

AC 2008-16: DISCOVERY PROJECT – IMPROVING SEVENTH GRADE CRITICAL THINKING SKILLS

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Discovery Project – Improving Seventh Grade Critical Thinking Skills

Abstract

In April 2006 the Wyoming Department of Education awarded Laramie County School District #1 (LCSD#1) of Cheyenne, Wyoming a grant of \$230K to integrate mathematics, science, and language arts into the district's seventh grade curriculum. The overall goal of the grant was to enhance the technical and cultural literacy of the students. To achieve this goal an objective was set that all seventh grade students would improve their authentic critical thinking skills by developing inquiry skills through the use of Discovery Boxes that would integrate mathematics, science, and language arts skills. A Discovery Team was formed to implement the grant. The team consisted of professional educators. Approximately 20 team members were teachers from constituent middle schools within LCSD#1. The remaining six team members were subject matter experts including educators from the nearby university and community college and the private sector. In this paper we discuss how this program was implemented, the contents of each Discovery Box, the impact on meeting state educational standards, some of the issues involved in creating such a program and most importantly the highlight of the program – students regularly journaling their progress throughout the year. Due to the success of this grant the program has been extended to the LCSD#1 eighth grade curriculum for academic year 2007/2008. We also plan on pursuing funding to extend this to the ninth grade in the coming year.

Overview

On April 1, 2006, the Wyoming Department of Education awarded Laramie County School District #1 (LCSD#1) in Cheyenne, Wyoming, a No-Child-Left-Behind grant for \$230,699. The purpose of the grant was to develop a Mathematics and Science Partnership, referred to as “The Discovery Project.” The focus was to be on seventh grade LCSD#1 students at the three Cheyenne Junior High Schools: Carey, Johnson and McCormick. Carey and Johnson were designated two “high need” schools after failing to meet annual proficiency for three prior years to the grant.

A “Discovery Team” was formed at the start of the grant, consisting of twenty LCSD#1 teachers and paraprofessionals along with six professors from the University of Wyoming and Laramie County Community College. The grant was led by a Facilitator and overseen by an evaluator. Administrative support was provided by LCSD#1 Administration.

The goal of the Discovery Team was to create project-based activities focused on three seventh grade science topics: chemistry, physics and biology. The Team succeeded in developing four highly innovative and well documented Discovery Boxes: Stretching and Shrinking, Exploration, Crime Scene Investigation and Genetics, which were truly

interdisciplinary efforts involving science, mathematics and language art standards. By “Discovery Box,” we are implying a metaphorical container for a collection of teacher training materials, lesson plans, assessment tools and physical materials which can be used to incorporate a theme-focused, hands-on, active learning activity within existing classrooms. The purpose of each box was to increase the students’ understanding and interest in science and mathematics, and to engage various stake holders in education: students, teachers, parents and higher education partners. Also, the fundamental premise of the Discovery Box approach was that contents would be aligned with standards, teachers would be trained in the content area, and the included activities would be multidisciplinary in nature. A detailed description of each Discovery Box contents is provided at Appendix 1.

Journaling was used as an innovative and important assessment instrument in determining the project’s outcome [1]. The boxes were developed during the summer and fall of 2006 and were deployed to the classrooms at each the three schools in early 2007 for classroom evaluation and further teacher training. Due to the limited time of use in an operational setting, the decision was made to replenish the boxes for continued use and evaluation during the 2007/2008 LCSD#1 school year.

The Discovery Project resulted in all LCSD#1 seventh grade students in Carey JHS and Johnson JHS being involved, as well as most seventh grade students at McCormick JHS. It also engaged teachers, parents, and collaborative partners to varying degrees.

The Discovery Project accomplished a number of teacher training initiatives over the course of the grant. Overall, the Discovery Grant involved most of the 899 seventh grade students in the LCSD#1 school district, and it resulted in 1684 teacher training hours with primary focus on the target audience – seventh grade science and mathematics teachers. In this paper we detail the development of this program, results, and plans for the future.

Problem Based Learning is not a new idea. Considerable related work has been accomplished in this area. The interested reader is referred to the Project-Based Learning (PBL) website hosted by the George Lucas Educational Foundation [2].

