their professional development to see sustained gains in their student achievement.
- Contextual learning gives relevance to topics. There is a reason for learning math and teachers need to be able to convey this to their students in a meaningful way, not just give it “lip-service.”
- Group work helps all students. The best students do not lose ground interacting with lower achieving students and the lower achieving students make bigger gains than if they worked in isolation.
- Students have completely learned a concept when they are able to present the concept to their peers in their own words. That is why Drs. Webb and Richgels stress student presentations, both individually and in groups, in their classroom pedagogy.
- Practicing skills, exploring concepts, and presenting what students have learned during a class-period instead of at the end of the period keeps students engaged all hour. Many teachers have students do homework or worksheets most of a class period which results in low student engagement and boredom.
- A critical pedagogical change most teachers need to enact is to assign fewer, richer, more valuable homework problems. Fewer homework problems resulting in greater learning seems counterintuitive to most parents and teachers. But, student interest and success increases and this results in greater learning.
- Students need to be made aware of the fact that most problems have multiple solutions. Too many teachers present one solution and students come to believe it is the only correct (or “most correct”) solution. Students need to gain confidence in finding solutions to problems that make sense to them and are based on their particular skill sets. This topic of multiple solutions should not be ignored because teachers say: “there is not enough time to present multiple solutions because we won’t get through all the material.” This is not true. Multiple representations of problems is a must. This helps students see connections between the concrete and the abstract and helps them formulate models, pictures, and representations to help them solve problems.
- The use of dynamic software tools helps students see what happens instantaneously when changes are made. Programs such as Microsoft Excel, Geometers Sketchpad, Fathom, and Tinkerplots are examples of such programs. They are also better suited for learning than the conventional graphing calculator most mathematics teachers still cling to. Drs. Webb and Richgels advocate for using technology in the classroom that enhances student learning, not for using technology with which teachers are comfortable.
- Access to the internet re-enforces the fact that math is real, useful, and contemporary. It also helps develop independent student learning, gives students tools and skills for researching problems, and student confidence in that they can solve problems on their own. Drs. Webb and Richgels strongly advocate for curricula that makes use of the internet.
- Students are more important than course content. There is a need to develop a relationship with the students that demonstrates to them that the teacher is there to help them learn difficult material, and not just present it and abandon them

- Skills are important. Drs Webb and Richgels have learned that a teacher cannot fix bad foundational skills while practicing new or extending skills. Students can fix their foundational skills if the basics are reviewed briefly (day to day) in a short period of time. These skills need to be approached as long term development and maintenance skills. This is not how traditional texts deal with skills. A child can be taught how to dribble a basketball at one time. But proficiency develops with daily practice over time.

Partnering with Colleges

It has been very difficult creating lasting partnerships with colleges. There are many reasons for this:

- Politics – each college Drs. Webb and Richgels have dealt with has its own deep and difficult to understand political structure. This structure creates unpredictable roadblocks and slows down progress on offering the course and institutionalizing the course.
- Instructors – many instructors Drs. Webb and Richgels have interacted with already believe they “know” how to teach and are not interested in learning new pedagogy. They often show disinterest or actual disdain for Drs. Webb and Richgels implying Drs. Webb and Richgels know a “better” way to teach students who struggle in traditional math courses. This is a problem not only at the colleges Drs. Webb and Richgels have visited, but across the entire nation and is one of the most important reasons why the United States is struggling with improving student success, especially at the high school and post secondary levels.
- Time – Instructors often do not want to teach in a laboratory environment. The MCRP course is intended to be offered in a computer laboratory environment in two-hour course periods instead of one-hour course periods. This translates into being in the classroom for 6 hours per week instead of 3. There are very good research based pedagogical reasons for why the course was designed this way. But, most instructors are not interested in participating once they find out how much time is involved, even if it is better for the students.
- Curriculum – many college instructors and administrators have difficulties with how the course fits in their curriculum. These difficulties result in discussions of prerequisites, offering the course as experimental, and many other issues associated with the complex curricular structure at the college level.
- Not innovative – Many instructors view the course as “not innovative” even though the course is research based and Drs. Webb and Richgels have empirical evidence of its success over that of traditional algebra courses. Curiously, the course is often compared to an algebra course or a traditional liberal education math course.
 - The comparison to an algebra course makes no sense because of the breadth of mathematical topics covered in our course.
 - The comparison to liberal education courses speaks to the very traditional view most math instructors have with regard to teaching students: *cover as much material as possible and expect the students to figure out on their own how to succeed. If they cannot succeed then they fail or drop out. Failing students and students that drop out are not of concern to the instructors in the traditional teaching model. Instructors that teach traditionally expect students to complete homework on their own and sit and listen to instructors LECTURE all period long.* This type of traditional math teaching is very common in the United States but not in the rest of the world. The MCRP course is the antithesis of this

traditional teaching model. Fewer topics are covered, but the topics covered are given more attention and students develop a deeper and longer lasting understanding of them. Drs. Webb and Richgels know most students will “give up” on homework if they are struggling in isolation without resources. Therefore, in the MCRP course, students learn in a two-hour exploratory laboratory environment. This ensures that students are successful in the course before going home and they develop confidence in their mathematical abilities.

- Developmental – many instructors view MCRP course as developmental and not a course that is at an appropriate level for college. They just see the course as a list of topics and don’t understand the depth of understanding students achieve in the course. The course has been through the Bemidji State University curricular process and is accepted in the Minnesota Transfer Curriculum in area 4. It is a college level course that is transferable to any college or university in MnSCU.

Partnering with High Schools

Partnering with high schools is very different than partnering with colleges.

