**Action Research Plan: Problem-Based Learning in Math at Turning Point School**

**I. Topic/Rationale**

At Turning Point School, the school I teach at, if students are unable to perform well on standardized tests, they are limited in the choices they have for middle and/or high school. Some of the best students are not good test takers. While I nor the administrators I work with believe in teaching to the test, we do not want to see these capable students be limited by their school prospects.

Some students at my school are excellent math students in the classroom, but do not demonstrate this knowledge on standardized tests. The math program we use, Everyday Math, focuses on the process of learning and discovering the patterns in mathematics. However, when students take standardized tests somehow these critical thinking skills are not transferring. I want to study the effectiveness of the math program to reach the needs of these students and determine what supplemental activities or modifications are needed in order to ensure these students succeed in the class as well as on standardized tests.

One limitation of the proposal may be the short amount of time to determine the effectiveness of the math program and how to best serve our students who are not transferring their math skills to standardized tests. I see this project as the beginning steps to improving our math program and to meeting these students’ needs. Another limitation is every student tends to learn differently and finding supplemental activities or modifications to help all these students may not work. They may have different needs. Last, looking at students on multiple grades/levels is beneficial in being able to analyze the program, but it may be limiting in that the scope is large.
II. Literature Summary of Selected Articles

When people commonly think of math they think of rote memorization and algorithms. However, math is about recognizing relationships among numbers, not memorizing or completing drills (Silverman, 2002). When students are taught an algorithm without providing them understanding, it leaves the students to resort to memorization of a procedure without comprehending the reasoning behind the algorithm (Brown & Quinn, 2007). If students only understand the step-by-step procedure, they cannot understand the meaning and patterns behind the math concept. Teachers need to facilitate learning by having students share their reasoning, bringing to light any misconceptions they may have. Then the teachers and their peers are able to guide and coach the students effectively.

Students who have math deficits demonstrate deficiencies in self-help skills and organization (Rourke, 1993). They often demonstrate difficulty with memory, poor calculation skills, number reversals, and conceptual and/or procedural processes (Bryant, Hartman, & Kim, 2003; Bryant, Bryant, & Hammill, 2000). Some of the students at my school exhibit these difficulties. Their struggles include working through math word problems, understanding more abstract concepts such as fractions, and memorizing and answering math facts quickly. These difficulties must be addressed to make math accessible to them. They need fundamental skills of how to approach and see patterns in math to ensure success and transfer of knowledge. Problem-based learning provides such an opportunity.

Problem-based learning (PBL) is a student-centered approach in which the teacher acts as a facilitator. This strategy is most commonly used in math and science. PBL
involves students working with a group to collaborate, sort their knowledge, and present a solution with explanations (Cerezo, 2004). A powerful form of collaborative work involves group members depending on each other to create, challenge, and process new ideas (Francisco & Maher, 2005). Conversations about the realistic problem or case allow students to share their understandings and misconceptions of the concept taught. They sort through a problem using manipulatives or materials they choose and then are required to adapt their ideas according to new input received. Ultimately they must present their work with a clear explanation of how they arrived at their solution.

Research has shown that by interacting with their peers, students are able to identify their misconceptions and improve their cognitive development. Listening to one another’s arguments caused students to return to previous misconceptions and challenged arguments, which led to stronger arguments (Maher & Mueller, 2009). The process is emphasized, not the outcome, helping students become more self-reliant and independent (Cerezo, 2004). From this they can develop confidence and take ownership of their learning. Metacognitive strategies allow students to think about what they are doing and learning by planning how to approach a task, monitoring understanding, analyzing a problem, and assessing progress toward completing a task (Little, 2009). Problem-based learning provides students with these valuable skills that are needed to assess their progress and understanding. This in turn motivates them to learn by developing self-regulation and self-efficacy.

Problem-based learning improves student academic success and instills intrinsic motivation. Students felt problem-based learning cases interested them because they enjoy group work, completing a challenging task, and it benefited their learning process
Students are motivated to learn and it enables them to monitor their own progress. Math activities should incorporate intellectual and social stimulation to engage students in learning (Ricks, 2010). Both components are included in problem-based learning where students are acting as mathematicians and are developing understanding by determining a solution collaboratively. Schunk (1996) found students are more likely to believe they are able to learn if their peers can learn. Students tend to see teachers as masters of knowledge, but if one of their peers is able to learn a concept, then they believe they can do it as well. Problem-based learning provides this environment for students in which they can observe and hear how their peers move toward a better understanding of a concept.