Background

Description of the Project. This project was designed to create science/mathematics “Discovery Boxes” that were developed by teachers, students, parents and partners from Institutes of Higher Education (IHE). The intent was to provide an interdisciplinary focus to learning, focused on three science themes: physics, chemistry and biology. Discovery Box participants were required to include the content standards for science, mathematics and language arts into the Discover Box projects, and establish bridges promoting interdisciplinary connections to learning. State-of-the-art technologies were sought to provide students with a project-based curriculum, centered on authentic critical thinking skills. Students created writing journals, following the six traits of learning (ideas, organization, voice, word choice, sentence fluency, and conventions, and

presentation [3]), as the main assessment tool over the course of the grant. They were required to organize and conceptualize the science and related mathematics themes employed in the Discovery Boxes whereby displaying more complete in-depth understanding. A 4-point rubric system was used to evaluate their performance.

At the start of this grant, LCSD#1 in Cheyenne, Wyoming, had two high need junior high schools (JHSs), Carey and Johnson, comprising the major emphasis of the grant. The third district school, McCormick JHS, was also included in the project to ensure all seventh grade students had an equal opportunity in experiencing the activities of the grant. Early in the grant life we met with junior high student representatives to have them voice their desires on classroom education. Time and again the students indicated they desired projects and activities to learn concepts while seeing how these concepts could be used and applied in the world.

To better enable achieving the grant goals and objectives, participants came from various segments of the learning community. All seventh grade mathematics and science teachers were invited to participate in the project, along with certified language arts teachers who were asked to serve as writing and oration coaches. Faculty and staff from the University of Wyoming (UW), the Science and Mathematics Teaching Center (SMTC) and the Colleges of Education, Engineering, Arts and Sciences were invited, as were faculty from nearby Laramie County Community College (LCCC) Department of Mathematics and Social Sciences Division-Department of Education. All district seventh grade assistant principals were asked to participate, as were parents of the seventh grade students. While a number of people assisted at various times in the project, the formal development and implementation team, The Discovery Team, was composed of twenty (20) LCSD#1 professionals and paraprofessionals along with six (6) IHE partners. (Reference Acknowledgment section for list of participants.)

Team Building. Early in the project the grant facilitator scheduled some team building events. The events helped participants to get acquainted with one another but to also establish a common mission, goals, objectives, and a list of common team beliefs. Our mission, goals, objectives, and beliefs are provided below:

Mission: To integrate mathematics, science and language arts in order to enhance the technical and cultural literacy of our students.

Goals and Objectives: All seventh grade students will improve their *authentic critical thinking skills* 1) through the use of Discovery Boxes, 2) by integrating mathematics, science and language arts, and 3) by developing the inquiry skills of resilient learners.

All teachers, parents and collaborating partners will develop an understanding of the importance of working together for a common vision of science, mathematics and language arts excellence within each professional learning community (PLC).

Student growth and understanding gleaned from the Discovery Boxes may be measured with classroom, district and state assessments, allowing for student involvement by selecting from a menu of assessment products, providing input on rubrics and exemplars, analyzing themselves as learners (demonstrating meta-cognition), and constructing an individual portfolio/learning record that demonstrates math, science and language arts proficiency.

Beliefs: We, the Discovery Team, believe...

- Our Nation is at risk in maintaining our leadership superiority in technology.
- Science, mathematics and language arts proficiency are fundamentally linked.
- Learning should be fun.
- There is an essential partnership between teachers, parents, students and the community and that each entity benefits by working together and building trust through communication.
- We need to prepare our students to compete successfully in a new world economy.
- In the power of education to secure our Nation's future.
- In the empowerment of students to control their destinies.
- In intellectual mastery of exploration and discovery.
- In the strength and talent of our Nation's youth
- In building new bridges of communications and breaking systems that don't advance our mission.
- In building bonds between mathematics, the sciences and language arts.
- In enhancing educator's teaching abilities and not adding to their existing workload.
- In establishing and maintaining open communication for all team activities and participants.
- In creating possibilities for success for all youth and promoting post-secondary education and life-learning goals.
- In developing short term and long term accountability measurements of the team activities.
- Taking chances and risks.
- Not being afraid to fail and learn from failure.

Establishing Data-Driven Needs. The two high need schools, Carey JHS and Johnson JHS, have been in this status for the past three years prior to the grant. In effect, each school had not made adequate yearly progress (AYP), especially in mathematics. Moreover, both schools had shown little, if any, gains in seventh grade mathematics assessment, as identified by the Terra Nova testing program [4].