- The high schools we are partnering with have been eager to have an offering in their curriculum that attracts juniors or seniors who might, otherwise, not take any mathematics at all or take a math course that does not really benefit them at a post secondary institution. Most high school administrators also understand the need for a different type of mathematics offering for their juniors and seniors. They are also open-minded to an alternative type of pedagogy that our course uses and understand that some students do not learn well in a traditional math course and need an alternative.
- *A very big difference between high school and colleges is that high schools are being held accountable for student success by the federal government and the state. Colleges are not. Therefore, high schools are eager to find alternative mathematics curricula that may help their students. Colleges are happy to continue with “business as usual” which means continue teaching traditionally.*
- One relationship that has led to success in implementing our course at the high schools is that many of the high school instructors we work with have attended one or more of our summer in-service instructor professional development courses. The instructors have spent weeks immersed in our curriculum and pedagogy. This allows for the instructors to implement our course with less mentoring than instructors that have not had our professional development.
- High school courses have more contact time than college courses. Our course taught in a college, 2 hours per day, 3 days per week for one semester results in approximately 90 contact hours. Our course taught in a high school 45 minutes per day, 5 days per week for one year results in approximately 120 hours per year. This allows for high school instructors to spend additional time in our course covering material their students are weak on or need remediation on so that the students can be successful on standardized exams. This benefit of the course based on extra hours at the high school level is very positive for students.
- The biggest challenge we face with having our course implemented in high schools is budget. Most high schools in Minnesota have significant budget issues to deal with and many high schools in northern Minnesota are stretched to the breaking point because of budget shortfalls. Asking a high school to dedicate resources to starting up a new course is sometimes a difficult sell, even with all the positives mentioned above.

Current Partners

- **Clearbrook-Gonvick High School**
 - Course length: 48 minutes, 5 times a week, yearlong course Fall/Spring 2009
 - Number of courses: 1
 - Course size: approximately 18
 - Classroom facilities: excellent – course is taught in a computer laboratory environment with enough computers for course size.
 - Administrative support: administration dedicated to success of the course and administration recognizes the synergy of the course and other STEM initiatives.
 - Number of previous times course has been taught: 0
 - Likelihood of continuation of partnership: high – this institution shows dedication through its curricular and administrative decisions to all of its students, not just the top 20% of students.
 - Instructor: Gus Vettleon
 - Narrative: Gus is very knowledgeable of technology and incorporates it into the curriculum. He understands the importance of group work and students having the opportunity to explain their thought processes verbally and in writing. Gus requires very little mentoring. One major reason is that Gus took part in a professional development program at Bemidji State University in Summer 2009. The professional development courses covered assessment, probability, and statistics. Gus recognizes the value of the curriculum and pedagogy, is willing to express his support to the administration, and is dedicated to the success of the course.
 - Grant support: weekly site visits to discuss course content and pedagogy.

- **Grand Rapids High School**
 - Course length: 45 minutes, 5 times a week, yearlong course Fall/Spring 2009
 - Number of courses: 2
 - Course size: There are two courses, one with 34 students and one with 36 students.
 - Classroom facilities: poor – classroom is too small for number of students and there are not enough computers for students. Students must work in groups of 3 to 4 per computer.
 - Administrative support: administration dedicated to course but is still figuring out how course fits with existing curriculum and how to most appropriately place students into course.
 - Number of previous times course has been taught: 0
 - Likelihood of continuation of partnership: high – even though this institution is struggling with severe budget and demographic issues its administration is making decisions that result in good mathematics opportunities to all students, not just the top 20%.
 - Instructor: Maren Hagen

- Narrative: Maren is extremely dedicated to her students and understands the value of this course for underachieving students. She is extremely bothered by the poor facilities, but does her best to overcome this shortcoming. Maren is a traditional instructor. On many occasions she has indicated that she has read or has access to information on new instructional techniques. However, she has not experienced a course that has been taught this way and she has problems visualizing how to teach in a new way. She really appreciates mentoring and shows a great deal of concern for her students. She has purchased twenty laptop computers out of her own money and given laptops to the school district for use in her courses. She has used them to bring technology into her courses to motivate her students. The course structure and pedagogy is unfamiliar to Maren and represents a learning opportunity that she is willing to accept.
 - Grant support: twice weekly site visits to discuss course content and, more importantly, pedagogy. Glen and Derek each try to visit with Maren once per week (Glen at the beginning of the week and Derek at the end). The additional visits are necessary because of Maren's unfamiliarity with the course content and pedagogy and the large number of students Maren has to work with.

- **Floodwood High School**

- Course length: 52 minutes, 5 times a week, yearlong course Fall/Spring 2009
- Number of courses: 1
- Course size: approximately 18 students
- Classroom facilities: good – course is taught in a classroom and a computer laboratory alternating as necessary. There are enough computers for course size.
- Administrative support: administration made staffing changes during the summer of 2009 and was able to offer the course. We believe administration is still figuring out how the course compliments existing courses and what students are best served by taking the course.
- Number of previous times course has been taught: 0
- Likelihood of continuation of partnership: medium – not enough is known at this time to give an assessment of the institutions dedication to this course or to mathematics for all students. The institution has adopted the course for academic year 2010 which is a very positive step.
- Instructor: This course is team-taught and the instructors are Vangie Mattfield and Amy Fox
 - Narrative (Vangie Mattfield): Vangie brings years of experience to this course and it shows. She has a good understanding of the content and pedagogy and requires little mentoring. She also has taken professional development courses at Bemidji State University on several occasions including the assessment and probability and statistics courses. Vangie is very familiar with the NCTM standards and recommendations and implements them in her teaching. She also has very good communication with instructors at lower grades in her school district which means these instructors understand the topics that are important for their students so that they are successful when they get to high school.