Research shows that there is a positive relationship between engagement and academic achievement (Finn, 1993; Greenwood, 1991; Newman et al., 1992). Students need to be engaged in order to succeed academically. Without a purpose or understanding of how to apply math to their lives students lose interest because math becomes memorizing without meaning. Mathematical reasoning is a crucial component. Recognizing patterns and understanding the complexities of the algorithms helps students grasp math concepts. The students identified for this action research have deficits in math on the CTP IV standardized test. Participating in problem-based learning should improve math conceptual understanding through communicating and collaborating with their peers and increase their motivation through active engagement in small group interactions.
III. Student Achievement Issue and Propose Leadership Project

The major problem is there are students who perform satisfactorily in our Everyday Math program, but perform poorly on standardized tests. Despite the fact that the program develops critical thinking skills, some students are unable to transfer their math knowledge on standardized tests.

Two questions will guide my action research:
• Short term: In what ways will problem-based learning affect cognitive development and motivation in math?
• Long term: How will problem-based learning impact student learning and perceptions of math over time?

Hypothesis:
• By using problem-based learning, the targeted math students who perform poorly on standardized tests will experience improved cognitive development and increased motivation in math.

Increased motivation will be determined by the following measures:
• Homework completion charts
• Teacher observations

Increased cognitive development will be determined by the following measures:
• Open Response and Math test
• Self-Assessment by students
• Teacher observations in group work, independent work, games, discussions, and class participation
• CTP IV test results (will need to be analyzed in the years to come)

Problem-based learning in this action research is defined as a process of learning in which a group of math students are presented with a case problem and are asked to collaborate and apply reasoning to come to a solution. Case problems are presented in steps called scenarios. These scenarios present new information or clues to the case problem. Teachers who are participating in this action research will present at least two case problems per month to their students.
Opportunities for this project include guidance for students' development in math, differentiated instruction, support to enrich student learning, and creating a common mathematical language to be used among students. A primary, level 2, level 5, and middle school teacher from my school will work with me to develop a plan. My plan is, with these teachers, we will read, watch, observe, and analyze how problem-based learning impacts our students understanding of math concepts and motivation to learn. After which I will share our findings, model best practices, and have teachers develop these ideas in professional development. In addition, parents should be educated about the strategies and techniques implemented and given ideas on what they can do to further enrich their child's learning at home. Parents should also receive additional information on how to lower student anxiety before a test. The teachers will involve students by analyzing and assessing their understanding of concepts and developing plans to motivate and empower their learning.

This proposed plan should positively impact student achievement among students not performing well on the math section of the standardized test, CTP IV. While the results may not be evident initially, with time and continued collaboration these students should improve their math skills. By reading, sharing, modeling, and evaluating ideas and practices, we will be able to develop more effective lesson plans to meet these students' needs and ensure these students are able to take the skills they learn in Everyday Math and apply them on standardized tests.

IV. Leadership Project Plan

The action research plan will be a study analyzing the effectiveness of implementing problem-based learning in math at Turning Point School. Turning Point
School is an independent school with grades spanning from primary to Level 8. It is a small school of about 370 students. Most of the students come from a middle or upper income family. To study the effectiveness of problem-based learning at Turning Point School, a range of research methods will be utilized to collect both qualitative and quantitative data.

This data includes:
- Records of homework completion
- Teacher observations
- Open Response and Math test
- Self-Assessment by students
- CTP IV test results (will need to be analyzed in the years to come)

The action research plan will be conducted at Turning Point School in which five classes will partake in the study. There will be a primary, two Level 2 (one of which is my class), a Level 5, and a Level 7 class using problem-based learning to determine its effectiveness. The teachers involved will need to be trained on how to teach problem-based learning before it can be initiated in the classroom. The training will focus on teaching them about the role of the teacher and the students, as well as how to create a case with scenarios that will challenge students’ thinking. The teachers involved will be trained in December 2010 and mid-January 2011. After which, the teachers and I will meet once a month in February – May to discuss the problems encountered, best practices, and findings from implementing problem-based learning. In addition, I will be meeting with the Assistant Head of School on an ongoing basis to discuss our progress.

All students in the class specified will participate in problem-based learning, but data will be collected on the students targeted. The 10 – 20 students targeted are students who received a 1 or 2 on the CTP IV, or for younger students, students who are perceived
by their teachers to be poor test takers. The rationale for selecting these students is they have a history of performing satisfactory in class, but not on the CTP IV test. As a result, these students demonstrate low motivation to work through a problem, have poor understanding of more complex systems such as fractions, and/or lack fluency of math facts. With problem-based learning these students should experience more interest, understanding, and confidence in math.