This grant was tasked to create science/mathematics "Discovery Boxes", aligned to district and state science and math content standards in an attempt to address this problem. The Discover Team was tasked to developed chemistry, physics and biology-based hands-on projects as a direct result of student input.

Over the course of the grant year, students engaging in the Discovery Projects, learned how to graph and build mathematical formulas in their investigations; they used the box

resources to confront and challenge their misconceptions about science and the related mathematics; and most importantly they learned how to communicate better through technical writing and orating. The unique attribute of the Discover Boxes was to entice student curiosity, whereby creating a hunger for exploration through the use of “state-of-art” technologies and innovative activities.

Examples of the incorporation of content standards through a collaboration between science and mathematics with the related language arts component would be “Science as Inquiry” (Science) combined with “Data Analysis” (Math) and “Writing” (Language Arts). Students utilized “Number Operations and Concepts” (Math) with graphical communication of data, “Concepts and Processes” (Science). They also were required to verbalize their findings through classroom presentations and public forums, “Speaking and Listening” (Language Arts). A detailed description of each Discovery Box contents is provided at Appendix 1.

A collaborative team approach was used to determine the contents of each box. Team members then assisted in helping to find sources on where to purchase box contents. All team members shared in the responsibility to develop the teaching materials and lesson plans for the boxes. Team members then taught participating teachers how to incorporate the boxes into their existing lessons.

Establishment of Project Goals and Measurable Objectives. The Discovery Team set both student and participant goals with accompanying measurable objectives.

Student Goals: All seventh grade students were asked to develop a conceptual understanding of mathematics, science and language arts through hands-on, minds-on activities as a primary goal of the grant.

- **Objective 1:** All seventh grade students will learn authentic critical thinking skills through the use of Discovery Box activities that connect science, mathematics and the language arts.
- **Objective 2:** All seventh grade students will take an active roll in the development and implementation of assessment tools such as rubrics with the guidance of instructors.
- **Objective 3:** All seventh grade students will demonstrate, through their investigations, the desire to become scientific thus enhancing their self-esteem and confidence when sharing their results with others.

Measurable Outcomes. Student journaling and oral assessments during the project were measured in order to demonstrate an understanding of science and mathematics disciplines. In addition, the school(s) meeting AYP goals in the 2006/2007 school year was also used as a related accomplishment factor.

Participant Goals. All participants, the teachers, parents and collaborative partners, were tasked to develop an understanding of the importance of working together for a common vision of science and mathematics excellence within each learning community.

- **Objective 1:** Participants will define what “critical thinking” is and how it should be implemented in each learning environment.
- **Objective 2:** Participants will understand the importance of working with students to develop a workable, fair and consistent assessment rubric. This will require delegating authority downward to the students who will be required to work within the rubric.
- **Objective 3:** Participants will embrace the concept of change thus working toward scientific, mathematic and technical literacy, providing leadership and role models for young scientists and citizens. This can be accomplished by encouraging all participants to develop their own line of investigation centered on a problem-solving theme of their interest.
- **Objective 4:** Professional Teaching Standards Board (PTSB) credit will be available to teachers for all trainings offered.

Measurable Outcomes. Participants were asked to develop a daily self-assessment that combined all points of view working within the “Facilitative Leadership” model.

Methods

This project was divided into two phases: Phase 1 – Design and Development, and Phase 2 - Implementation and Evaluation. The initial intent was to complete Phase 1 early in the start of the 2006/2007 LCSD#1 school year. Phase 2 was to follow for the remainder of the school year with the Discovery Boxes being evaluated and used in an operational classroom setting. These milestones were modified, however, as the size and scope of the project became more fully realized after the initial summer institute. A brief description of Phase 1 and 2 follow with a listing of chronological events in each phase.

Phase 1 – Design and Development, April 2006 – January 2007:

A summer institute was held in May and June 2006. A second training session was held in August 2006. The first training session was used to identify the modules that were to be developed. The August training session was used to finalize construction activities.

Chronological events in Phase 1:

- The grant was approved and funded by the Wyoming Department of Education (WDE) on April 25, 2006, as a Mathematics and Science Partnership, LEA Number: 1101000, Project ID: 06T2B10002, CFDA#: 84.366B, for the amount of \$230,966. The award period was for 4/1/06 through 9/1/07.
- **A Discovery Team Assembled, Facilitator and Evaluator selected:** Twenty LCSD#1 science, math, language arts and paraprofessionals comprised the permanent part of the Discovery Team. Six faculty members, five from UW and one from Laramie County Community College (LCCC), formed the permanent pool of Resource Advisors. Also engaged were the District Math and Science Coordinators.