- Classroom facilities: good – course is taught in a classroom with smartboard and a computer laboratory alternating as necessary. There are enough computers for course size.
 - Administrative support: administration is very supportive of this course and has made the decision to offer the course both Fall 2009 and Spring 2010. The instructor receives strong support from the administration to teach the course in the pedagogic spirit that the course was intended to be taught in.
 - Number of previous times course has been taught: 0
 - Likelihood of continuation of partnership: high – the administration views this course and the pedagogy of the course as key components to their efforts to have a positive impact on underachieving students.
 - Instructor: Mark Hernes
 - Narrative: Mark is a very energetic dynamic instructor and the content and pedagogy of our course fits his teaching style well. Mark requires little mentoring because he understands fundamentally what we are trying to achieve with the design of the course.
 - Grant support: Due to the location of this institution on the Iowa border weekly visits to work with the instructor are not possible. Derek visited the institution at the beginning of Fall 2009 and worked with Mark to get him ready for the semester. Derek and Glen keep in regular phone and email contact with Mark and are working on ITV contact.
- **Bagley High School**
 - Course length: 49 minutes, 5 times a week, yearlong course Fall/Spring 2009
 - Number of courses: 1
 - Course size: approximately 25 students
 - Classroom facilities: good – course is taught in a classroom with smartboard and a computer laboratory alternating as necessary. There are enough computers for course size.
 - Administrative support: The administration will examine the research results, student comments, and instructor comments before making a decision to continue to offer the course. The administration must also consider budget implications and remediation needs for seniors who fail the MCA II test as juniors.
 - Number of previous times course has been taught: 0
 - Likelihood of continuation of partnership: high – the administration views this course and the pedagogy of the course as key components to their efforts to have a positive impact on underachieving students.
 - Instructor: Becky Rud
 - Narrative: Becky is very organized and dedicated to the course. She has a good understanding of the pedagogy and is knowledgeable of the content. Becky does not require a lot of mentoring. Becky has taken the assessment, probability and statistics professional development courses at Bemidji State University which strongly contributes to her preparedness.
 - Grant support: weekly site visits to discuss course content and pedagogy.
 - **Win-E-Mac High School**
 - Course length: 48 minutes, 5 times a week, yearlong course Fall/Spring 2009

- Number of courses: 1
 - Course size: approximately 18
 - Classroom facilities: good – course is taught in a classroom equipped with a smart board and a document camera that the instructor utilizes effectively. Students utilize a computer laboratory as necessary. There are enough computers for course size.
 - Administrative support: administration dedicated to success of the course and supports the instructor.
 - Number of previous times course has been taught: 1
 - Likelihood of continuation of partnership: high – This institution and instructor are committed to the continuation of the course. They recognize the benefits the course has on underachieving students.
 - Instructor: Jessica Strom
 - Narrative: This is the second time Jessica has taught the course. Jessica is very comfortable with the course content and pedagogy and requires little support. Jessica is now capable of mentoring other instructors new to teaching the course. Jessica has taken many professional development summer courses at Bemidji State University that have prepared her to be successful in teaching our course.
 - Grant support: infrequent site visits to discuss course content and pedagogy.
- **Cass Lake – Bena High School**
 - Course length: 90 minutes per day, five days a week, for two tri-mesters (September to March)
 - Number of courses: 1
 - Course size: 20
 - Classroom facilities: excellent – course is taught in a computer laboratory environment with enough computers for course size.
 - Administrative support: The administration is very supportive of the course at this time. They hope to get to the point where the course can be taught for college credit.
 - Number of previous times course has been taught: 0
 - Likelihood of continuation of partnership: The district was one of the original partners and has been very enthusiastic about working with BSU to improve mathematics offerings at the school. As many schools in northern Minnesota, local funding may be the determining factor in the course's continuation.
 - Instructor: Al Habedank
 - Narrative: Mr. Al Habedank is a very concerned instructor. He wants to help his students for the long run. He is not a typical high school math instructor and is not a part of the high school math department. He loves the course and that fact that it is project oriented. He has stated on several occasions that if kids in his district would learn math in this manner, they would have a better chance of learning compared to what is currently being done. Al wants to visit other instructors to see how they are teaching their courses. He has administrative support to do this as professional development.
 - Grant support: weekly site visits to discuss course content and pedagogy.

- **Northwest Technical College**
 - Course length: 120 minutes, 2 times a week, semester-long course Fall 2009
 - Number of courses: 1
 - Course size: approximately 25
 - Classroom facilities: good – course is taught in a classroom and a computer laboratory alternating as necessary. There are enough computers for course size.
 - Administrative support: administration dedicated to success of the course and administration recognizes the synergy of the course and other STEM initiatives.
 - Number of previous times course has been taught: 2 – two sections of the course were taught in Spring 2009
 - Likelihood of continuation of partnership: high – this institution shows dedication through its curricular and administrative decisions to all of its students, not just the top 20% of students. This institution has also institutionalized the course through the curriculum process and the course will be a regular offering.
 - Instructor: Scott Vettleon
 - Narrative: Scott is personality-wise perfect for teaching this course. He is very engaging with each and every student without regard for their ability. He keeps the students focused and involved in the learning process for two hours at a time and he has a knack for group work and student discussion/presentation. Scott is also very knowledgeable of the course content. Scott requires very little mentoring.
 - Grant support: infrequent site visits to discuss course content and pedagogy. In Spring 2009 grant funding paid \$2,500 each (total of \$10,000) for four instructors. The instructors were from other disciplines at Northwest Technical College. The grant funding allowed Scott to teach the course and the other three instructors to sit in on the course and discuss course content with Scott. This was critical for institutional support of the course because instructors from other disciplines had to make sure the course would meet the needs of their students.