My role in this process will be to train, plan, and organize the implementation of problem-based learning. I will train the teachers involved and monitor their understanding of how to implement problem-based learning by providing feedback from observations of them facilitating PBL and the cases they create. I will communicate the plans to the teachers involved and the Assistant Head of School. The teachers participating will communicate the plan to their students and parents involved. I will have the participating teacher administer and collect the surveys and assessments. They will be responsible for presenting their class’s data to me and I will in turn analyze the relevant data. Student confidentiality will be protected in that data collected will not focus on one student, but on the group of students being studied.

As a Level 2 teacher at Turning Point School I teach some of the students involved in this study. Since this is my research at my school, the objectivity of this study could be affected because I am greatly interested and invested in the students’ success in math. To avoid this outcome, I plan to work with the other teachers to collect data. I will confer with the participating teachers and the Assistant Head of School to guarantee an unbiased evaluation of problem-based learning is realized.
V. Strategy for Formative Feedback & Assessing Effectiveness of the Leadership Project

Both qualitative and quantitative data will be collected to accurately measure the effectiveness of problem-based learning. Evidence will be collected on students who received a 1 or 2 on the math section of the CTP IV as well as on students who are not old enough to take the CTP IV, but demonstrate poor test taking skills in math. Data will initially be collected to determine student interest through surveys and homework completion charts. This baseline data will be compared with similar data collected during and after implementation of problem-based learning. The data collected will be analyzed and looked at for patterns of growth in interest and cognitive development. Some data will be graphed and other data will be examined for common trends in observations and surveys.

To ensure truth-value validity I plan to triangulate data through the use of student and parent surveys, teacher observations, homework completion charts, open response and math assessments, student self-assessments, and CTP IV test results. Data will be collected throughout the study and the participating teachers will help inform the data's accuracy. Throughout the study I will debrief with the participating teachers to increase dialogic and neutrality validity. In addition, I will present the results of the study to the Assistant Head of School on an ongoing basis to increase catalytic validity and make adjustments as need to the action research plan.
VI. Relationship to CPSELS and Fieldwork

This action research plan will be completed as one of the six projects for my fieldwork plan during the 2010 – 2011 school year. This study is on promoting equitable educational access to all students by focusing on a group of students who are marginalized. This plan is created based on the administration’s interest to analyze how we can improve our math curriculum to meet all students’ needs. I will utilize and develop many leadership skills and practices.

During this action research plan I will work on the following California Professional Standards for Educational Leaders (CPSELS):

- Standard 1.1 – Develop a Shared Vision
- Standard 1.2 – Plan and Implement Activities Around the Vision
- Standard 2.2 – Guide the Instructional Program
- Standard 2.3 – Guide Professional Growth of Staff
- Standard 2.4 – Create and Utilize Accountability Systems
- Standard 3.3 – Manage the School as a Learning-Support System
- Standard 3.4 – Maintain Legal Integrity
- Standard 4.1 – Collaborate to Incorporate the Perspective of Families and Community Members
- Standard 5.1 – Maintain Ethical Standards of Professionalism
- Standard 5.2 – Guide Sound Courses of Action Using Pertinent, State-of-the-Arts Methods
- Standard 5.3 – Model Reflective Practice and Continuous Growth
- Standard 5.4 – Sustain Professional Commitment and Effort
- Standard 6.2 – Interact with Stakeholders
- Standard 6.3 – Incorporate Input from the Public

Through these standards I will develop my practice as a leader. I will enable teachers to implement problem-based learning in math by modeling and teaching the strategy. In addition, I will facilitate collaboration and communication among the teachers participating in the study when we meet monthly. Through collecting data, I will evaluate and reassess how the action research plan is progressing. This action research plan will further equity by focusing on making math accessible to all learners.
and will work toward closing the achievement gap on the CTP IV standardized test.

Problem-based learning provides students an opportunity to work as mathematicians do, developing their understanding of the problem presented and collaborating with others to make sense of the case. By incorporating problem-based learning into our math curriculum, the students enrich their conceptual understanding and deepen their motivation to become lifelong learners of math.

VII. Appendix

- Records of homework completion will be collected from the sticker charts teachers use in their classrooms.

- Teacher observations will be collected by hand.

- Open Response and Math tests are given at the end of each Everyday Math unit. An example is provided.