The Discovery Project Facilitator was competitively chosen at the start of the grant, and the Evaluator was identified later through a competitive process.

- **Working Box Teams established:** A team was formed for each of the four designated Discovery Box Topics: Exploration, Stretching and Shrinking, Crime Scene Investigation (CSI) and Genetics.
- **Discovery Boxes Developed:** Three identical Discovery Boxes, one for each participating school, were developed for each Discovery Box topic. A template was designed and used for each Box to ensure some measure of standardization. It included identification of the project, a list of resources, and specific documentation requirements. Each team worked independently with the goal to complete all of the box requirements by the end of the first semester, at the latest.
- **Discovery Box Specifics:** Each Discovery Box team was composed of a science, math and language arts representative, who was tasked to ensure relevant district standards were applied to each box project or activity. Resource Advisors from IHE partners were placed on each development team to provide an additional level guidance and quality control.
 - **Exploration:** This box involved experiments with building and flying hot air balloons, exploring submarines, conducting bio-measurements of body temperature, blood oxygen content, and blood pressure. Included in the box were related items designed to stir student curiosity. These included movies, books and selected reading materials.
 - **Stretch & Shrink:** This box was primarily focused on mathematics. Projects involved building and sailing boats, orienteering, use of SmartBoards™ in teaching mathematics, and experimenting with weights and measurements.
 - **Crime Scene Investigation:** This box made use of each of the three required science subjects by integrating them into innovative projects investigating various crimes. Use was made of stereo-microscopes, pupil cameras for classroom display, and a spectrophotometer. Also included were selected fiction and non-fiction readings.
 - **Genetics:** This box made innovative use of the latest in DNA investigative technology involving a thermocycler and electrophoresis bath. Students were able to deconstruct their own DNA in the classroom and examine the world of DNA analysis in real time. Also included was a strong language arts component with selected fiction and non-fiction readings involving genetics.
- **Other Sub-Teams:** Two additional sub-teams were formed to further define the project: language arts and assessment.

- A UW Computer Science Professor developed a special Discovery Project website -- http://wwweng.uwyo.edu/hewlett-wiki/index.php/Main_Page
- Efforts started in late August 2006 to begin to publicize the Discovery Project to District officials and other interested parties. The Discovery Team made a PowerPoint™ presentation on August 25 to all District seventh grade teachers at Central High. The implementation plan and Discovery box concepts were discussed and were generally well received.
- The Discovery Project, as part of the Assessment and Evaluation needs addressed in the Grant Application, delivered 1503 journals to each of the participating schools (Carey - 780, McCormick – 348, Johnson – 375). A Journal Vehicle was developed and promoted by participating junior high school science and language arts teachers to be used in each of the participating schools. Journaling was viewed as important measurement tool for the Discovery Project. It was used to assess the effectiveness of teacher training, and to measure the relevancy of the Discovery Boxes.
- A newspaper article announcing the Discovery Team Project appeared in the Cheyenne Tribune-Eagle on September 15, 2006.
- On the evening on October 9, members of the Discovery Team, including the UW resource advisors, met at Carey JHS with Content Specialists from the Wyoming State Department of Education (WDE). The purpose of the meeting was to display the Discovery Boxes and discuss the planned assessment activities, especially as they relate to the state assessment requirements.
- A brochure announcing the Discovery Project was distributed to all seventh graders and designated district staff and teachers in early November.
- The grant facilitator, W.T Parker, and grant originator, Paul Crips, attended the Student Math Association at UW on December 6, 2006, to make a presentation about the Discovery Project to graduating math teachers.
- The Wyoming Tribune-Eagle provided an article on December 14, highlighting the December teacher training.
- **Discovery Boxes Delivered:** Starting as early as November 2006 and continuing through January 2007, four Discovery Boxes were delivered to each participating school.

Phase 2 – Implementation and Evaluation, January 2007 - August 2007:

This phase of the project saw the gradual phase-in of completed Discovery Boxes into the classroom, accompanied by special teacher training. During this phase, journaling and other assessments were accomplished to measure the impact and effectiveness of the Discovery Boxes in an operational setting.