- **Northland Community and Technical College**
 - Course length: 120 minutes, 3 times a week, semester-long course Fall 2009
 - Number of courses: 1
 - Course size: approximately 20
 - Classroom facilities: Excellent – course is taught in a computer laboratory environment with enough computers for course size.
 - Administrative support: administration dedicated to success of the course and administration recognizes the benefit of the course for students who struggle with mathematics at the post-secondary level.
 - Number of previous times course has been taught: 1 – course was taught in Spring 2009
 - Likelihood of continuation of partnership: high – this institution has shown a dedication to the course and it is likely the course will become institutionalized and a part of the institution's regular curricular offerings.
 - Instructor: this course is team-taught and the instructors are Alan Swanson and Ralph Cox

- Narrative: (Alan Swanson) Alan is very comfortable with the course content and understands the pedagogical philosophy that the course embodies. Alan has a good sense of the proper pace to teach the course at so that all students, even the ones who struggle the most, keep up and make progress.
 - Narrative: (Ralph Cox) Ralph is a very engaging and dynamic instructor who naturally feels comfortable with the pedagogy of the course. He has a knack for connecting with students of different backgrounds and making them feel welcome and comfortable in the mathematics classroom. This is critical for underachieving students to succeed.
 - Grant support: infrequent site visits to discuss course content and pedagogy. Instructors are virtually self-sustaining. The course was team-taught in Spring 2009 (Alan Swanson and Ralph Cox team taught) and grant funding paid the salary of Ralph Cox. The course is again being team-taught in Fall 2009 and grant funding is paying the salary of Ralph Cox. This is an unusual situation in that this institution has received grant funding two semesters in a row for a second instructor's salary. The reason the grant Principle Investigator has chosen to support Northland Community and Technical College in this way is political. The institution has two campuses, one in Thief River Falls and one in East Grand Forks. The Thief River Falls campus embraces the course and desires to continue to offer it while the East Grand Forks campus has reservations about starting to offer the course. A second semester of grant funding for Ralph Cox demonstrated to the institution the importance of the course and our desire for students at both campuses to have access to the course.
- **Red Lake Nation College**
 - Course length: 120 minutes, 2 times a week, semester-long course Fall 2009
 - Number of courses: 1
 - Course size: approximately 15
 - Classroom facilities: poor – course is taught in a computer laboratory, but there are not enough computers for the course size. There also is no smartboard nor projection device to display computer images.
 - Administrative support: administration at the Red Lake Nation College site is dedicated to success of the course and recognizes the benefit of the course for Red Lake Nation students. At this time it is unclear what the administration's views of the course are at Fond du Lac Tribal and Community College. This is an issue because Fond du Lac Tribal and Community College oversees Red Lake Nation College. Please see entry below for Fond du Lac Tribal and Community College for more details.
 - Number of previous times course has been taught: 1 – course was taught in Spring 2009
 - Likelihood of continuation of partnership: high – this institution has shown a dedication to the course and it is likely the course will become institutionalized and a part of the institution's regular curricular offerings.
 - Instructor: this course is team-taught and the instructors are Ken McBride and Jason Schultz

- Narrative: (Ken McBride) Ken has taught at Red Lake Nation College for many years and has an excellent rapport with the students. He understands how to connect with and motivate the students. Ken believes in the pedagogy we are using and tries to use it in the classroom, although he sometimes slips back into the pedagogy of a traditional math instructor.
 - Narrative: (Jason Schultz) Jason team-taught the course with Ken in Spring 2009 and again Fall 2009. Jason has very little teaching experience, but has experience working at Red Lake Nation College in technology support. Therefore, he is known and trusted by students and staff at the college. When the grant opportunity came along for Jason to team-teach the course with Ken, Jason was very excited about the opportunity and has learned a lot from the experience.
 - Grant support: infrequent site visits to discuss course content and pedagogy. Instructors are close to self-sustaining. The course was team-taught in Spring 2009 (Ken McBride and Jason Schultz team taught) and grant funding paid the salary of Jason Schultz. The course is again being team-taught in Fall 2009 and grant funding is paying the salary of Jason Schultz. This is an unusual situation in that this institution has received grant funding two semesters in a row for a second instructor's salary. There are two reasons why the grant Principle Investigator has chosen to support Red Lake Nation College in this way: 1) Jason Schultz had limited teaching experience prior to this opportunity and it was deemed necessary for him to team-teach the course twice before having the necessary experience to teach it on his own. 2) Ken McBride is not a permanent fulltime employee of the college and so having a well trained second instructor is critical for the college to offer the course long-term.
- **Red Lake Head Start instructors and pre-service instructors**
 - Course length: 120 minutes, 3 times a week, semester-long course Fall 2009
 - Number of courses: 1
 - Course size: approximately 10
 - Classroom facilities: Excellent – course is taught at Red Lake High School. The classroom has access to laptop computers for each student and a smartboard.
 - Administrative support: The course is being taught at the request of the Head Start program to help the individuals complete their liberal education requirements.
 - Number of previous times course has been taught: 1 – course was taught in Spring 2009 by the instructor, but he taught the course for high school students not for the Head Start program.
 - Likelihood of continuation of partnership: this course may be needed again in the future. However it may not be an annual course.
 - Instructor: this course is taught by Bill Grundy
 - Bill Grundy is a high school math instructor with a masters degree. He taught the course at Red Lake High School in the spring of 2009. The students for the course are paid to attend. Mr. Grundy has indicated that this has made attendance stable and that the students are motivated and are learning. Bill has indicated that he has been and will be using ideas

from the course in his other courses at his high school. In fact he has been sharing some of the ideas with other staff members at Red Lake High School.