- The self-assessment form is provided by the Everyday Math program. An example is provided.

- CTP IV test results will be collected.

- An example of a problem-based problem is provided.
Train Boxes

In Flatland, trains make several stops a day. All the trains in Flatland have an engine. The engine picks up new boxes at each stop.

When the engine begins its day, it looks like this. It is 1 box long and it has 2 wheels.

At each stop, the train gets 3 more boxes and 6 more wheels. At the first stop, the train looks like this. It is 4 boxes long and it has 8 wheels.

1. Draw a picture of the Flatland train after 3 stops.

2. One train has 32 wheels. How many stops do you think it made?

Explain or show how you figured it out.
Part A

1. Add and write the turnaround.
   \[5 + 3 = \underline{8}\]  Turnaround \underline{8}

2. Write the fact family for 2, 11, and 9.
   \[2 + 9 = 11\] \[9 + 2 = 11\] \[11 - 2 = 9\] \[11 - 9 = 2\]

3. Add.
   a. \[6 + 1 = \underline{7}\]
   b. \[4 + 4 = \underline{8}\]
   c. \[0 + 9 = \underline{9}\]

4. Subtract.
   a. \[7 - 0 = \underline{7}\]
   b. \[\underline{11} - \underline{1} = 11 - 1\]
   c. \[7 - 4 = \underline{3}\]

5. Fill in the empty frames.

   Rule: \[+5\]

   \[
   \begin{array}{cccccc}
   20 & & & & 40 & \\
   \end{array}
   \]
Part B

6. Circle the names for 14.
   Cross out names that do not belong.

7. Find the rule and complete the table.

8. Add.
   \[ \begin{align*}
   \text{a. } 9 & \quad +6 \\
   \text{b. } 5 & \quad +6 
   \end{align*} \]

   \[ \begin{align*}
   \text{a. } 9 & \quad -5 \\
   \text{b. } 13 & \quad -8 
   \end{align*} \]
10. Put an X on the number in the tens place.

154        726

11. Show $1.00 two ways using \(\circ \) \(\Delta \) \(\natural\).

12. How Many Books?

Who read the most books? ________________________________
Who read the fewest books? ________________________________
How many books were read all together? ________________
Check one box for each skill.

<table>
<thead>
<tr>
<th>Skills</th>
<th>I can do this by myself. I can explain how to do this.</th>
<th>I can do this by myself.</th>
<th>I can do this with help.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Add coins.</td>
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<tr>
<td>2. Solve 2-digit addition.</td>
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<tr>
<td>3. Find change.</td>
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<tr>
<td>4. Read the temperature.</td>
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<tr>
<td>5. Find patterns on the number grid.</td>
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<tr>
<td>6. Recognize odd and even numbers.</td>
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</tbody>
</table>
Appendix A

Patty O’ Design*
A Problem-Based Learning Case

Scenario 1

You are employed as a landscape architect. You work on the design team and your group receives this letter:

Smith-Jones Landscaping Design, Inc.
1575 East Forsyth Boulevard

Dear Sir or Madam:

We are interested in adding a patio to our house. We have decided that we would like to use as much as possible of the 20-foot by 20-foot area directly behind our house for a patio shaped in a nontraditional design. We would like for you to submit two designs with specifications so that we can choose the one we like better. Please be aware that we want to use at least 340 square feet of the available area for the patio.

We have read your brochure and enclosed the $200 design fee. We appreciate your guaranteed delivery date of one week.

Sincerely,

Ian and Patty O’Brien

What would be helpful to know before you begin your design? How will this information help you? What will you do next?
Patty O' Design®
A Problem-Based Learning Case

Scenario 2

Smith-Jones Landscaping Design, Inc.
1575 East Forsyth Boulevard

Dear Sir or Madam:

This letter is to inform you of the modifications we would like to add to our original instructions in regard to your company's designing a patio for us.

Looking back on our vacation photos of our trip out west last year, we were reminded of some creative yet beautiful patios we saw. We would like for you to make sure that your designs for our patio have the following features:

- We would like two areas for flowers on the sides of the patio that are adjacent to the house. Please use only about 70% of patio footage for the flower areas; then on each side extending from the house out to the yard, use about 80%.
- A small area in the center of the patio for flowers (this area should be in the same geometric shape as the patio design and about 10% of the entire patio size).

Again, thank you very much for your cooperation and understanding in this matter. We eagerly await your designs.

Sincerely yours,
Ian and Patty O'Brien

VIII. References and Bibliography

References