Chronological events in Phase 2:

- **Activities in the Participating Schools:**
 - **Johnson JHS** – Participation – 450 Students and ten teachers.
 - **Carey JHS** – Seven teachers from Carey Junior High participated in the development of Discovery Box projects. These individuals represented the math, science, and language arts curriculum, as well as special education considerations for the lessons. As a result of the collaboration, 437 seventh grade students were engaged in Discovery Box activities.
 - **McCormick JHS** – Extensive Journaling was accomplished at McCormick JHS.
- **Discovery Newsletter Issued:** The first edition of the Discovery Newsletter was issued in late February. Printed copies were distributed to specific staff at each of the LCSD#1 JHSs and to selected people at District Administration and the Wyoming Department of Education.
- **In March a Parent’s Night** was held at Carey JHS to demonstrate the Discovery Boxes. Discussion centered on use of the boxes over the remaining portion of the school year at Carey.

Results

The following summarizes the significant claims and recommendations from the grant. It should be noted that a second year of the Discovery Grant was authorized in April 2007, whereby enabling the project to proceed into the eighth grade, but further enabling the seventh grade boxes to be evaluated for one more year as long as the resources remain viable. No second year funds are to be used for the continuation of first year activities.

- **Claim:** The initial organization of the project took more time than was originally planned. The amount of time needed to invent, assemble and document the Discovery Boxes was underestimated, especially given the fact that the team participants were teachers who had previous commitments during the summer break period. Regardless of this limitation, however, and to the credit of the team participants, the quality of the finished seventh grade boxes was first-rate. In no way should this delay in development reflect negatively on the development team, and while the classroom evaluation time was limited to the end of the 2007 spring semester, sufficient resources remained in the seventh grade boxes to enable another year of evaluation during the 2007-2008 LCSD#1 school year.
 - **Recommendation:** As long as the box resources exist, the seventh grade boxes should continued to be evaluated in the classroom one more year (2007-2008).

- **Claim:** The project represented a significant cost effective and interdisciplinary effort that successfully engaged district professionals and paraprofessionals, along with experienced IHE partners. Over the course of the project synergy grew among the team members, with the resulting Discovery Boxes reflected a level of passion and commitment that was second to none. The Discovery Boxes employed state-of-art technology and resulted in high quality documentation which reflected credit both on the participants and on the grant, in general.
 - **Recommendation:** Similar teams should be considered and strongly supported in future activities. The post-secondary partners were able to add a degree of expertise and guidance that could not have been easily obtained elsewhere. More efforts should be made to enable participation between IHE partners and secondary school teachers as time and resources will allow.

- **Claim:** The Discovery Project was truly an interdisciplinary effort. At every juncture, whether it was in organizing of the Discovery teams for box development, or in accomplishing various grant activities, efforts were routinely made by the team members to involve science, mathematics, and language arts perspectives whenever possible.
 - **Recommendation:** Future efforts need to create and promote more interdisciplinary activities. Science, mathematics and language arts are fundamentally linked, and these pathways need to be continually exploited for the benefit of secondary education. Furthermore, other disciplines, e.g. Technical Education, would benefit, and need to be involved.

- **Claim:** Initial subjective findings indicate that journaling in both science and mathematics classes appear to be an extremely productive activity toward improving learning and comprehension in these essential disciplines. The entire seventh grade science and mathematics student population was involved to some degree with journaling due to the Discovery grant.
 - **Recommendation:** The success observed with the use of student journals during the Discovery Project strongly supports further examination by the school administrators to consider formalizing journaling for all students in mathematics and science secondary classrooms.
 - **Recommendation:** Language Arts professionals should be used as essential resources throughout the journaling process to assist the science and math teachers in the learning process. Moreover, language arts teachers should be encouraged to offer training in technical writing and proper journaling procedures to science and math teachers.

- **Claim:** Identifying innovative, state-of-art technologies were the key to creating the Discovery activities. More important, however, was providing timely, focused, hands-on teacher training. The need for teacher training was directly related to the

complexity of the technology being deployed. The Discovery Project demonstrated that state-of-art technologies can be integrated into today's busy classroom with minimal impact, but this technology carries an added burden of requiring well thought out teacher training.