- Grant support: The grant is paying for weekly visits.
- **White Earth Tribal and Community College**
 - Course length: 120 minutes, 3 times a week, semester-long course spring 2010. This is the plan. During the spring of 2009 the course met for one hour a day, three days a week. The instructor was so impressed with the course that he is now advocating for the course meeting 2 hours a day for three days a week.
 - Number of courses: 1
 - Course size: approximately 10
 - Classroom facilities: Adequate – the course meets in a science classroom and can then move to a nearby computer lab
 - Administrative support: To date the administration is very much in support of the course.
 - Number of previous times course has been taught: 1 – course was taught in Spring 2009 by Steve Dahlberg.
 - Likelihood of continuation of partnership: the partnership will continue.
 - Instructor: this course is taught by Steve Dahlberg
 - Steve Dahlberg is the math and science instructor for WETCC. He has taught in the past similar to the philosophy of the course. He is very much in favor of the content, pedagogy, and intent of the course. He is a very strong advocate of the course.
 - Grant support: weekly site visits to discuss course content and pedagogy.
- **Red Lake High School**
 - The course was taught at Red Lake High School in the spring of 2009. While the listed course size was 18, few if any days found a complete class. On several occasions, by Wednesday of the school week, Mr. Grundy reported that every student attended class for, at most, one day. Instruction became problematic because of chronic absenteeism. There are more problems and deeper problems at this location than the problems related to the difficulties teaching our course. These problems need to be addressed by the school district. The administration is attacking these problems first and has expressed appreciation for being included in the original grant, but their priorities now are different and they do not intend on offering the course in the spring of 2010 at this time.

Past Partners

- **Bemidji High School**
 - Course length: 120 minutes, 5 times a week, semester-long course not to be offered again
 - Number of previous times course has been taught: 2 – course was taught in Fall 2007 and Fall 2008
 - Course size: approximately 15 in Fall 2007 and 25 in Fall 2008

- Classroom facilities: good – course is taught in a classroom and a computer laboratory alternating as necessary. There are enough computers for course size.
 - Administrative support: Financial difficulties were given as the reason for not offering the course in the 2009-2010 academic year.
 - Likelihood of continuation of partnership: low – the administration has not shown a dedication to the course nor a belief in the pedagogy as valuable for their students even though there is quantitative data from the first two times this institution offered the course. The Bemidji school district has cut the course from their course offerings twice in four years for financial reasons.
 - Instructor: this course was taught by Seth Knudson in Fall 2007 and then team-taught by Seth Knudson and Terry Hewitt in Fall 2008
 - Narrative: (Seth Knudson) Seth starting teaching the course in Fall 2007 as a very traditional math instructor. For example, the first four days he taught the course he covered about 4 weeks of material. This is because he did not understand the pedagogy which stresses that no students are left behind and the course develops mathematical concepts more slowly and more deeply than in traditional math courses. By the time Seth had completed teaching the course a second time he was more comfortable with the pedagogy and had a better understanding of its benefits for students that struggled in traditional math courses. We believe Seth would have continued to be interested in teaching the course if the administration supported continuing offering the course.
 - Narrative: (Terry Hewitt) Terry is the head of the mathematics department at Bemidji High School and is known for supporting the best students (approximately top 20%) and is a strong advocate for gifted and talented programs. Terry has worked hard at having college level courses available for students. Bemidji high school offers AP Calculus, AP Statistics and College Algebra (college credit for students who qualify). During the past three years, concurrent enrollment courses have increased the percentage of seniors taking math courses from 30% to 60%.
 - Grant support: weekly site visits to discuss course content and pedagogy occurred during the previous two offerings of the course. During Fall 2008 the grant covered the expense of Terry Hewitt so that the course could be team-taught and Terry could familiarize himself with the content and pedagogy. We believed it was very important for the grant to support Bemidji High School as much as possible because of its close proximity to Bemidji State University and because it is the largest high school that the course has been taught at. We are extremely disappointed in the decision by Bemidji High School to not continue to offer the course.
- **Mahnomen High School**
 - During the 2007-2008 academic year Glen met several times with northern Minnesota schools to put together a group of partnering institutions. During a meeting with Red Lake Superintendent, Brent Gish, it was suggested that Glen should meet with the Mahnomen high school principal to discuss the NMCRP program. The principal at that time was very interested in the Introduction to Mathematical Sciences course. Glen met at least twice with the principal and

once with math instructors at Mahanomen. The principal carefully selected the instructors as possible instructors in the course. Following the meetings the principal wrote letters of support for the project.

A new principal was hired for the 2008-2009 academic year. During an initial conversation with Glen the principal was extremely excited about the course and partnering with BSU. Glen contacted the principal later in the fall and a meeting was arranged with the entire Mahanomen math department. The course objectives and content was described in detail. Only the math department chairperson asked questions. At the end of the meeting, the principal said that he would get back to Glen. About a month later Glen contacted the principal and was told that the math department had decided to pursue other options for their students.

Glen was puzzled by this turnaround in attitude. He then questioned the previous principal who was now employed by WETCC and two other math consultants who had worked with the Mahanomen school district. All gave the same opinion. The math department chairperson made the decision not to pursue the partnership with BSU. He is a very traditional instructor and the proposed course did not fit with his ideas about mathematics. That is the reason that he was not included in the decision making process by the first principal that talked with Glen.

Mahanomen is an example of the situations that Derek and Glen have encountered with traditional instructors, be it at the high school or college level.

- **Fond du Lac Tribal and Community College**
 - In early fall of 2008 Glen traveled to Fond du Lac Tribal and Community College and met with administration to discuss the college becoming a partner. There was interest by the administration in partnering with us and an instructor, Connie Wappes, was interested in teaching the course. Then, later in the winter of 2007/2008 Glen and Derek traveled to Fond du Lac Tribal and Community College to meet with Connie and discuss the course with her. All indications from Connie and the administration were that the course would be offered in spring of 2009. During spring 2009, Derek made multiple efforts to contact Connie via email and phone and was not successful. Derek then contacted the Vice President of Academic Affairs and asked that the Vice President personally contact Connie and have her reply to Derek because she was not responding to Derek. Connie finally replied with a very terse email stating that her institution was no longer interested in partnering with us. She never gave a substantive explanation as to why.

