Objective

- To integrate the benefits of discovery based learning with a cognitive structure that would allow for accountability and tracking.
- To integrate problem based learning into traditional teaching to allow for the benefits of both to co-exist.
- To propose improvements to the Middle School Mathematics through Applications Project curriculum and design that addresses the reservations teachers have due to the unstructured, free nature of the program.

Assumptions

- The current software application adequately meets the need for an authentic, discovery-based learning experience.
- The software application successfully serves knowledge database for the needs of the student.
- The software interface is easy to use and does not require a high learning curve.

The Guiding Principles

- Teachers express a need for more structure and guidance than the program currently provides.
- Teachers need evidence that progress is being made and the required mathematical objectives are being met.
- Teachers, parents, and administrators require reassurance that learning is occurring, rather than just “playing with computers”.
- Students learn through different teaching styles. A purely problem-based approach may make it difficult for students who are better suited to traditional, instructor-led lecturing. A combination of classroom approaches will benefit the greatest number of students.

The Redesigned Program

Rather than having a completely free-form, discovery-based mathematics learning experience where the students happen upon mathematical concepts as they solve problems, our team advocates a more structured approach that will appeal to the goal-oriented teacher and credulous parent. This goal will be achieved through the adoption of changes to the curriculum structure and changes to the pedagogical approach.

A Redesigned Curriculum

First, we propose that the project researchers compose a list of the mathematical topics that are encompassed in the problems and applications of the project. These mathematical topics will include elements taken from the state standards necessary for this particular grade level. Along with these topics, examples of problem based learning scenarios will be included for the teachers to utilize.
This will serve as a roadmap for the teacher to follow throughout the semester and will give them evidence that they can point to when parents and administrators inquire as to the class’s progress.

The teachers will then design a curriculum that would teach the Math concepts in two approaches: in a 1) traditional method, where the Math concepts are presented and interacted with abstractly and in a 2) situative method where these concepts are translated into problem-based situations and tasks. Hence, the teachers are aware of the cognitive structure underlying the real-world problems and will be able to document and prove the rationale behind the assigned student tasks.

**Curriculum Phases**

**Day 1**
Day 1 introduces the student to the idea of problem based learning. We do this by presenting the students with the Antarctic scenario. We describe that they will be constructing a dwelling in Antarctica and that throughout the course of the term, they will be gaining the tools necessary to complete this task and actually completing the “virtual” construction of the dwelling.

We will also break them up in individual groups of five students each. Once in these groups, each student will be asked to briefly write about how they would begin to think about the task of building this dwelling. After this writing, the students would be given time to interact within their group, and begin to form the team dynamics that will become important throughout the process.

**Objectives**
- To peak student interest in the mathematical syllabus but presenting a glimpse of the real-world application of their skills.
- To reframe mathematical concepts in a situative context
- To motivate students to learn the Math skills by presenting them a task they need to complete.
- To make problem solving the driving force of learning new Math concepts.

**Instruction**
- Brief overview of the Real-World Project and software tools.
- Break the class into groups to brainstorm ideas of how to solve the problem given their existing knowledge and mental model.

**Week 1 through Week 6:**

**Mathematical Toolkit**
This phase of the curriculum addresses the cognitive framework that the teachers expressed was lacking. For the next six weeks, the students will be presented traditional, instructor-led mathematical instruction. In these 6 weeks, students interact in the ‘abstract’ world of Math learning the concepts on the “symbolic level.” Teaching in this
phase would be primarily behaviorist and cognitive and focus on providing the students with a mathematical toolkit to attack the tasks ahead.

The one situative component in this phase is empowering the students by having them create the assessment tools to quiz each other on the material learned. The students are encouraged to frame the cognitive material into word or symbolic problems. By allowing the students to act as “teachers” and create their own quizzes and problems, we soften the edge off traditional evaluation methods and provide an alternative way of assessing the cognitive models in the students’ head. Apart from the answers to the questions, the teachers can also evaluate the questions created by the students.

Objectives

- To provide the student a cognitive mental model for the mathematical concepts needed for the task
- To integrate some situative component into traditional Math learning by allowing students to create their own assessment tools
- To allow students to envision problems in which the Math skills can be applied.
- To find an alternative way of evaluating the students’ mental cognitive model (by evaluating their questions along with their answers.)
- To introduce the students to mathematical software programs that that will ensure the comprehension of mathematical rules and principles as well as the practice of math drills.

Instruction

- Traditional based Math teaching
- Mathematical software programs

Week 7 –11

The next five weeks will be devoted to problem-based learning. A problem shall be defined and given to the students that will encompass all of the mathematical skills that they were taught in the previous six week session. Working in groups of five, the students will need to demonstrate the mastery of these skills in order to solve the problem and present the solution to the class in an end-of-semester presentation. During the problem-based learning period, students will keep detailed journals on their thought process including the hypotheses they draw, the methods they attempt, the solutions they arrive at, and the dead-ends they reach. This work will assist the students in organizing their thoughts and will be invaluable in evaluation at the end of the program.

During this phase, the teacher will be meeting with groups and the students individually. She will ultimately be monitoring the progress of the group and individual students. As needed, further explanations and models of the mat concepts may be taught individually, in groups or to the entire class.
The students will create a final project that will require them to utilize a computer aided design and analysis program as well as paper based mathematical calculations. Throughout this process, the students will be evaluated on their progress and understanding of the concepts as well as their group interactions.

**Objectives**
- To contextualize the cognitive material previously assimilated
- To provide a learning environment that allows the students to initiate application of previously learnt material.
- To interest the students in completing the task and seeing that the math skills are necessary to complete it.
- To improve higher level reasoning skills
- To bring the idea of math instruction into a similar situative perspective as other learning.

**Instruction**
- Mentoring and assisting in the group process
- Individualized scaffolding based on level of experience and cognition.
- Acknowledgment and use of teachable moments

**Week 12**
The final week of the program will be spent in presentation and evaluation. Students will present their solutions to the problem to the class and explain the mathematical skills that were used in each step of the process. The student’s documentation and journals will be made available to the entire class. As a final evaluation exercise, the students will be responsible for reviewing each other’s presentations and documentation and performing an evaluation, providing comments and feedback.

**Conclusion**
This combination of problem based learning and traditional cognitive modeling will address the concerns that teachers and students expressed from the first iteration of this teaching program. By shoring up skills and then contextualizing the concepts into a real world experience, the students will not only learn math as the great tool that it is, but also maintain interest in continuing to learn and discover it’s many benefits.