- **Recommendation:** The seventh grade Discovery Box projects should be integrated and supported by the standard LCSD#1 seventh grade curriculum, to include replacement and replenishment of supplies. The Discovery Box activities provide innovative tools that can be easily augmented into the existing seventh grade curriculum.
- **Claim:** Effort was made during the grant to ensure all seventh grade students were knowledgeable about the existence of the Discovery Box resources and related activities; however most of the emphasis for obvious reasons fell on math and science students.
 - **Recommendation:** The ideas promoted by the Discovery Project, namely providing hands-on project-based learning, should become commonplace in secondary science and mathematics classes. Students learn best if their passions are challenged and their bodies, as well as their minds, are engaged in the learning process.
- **Claim:** Publicity was adequate over the course of the first year, but more was needed. Moreover, the Discovery Project, while well intended, needed to be viewed more favorably and supported more overtly by District and participating school administration. Too much time was required to educate or to re-inform that could have otherwise been used for more productive activities. More effort was needed to prepare the participating school's faculty and administration prior to the Discovery Project. This was needed to overcome any reluctance or misunderstanding.
 - **Recommendation:** In addition to promoting the second Discovery Grant funded for the eighth grade in LCSD#1, the seventh grade grant should also be promoted again for the 2007-2008 school year as long as box resources exist and are viable for classroom use. Moreover, to have a better chance for success, the Discovery Boxes for both seventh and eighth grade, should be overtly promoted by District and school Administration to avoid the problems that were noted in the first year of the grant.
 - **Recommendation:** Maximum use should be made of the formalized LCSD#1 publications and other news sources to promote the Discovery Project and increase District-wide understanding.
- **Claim:** More effort is needed to engage parents in the Discovery Project. Students and teachers were the primary focus of the first year of the grant.

- **Recommendation:** The 2007-2008 school year should begin to expand its focus to include parents more. While teacher training will remain the primary focus, more activities designed to engage students and parents together should be provided.
- **Claim:** At the end of the 2006-2007 school year, the two high need schools, Carey and Johnson JHSs, met their AYP objectives. Clearly, many factors went into this outcome, but the strong presence of the Discovery Project in both schools could not be ruled out as having a contribution to the outcome.
 - **Recommendation:** The Discovery Project should be given increased attention for the 2007-2008 school year, as it can be viewed as an added benefit; not a liability.

Discussion

Aside from the claims provided in the previous section we have other positive indicators toward the success of the program: 1) positive feedback from a Project-based Learning Forum conducted in December 2007, 2) follow-on funding from an external source, and 3) follow on funding for extending the program to the eighth grade curriculum. A brief description of each item follows.

Project-based Learning Forum, Cheyenne Kiwanis Community Center. This event was scheduled as the culmination of implementing the program in the LSCD#1 seventh grade schools in Cheyenne, Wyoming. We also used this event to provide a status report on implementation efforts to the eighth grade curriculum. The overall purpose of the event was to have learners come together to share their visions of the perfect school. The following desired outcomes were established for the event:

By the end of the meeting, attendees will have ...

- a better understanding of the Discovery Grant outcomes
- a better understanding of National Center for Atmospheric Research (NCAR) and its future in Cheyenne
- an opportunity to share with one another our project-based learning experiences and perspectives
- a commitment to further explore and develop community support for the perfect school
- exercised our collaboration, partnership, and commitment as learners for learners

The evening began with a review of the seventh and eighth grade Discovery Project boxes. Students demonstrated to the visitors what they had learned through the project. A keynote address was the provided by the Director of NCAR who highlighted the interrelationship of science and mathematics with other disciplines.

The Director of Wyoming Public Radio then led a panel discussion of distinguished educators, scientists, and legislators whose goal was to describe the perfect school. The panel consisted of the following dignitaries:

- Wyoming’s Superintendent of Public Instruction, Dr. Jim McBride
- Wyoming State Senator Bob Fecht
- Wyoming Representative Amy Edmonds
- Wyoming Representative Dan Zwonitzer
- Dr. Sheila Martin, Director Wyoming State Scholars Initiative
- Dr. Derrell Hammon, President of Laramie County Community College
- Dr. Mark A. Northam, Director School of Energy Resources - UW
- Dr. Robert Ettema, Dean of College of Engineering and Applied Science – UW
- Dr. Bryan Shader, Department Head, Department of Mathematics – UW
- Ted Adams, LCSD #1 Superintendent
- Jan Stalcup, LCSD #1 Board President
- Dr. Tim Killeen, NCAR Director