Potential Future Partners

- **Anoka Ramsey Community College**
 - Glen has met with the Dean and the ARCC math department. A plan is being formulated to teach and evaluate the Introduction to Mathematical Sciences course at the Cambridge campus. The Dean has identified an instructor and a

possible second instructor and is working on funding for the second instructor and working within union contracts so that the course can be taught in the spring of 2010.

- **Hibbing High School**
 - Glen discussed the course on two occasions with the principal and a guidance counselor at Hibbing High School. Both liked the concept of the course. The course is not being offered this academic year because of finances and lack of time to schedule students.

- **Nashwauk High School**
 - Glen was called by the superintendent and was asked to come and present information at Nashwauk high school. Glen met with a group of four: principal, instructors and counselors, to discuss the BSU course. The reception for the course was very positive. The concerns were for an instructor and money. In the follow-up to the meeting, Glen was told that the school would not be able to offer the course in the 2009-2010 year, but they wanted to be contacted again if the project were to continue.

- **Leach Lake Tribal College**
 - This institution was one of the original project schools. Before the project started, political problems resulted in a change in campus leadership, loss of many jobs, new administration and new assignments for staff. While the math staff expressed interest in teaching the BSU course, all of the changes made it impossible for the course to be implemented. Derek and Glen plan on meeting with the new administration to see if they may have an interest in the course for their students.

- **Walker High School**
 - Walker High School is like many school districts: They are looking for mathematical alternatives for their seniors who opt out of traditional math courses; they need to address AYP concerns; they need remediation for their students. A math instructor and principal met with Glen and arrived at a plan for the school. It included the BSU math course and a concurrent enrollment course for students who qualified for the course. As the budget became finalized, Glen was called and informed that Walker would not be able to participate in the project in 2009-2010, but wanted to be kept informed for the future.

- **Bug-O-Na-Ge-Shig High School**
 - The mathematics specialist for the school learned of the BSU math course. She contacted Glen and said that she would be pursuing the course with the administration. The follow-up call indicated that the school could not participate in 2009-2010 and would like to be kept informed of future work.

**Improving Student Interest, Mathematical Skills, and Future Success
through Implementation of Novel Mathematics Bridge Course for High School
Seniors and Post-secondary Students**

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Abstract

We present a new course titled “Introduction to the Mathematical Sciences.” The course content is 1/3 algebra, 1/3 statistics, and 1/3 computer science and is taught in a laboratory environment on computers. The course pedagogy departs radically from traditional mathematics courses taught in the U.S. and makes extensive use of spreadsheet software to teach algebraic and statistical concepts. The course is currently offered in area high schools and two-year post-secondary institutions with financial support from a Blandin Foundation grant (referenced under

BFG). We will present empirical evidence that indicates students in this course learn more algebra than students in a traditional semester-long algebra course. Additionally, we present empirical evidence that students learn statistical and computer science topics in addition to algebra. We will also present the model of developing this course which depended on increasing future student success in a variety of disciplines at the post-secondary level of study.

Introduction

Schools in the United States have been unsuccessfully trying to address two major problems in mathematics education: a lack of interest in the mathematical sciences by students who become worse as they progress through the grade levels *and* students choosing to not take any mathematics classes in 11th or 12th grade or only taking mathematics classes that satisfy requirements but do not help them to be successful in post-secondary education. These two problems are exacerbated by the fact that most high school mathematics curricula in the U.S. are based on what we call the *calculus model* which is four years of curriculum culminating in an advanced placement (AP) calculus course. The measure of success for this model is the AP calculus success rate and the number of students in the high school taking AP calculus. The problem is that only approximately 10% of a given high school has students ready and capable of taking AP calculus their senior year. The rest of the students (90%) may suffer from the *calculus model* by virtue of their exclusion. Problems with the post-secondary model of mathematics education also created a strong need for developing this course. Over a five year period (2001-2006), Glen Richgels examined Bemidji State University (note that BSU is a medium size liberal arts university typical of many post-secondary institutions across the U.S.) data and discovered that approximately 78% of all graduates across all programs need one or more statistics courses to graduate, just 12% need one or more calculus courses. The *calculus model* in high school is not benefiting most students at college.

With these problems in mind, during the spring of 2007, faculty at BSU (four from mathematics: Todd Frauenholtz, Ann Hougen, Ryan Hutchinson, Glen Richgels, one from statistics: Derek Webb, and one from computer science: Marty Wolf) created and piloted a novel new course titled “Introduction to the Mathematical Sciences.”

Creation and Content of the Course

The creation of our course occurred in the winter of 2007. The course was experimentally taught at BSU in the spring of 2007 and simultaneously at Lincoln High School in Thief River Falls, Minnesota. The initial experimental offering of the course at BSU in the spring of 2007 was supported by a Minnesota State Colleges and Universities grant (referenced under IPESL).

Choosing course content was novel compared to how most mathematical sciences courses are created. Course content focused on three areas of mathematical science: algebra, basic statistics, and basic computer science. Topics for the course were chosen based on their usefulness and applicability in various fields of study outside the discipline of mathematics that students may pursue at the post-secondary level. Our overarching goal was to populate our course with topics that would contribute to student success at the post-secondary level in a wide range of programs of study.

Topic choices were based on over 20 interviews of faculty at BSU in many different programs. Examples of the diverse programs from which faculty were interviewed include: political

science, psychology, theatre, geology, physics, applied engineering and business administration. The following table contains topics included in the course.

Algebra Topics	Statistics Topics	Computer Science Topics
<p>Functions</p> <ul style="list-style-type: none"> • Represented by formula, table, graph, words <p>Graphical and Tabular Analysis</p> <ul style="list-style-type: none"> • Tables and trends • Graphs • Solving linear equations • Solving nonlinear equations • Optimization <p>Linear Functions</p> <ul style="list-style-type: none"> • The geometry of lines <ul style="list-style-type: none"> • Linear Functions • Modeling data with linear functions • Linear regression • System of equations <p>Rates of Change</p> <ul style="list-style-type: none"> • Velocity • Rates of change of other functions 	<p>Collecting and displaying data</p> <ul style="list-style-type: none"> • Types of data • Creating data files in spread sheets • Displaying data in tabular format • Bar charts, histograms, pie charts, box plots, scatter plots <p>Populations and samples</p> <p>Measures of central tendency</p> <ul style="list-style-type: none"> • Sample mean, median, and mode <p>Measures of dispersion</p> <ul style="list-style-type: none"> • Sample range, standard deviation, and inter quartile range <p>Shapes of distributions</p> <ul style="list-style-type: none"> • Skewness, symmetry, and modality <p>Correlation and association</p> <p>Introduction to linear regression</p>	<p>Syntax and Semantics</p> <p>Understanding Processes</p> <ul style="list-style-type: none"> • Describing processes used to solve specific problem • Generalizing processes to solve general problem • Converting processes into computer solutions <p>The notion of a “variable” in computing</p> <ul style="list-style-type: none"> • Variable names, references, and values <p>Formulas and expressions</p> <ul style="list-style-type: none"> • Operations, evaluation order, results, and errors <p>Making decisions</p> <ul style="list-style-type: none"> • Logical and rational operators and their values • Conditional syntax • Conditional semantics <p>Using functions</p> <ul style="list-style-type: none"> • Function syntax and semantics.

Pedagogy and Learning Environment of the Course

The pedagogy and learning environment of the mathematics and statistics portions of the course are in alignment with the National Council of Teachers of Mathematics (referenced under NCTM) recommendations. The pedagogy and learning environment consist of the following components:

- Algebra, statistics and computer science topics are all presented in the context of real-world problems taken from many disciplines. This is especially critical in the teaching of algebra topics. In our class, algebra is not taught as a set of rules and symbol manipulation skills, which is what students typically see in traditional algebra classes. Students readily see the applicability of the algebra topics they are studying.

- Algebra, statistics, and computer science topics are interwoven and not taught in isolation. Our course content is not three topics taught separately. Rather, it is three topics taught in concert making use of natural relationships. Students understand how the “mathematical sciences” is a cohesive discipline, not silos of information.
- Most algebra, statistics, and computer science topics are taught using spreadsheets. Students are much more engaged in the learning of algebra topics using spreadsheets and they also have a much better understanding of, and need for, proper order of operation and algebraic syntax.
- Students spend at least half their class time in a computer laboratory environment. This pedagogical aspect of the course depends on the available facilities the school. If possible, we prefer that the course be taught entirely in a computer laboratory environment. If not, students should spend at least 50% of classroom time in a computer laboratory.
- The classroom time commitment for this class is approximately double that of a typical three credit college algebra course. This is very important because it allows enough classroom time for students to work together on their own, in student groups, and with the instructor to complete the majority of their “homework.” That way, they know they are being successful and do not struggle in isolation at home. This ensures that the majority of work is completed and students remain engaged in learning.

Initial Implementation and Expansion

In the spring of 2007 the course was piloted at BSU and at Lincoln High School. Afterwards, adjustments and improvements were made. One adjustment was to add content to the course when offered at high schools because high schools usually have many more course contact hours than colleges or universities. The course was then offered at BSU in the fall of 2007 and at two high schools: Bemidji High School and Lincoln High School. Bemidji State University continues to offer the course once per year and has accepted the course into the university’s permanent curricular offerings.

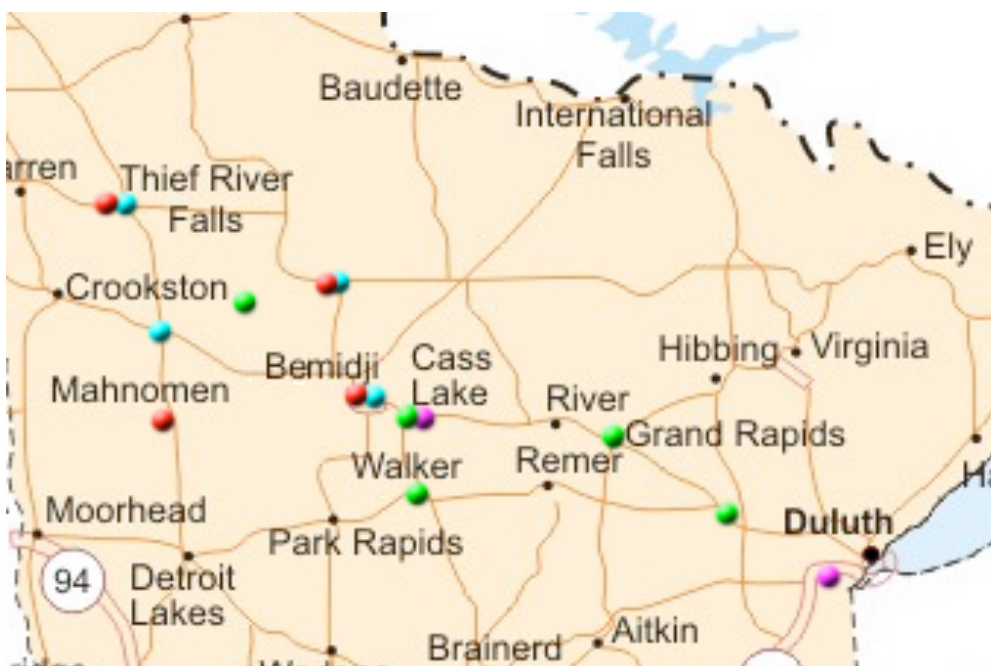
In the fall of 2008 Derek Webb and Glen Richgels were awarded a large grant from the Blandin Foundation to offer the course in multiple high schools and post-secondary institutions (referenced under BFG). The map below shows all partnering schools where the course is being offered. The institutions are color-coded in the following way:

Red: post-secondary institutions offering the course starting in the spring of 2009 – Northwest Technical College in Bemidji; Northland Community College in Thief River Falls, Red Lake Nation College in Red Lake and White Earth Tribal and Community College.