Some of the items discussed by the panel included:

1. Everyone in education talks about problem solving or critical thinking skills. In your mind what does problem solving or critical thinking really mean?
2. Equipment and technology are a big part of public education. What role do you think technology plays in the middle school learning environment?
3. One of the discovery projects mottos was the “WOW” factor. How can the wow factor be incorporated into the everyday educational experience of a learner?
4. This has been a big year for teacher training with this project. What ideas does this group have toward bringing the best researchers to contribute to the overall content knowledge and retooling the educational landscape to meet the learners’ needs?
5. The discovery project has changed our direction and emphasis many times over the last two years; still we have learned to trust certain practices to enhance learning. In a corporate or higher education environment, what leadership practices do you employ to promote best practices which reinforce the concept of reform?
6. If we are funded for a third year for this project, making the transition from the middle grades to high school, what suggestions do you have for us regarding balance, endurance, ownership and resilience of the team and our goal of reforming the way we educate?
7. Parents are very important partners in the public education system. How can we as a group insure that their input is valued and acted upon? How can we best use our community resources to unify our intent for excellence in learning?
8. Are there other models for integrated education or best practices that we should be aware of and practice?
9. If you could describe the ideally educated young person, ready for your classroom, or the workplace, what do you think that person should be?
10. How do we as educators instill a passion for learning that goes beyond the classroom?

External funding

Our goal has always been to maintain the continued funding of this project via external grants. In December 2007 we received our first external grant from the Western State Learning Corporation, New Futures, of Cheyenne, Wyoming. The WSLC New Futures grant provided \$2500 to purchase science/mathematics journals for junior high school students.

From recent PAWS test scores, writing in the content is an area that has been identified in need of intervention. The Discovery Box project has identified this as a priority area. Federal Chapter IIB Grants do not provide funds for student consumables. This grant will provide journals to students to continue their writing process as it relates to science and related mathematics investigations. This will provide writing journals to students who are currently working with the “Discovery Box” project, a Federal Chapter IIB grant. As in the first year of the grant, journal reviews take place regularly through the PLC process. This is one of the identified mutual assessments used by math/science and language arts teachers working in the Chapter IIB grant.

Second Year Funding

We were notified in Spring 2007 that this project has been funded for another year. It will be an extension of the four original Discovery Boxes bridging the current 7th grade students with the 8th grade earth-space science curriculum. Additional Discovery Boxes will be developed around the science, mathematics, and language arts 8th grade standards. Through the initial grant, a control group of 7th grade students was created. This group will be evaluated through an established assessment process that will be an integral part of the next set of activity boxes. Continuation of this initial control group is critical for data collection as to the effectiveness of the project.

As with the previous 7th grade boxes, these new boxes will be aligned with the 8th grade curriculum and standards for the District. Specific box topics will center on: Atmospheric sciences, geology, space science, the water cycle and oceanography. Mathematics standards will include geometry, numbers, measurement, algebra, and data collection. Likewise, the project will address the language arts standards of writing, reading, and verbal presentation. The following boxes are currently in development:

- Earth’s Waters – explore salt and freshwater environments
- Meteorology – high resolution computer access to numerical weather modes
- Astronomy – telescopes, binoculars, star party, Software Bisque-Seeker, JMI, space ship, sun spotters
- Geology – seismology, shaking tables, earthquakes
- Measurement Box – will contain basic measurement tools required by science in math students in the classroom

Also critical to this follow-on project will be the continued development of technical writing skills as outlined by our Institutes of Higher Education (IHE) partners. This Discovery Box Project will include technical writing, providing students with a means of

communicating an understanding of algebraic expressions as they relate to science data and subsequent interpretation of the statewide Professional Assessments for Wyoming Students (PAWS) assessment criteria. The team has been in close coordination with the Wyoming Department of Education (WDE) PAWS facilitators through emails and onsite demonstrations.

Summary

In April 2006 the Wyoming Department of Education awarded Laramie County School District #1 (LCSD#1) of Cheyenne, Wyoming funded a grant of \$230K to integrate mathematics, science, and language arts into the district's seventh grade curriculum. The overall goal of the grant was to enhance the technical and cultural literacy of the students. In this paper we discussed how the program was implemented, the contents of each Discovery Box, the impact on meeting state educational standards, some of the issues involved in creating such a program and most importantly the highlight of the program – students regularly journaling their progress throughout the year.