Blue: high schools offering the course starting in the spring of 2009 – Lincoln HS, Bemidji HS, Red Lake HS, and Win-E-Mac HS.

Purple: post-secondary institutions offering the course starting in the fall of 2009 – Leach Lake Tribal College and Fond du Lac Tribal and Community College.

Green: high schools offering the course starting in the fall of 2009 – Clearbrook-Gonvick H S, Grand Rapids HS, Floodwood HS, Cass Lake HS, and Walker-Hackensack-Akeley HS.



Empirical Evidence of Success

Assessment instruments were used to assess content knowledge gained during the course. A standard placement test was used to assess algebra knowledge. This placement test has been routinely used by various universities in Minnesota to place students into their initial collegiate mathematics course, including various algebra courses. The test was given at the beginning of the semester and again at the end. Statistics and computer science tests were also created and were given at the beginning and at the end of the semester. Appropriate and consistent pre-test and post-test assessment protocol was followed at all institutions every time the course was assessed.

During the spring semester of 2007, one traditional college algebra class and two liberal education mathematics classes were also studied as control groups. Students in each of these classes were given the same standard placement test (pre and post) to assess algebra knowledge gains throughout the semester. These students were not given the statistics or computer science tests because these topics were not covered in the algebra classes. In the liberal education mathematics class, statistics was only briefly discussed and computer science was not discussed at all. The pre-test and post-test results were analyzed using paired t tests. Significant increases in post-test scores vs. pre-test scores were found in the placement ($n = 14$, p -value = 0.010), statistics ($n = 17$, p -value = 0.000), and computer science ($n = 17$, 0.000) tests for our experimental course. Interestingly, no significant increase was found in the placement test for the students in the traditional college algebra class ($n = 16$, p -value = 0.308) or in the liberal education classes ($n = 9$, p -value = 0.087 and ($n = 13$, p -value = 0.151).

The course was again taught at BSU in the fall of 2007 and is being taught in the spring of 2009.

The course was piloted at Lincoln High School in the spring of 2007 and again in the spring of 2008. The course was piloted at Bemidji High School in the fall of 2007 and again in the fall of 2008. The pre-test and post-test assessment data are presented below. Note that for some institutions, the statistics and computer science (CS) pre-tests and post-tests were combined so

only one result is given. This was due to how the test results were compiled by the individual instructors at the partnering institutions.

Institution	Placement Test	Statistics Test	CS Test
BSU – fall 2007	n = 15, p = 0.218	n = 14, p = 0.013	n = 14, p = 0.000
Bemidji HS – fall 2007	n = 11, p = 0.008	n = 11, p = 0.000	
Bemidji HS – fall 2008	n = 22, p = 0.000	n = 22, p = 0.000	
Lincoln HS – spring 2007	n = 12, p = 0.263	n = 12, p = 0.000	
Lincoln HS – spring 2008	n = 22, p = 0.019	n = 22, p = 0.000	

Based on the placement exam pre-test and post-test results, the algebra knowledge gains of students in our class are not consistently statistically significant. There are two classes that had no statistically significant gain. The reason why most classes showed gains in algebra and two did not is not known and is a focus of ongoing research. There has been consistent statistical evidence of statistics and computer science knowledge gains in all the classes offered to date. This is a very positive result and a strong point of the course because, not only are the statistics and computer science topics engaging to most students, students are also increasing their content knowledge in these areas of mathematical science.

Summary

Most high school math curricula in the U.S. are based on what we call the *calculus model* which is four years of curriculum culminating in an advanced placement (AP) calculus course. We have developed a novel mathematical sciences class that we believe is a more appropriate and valuable alternative to the *calculus model* for many students in the U.S. in 11th and 12th grades. The course pedagogy was developed based on sound mathematics and statistics education research and the course content was created based on content needs in a variety of disciplines. The content is interwoven and consists of topics from algebra, statistics, and computer science. The content is largely delivered through projects and investigations that create and hold student interest and promote learning.

The course was piloted at Bemidji State University and two area high schools and by the end of 2009 will be offered in approximately 15 high schools and post-secondary institutions.

Through our research and the process of creating the course, we believe course content and pedagogy for mathematical sciences and, specifically, mathematics courses that have wide student exposure should be developed with input from many areas of study, not just from pure mathematicians. We believe this improves the pedagogy of courses and the content of courses focuses on relevant topics, not purely theoretical topics or topics for which students do not see any applicability. Too many mathematics courses in the U.S. remain unchanged through many years and are out of alignment with current mathematics education research and findings.

References

BFG – The Blandin Foundation awarded \$225,000 in support of the Northern Minnesota College Readiness Partnership Grant to the MnSCU Foundation in September, 2008. This is a regional initiative designed to improve student success and build capacity among local school districts and community colleges to sustain positive long-term results. Resources will be provided to

implement an activities-based mathematics course and to conduct research to determine best practices to better serve students of color, low-income status or who require nontraditional approaches to mathematics education.

IPESL – Initiative to Promote Excellence in Student Learning grant program through the Minnesota State Colleges and Universities awarded authors \$63,374 grant. Title of project: Building Student Success on a Foundation of Preparedness. Grant awarded in November, 2006.

NCTM – Principles and Standards for School Mathematics, published by the National Council of Teachers of Mathematics, 2000.