Conclusions

Due to the success of this grant the program has been extended to the LCSD#1 eighth grade curriculum for academic year 2007/2008. We also plan on pursuing funding to extend this to the ninth grade in the coming year. We would be happy to share material developed for this project as well as other information for schools wanting to implement a similar program.

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Portions of this paper are an abbreviated version of the first year final project report. Interested readers may contact the authors for the entire text of the report. The development of this project was truly a team effort. The authors would like to recognize the following educational professionals who made this project a reality.

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Appendix 1

Discovery Year 1 Box Contents

1. **Stretch and Shrink Box** – How Science Relies on Mathematics to Navigate:
 - a. Projects and Activities:
 - i. The Boat Lab
 - ii. Scale Drawing
 - iii. Pool Table Experiments – Paper Pool
 - iv. The Package Design Contest
 - v. The Carnival Game
 - vi. Exploring Geometry
 - vii. Orienteering
 - viii. Compass Theory and Operation
 - ix. Having Fun with Sundials.
 - b. Box Contents:
 - i. Magnetic Compass (30)
 - ii. Drawing Compass (30)
 - iii. Protractor (30)
 - iv. Stop Watches (30)
 - v. Ohas Scale (1)
 - vi. Mass Weight Set (3)
 - vii. Smart Boards and projectors for use in math classes.

2. **Exploration** – Density, buoyancy and temperature measurements are studied by exploring the human body and exploring through travel.
 - a. Projects and Activities:
 - i. Building and launching hot air balloons.
 - ii. Making Cartesian divers.
 - iii. Blood oxygen measurement
 - iv. Blood pressure and body temperature measurement
 - b. Box Contents:
 - i. Blood pressure cuffs (12)
 - ii. Forehead Thermometers (12)
 - iii. Blood Oxygen Measurements (12)
 - iv. Hot air balloon construction kits
 - v. Cartesian Diver kits.
 - vi. Altitude finder and distance measurement trundle wheel
 - vii. The box includes books and DVDs.

3. **Crime Scene Investigation** – students will gain knowledge of density and how it is used to help solve crimes through a hands-on activity of finding the densities of various samples of glass with the use of lab equipments. Students will incorporate their science, math, and language arts skills in order to successfully solve the crime and communicate their investigations.
 - a. Projects and Activities:
 - i. A Lesson on Density – The Hit and Run
 - ii. A Lesson on Density – The Parking Lot Collision
 - iii. A Lesson on Spectroscopy – The Assault at the Flower Shop
 - iv. A Lesson on Fiber Analysis – The Red Coat Homicide
 - v. A Lesson on Blood Typing – Blood Typing Pre-Lab Investigation
 - vi. A Lesson on Blood Typing – The Neighborhood Burglaries
 - vii. A Lesson on Hair Analysis – The Catnapping
 - b. Box Contents:
 - i. Spectrophotometer (1)
 - ii. Student – grade stereo microscopes (12)
 - iii. Teacher microscope and pupil camera (1)
 - iv. Blood typing materials
 - v. Relevant reading material

4. **Genetics** – students will describe reproduction as a characteristic of all living systems, which is essential to the continuation of the species, and identify and interpret traits, patterns of inheritance, and the interaction between genetics and the environment. Students will meet state standards in the areas of math, science, reading, and writing throughout this unit.
 - a. Projects and Activities:
 - i. Meet Cathy – watch a video about genetic counselor Cathy Burson and then explore your genetic features.
 - ii. Alike and Different – Discover what’s different and the same about you and your group.
 - iii. Mating Game: Meet mom and pop Smiley Face genomes and mate some genes to make a new baby.
 - iv. What Sort? Meet a cheek cell, say hello to chromosomes, and complete a human chromosome chart.
 - v. Inside DNA – Build a model gene using gumdrops and licorice and learn some secrets of DNA.
 - vi. Pulling It All Together – Create a story about a scientist who is a genetic counselor.
 - b. Box Contents:
 - i. Thermal Cycler (1)
 - ii. Electrophoresis power supply and gel baths (4)
 - iii. Micropipettes and well combs.

- iv. Gel Tray
- v. Genetic Counselor resource
- vi. Bitter Tasting Ability experiments.
- vii. Various selected readings.