Problem-Based Learning in the Classroom

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The purpose of my research project was to evaluate the effectiveness of Problem-Based Learning (PBL) in a fourth grade classroom of students accustomed to traditional teacher-led instruction. My interest in this topic stemmed from my desire to move away from conventional teacher and student roles within the classroom and observe how my students would operate in a self-directed learning environment on problems that require critical thinking, explanation through writing and an end result that is not solely focused on the right answer. Prior to implementing my intervention, I felt dissatisfied with the format of my math class and sought a way to help all of my students master newly acquired math skills without the use of rote memorization and drill. Additionally, I wanted to challenge my students to demonstrate their mathematical understanding in an innovative way.

My intervention took place over the course of three days during which students were asked to solve and explain problems grounded in real-world contexts that promoted critical thinking through the use of multiplication and division. The time students were given to work was largely independent, though small-group and later whole-group discussion followed. Throughout the work time, I circulated the classroom probing my students' thinking through questions that elicited their rationale for solving the problems in the manner chosen. Students were not only required to show the mathematical steps they took to solve, but were also asked to explain in writing why these steps were taken. Throughout this process, I made a strong effort to avoid offering any indication of right or wrong, but tried to maintain my role as a facilitator and asked questions only to challenge the learner's thinking and reveal the level of understanding that may not be present on the page. To culminate the mini-project,

students were required to demonstrate their knowledge attained in the first two days to create a summary of their work and a proposal plan to the “school board” which included a written report of their solution. The specific problems utilized for this intervention are included below.

Day One:
You are planning a field trip to a history museum for three fourth grade classes, each containing 28 students. The admission cost for students is $1.50. All three teachers plus an additional five chaperones from each class will also be on the field trip. The cost for adults is $2.00. In addition to admission cost, you will need transportation. Each bus can seat 40 people at a cost of $165/bus. How much money will you need to budget to make this trip possible?

Day Two:
There is currently a special at another history museum in town that you may want to consider due to its larger size containing far more exhibits. This museum charges a flat rate of $175 for three classes to enter which includes admission cost for all who enter. The museum will also provide the buses, which can seat 30 people at a cost of $130/bus. Explain which museum you will choose and why.

Day Three:
The school board has asked that you create a detailed budget plan with your choice of museum that reveals both options. How will you explain to them that your choice of museum makes sense considering both cost and overall experience for the students?

This project required several essential math skills to successfully solve for cost but also offered students the opportunity to defend their decision as to which museum makes more sense in terms of cost and educational benefit. Running the math class in this way was far outside of my usual method for teaching math, which has been very

reliant on teacher-led instruction followed by practice on several similar problems. While some students are successful with that structure, many others have struggled. Additionally, I think it's important that students are introduced to real-world problems such as these that help them understand how to apply the skills they have learned in a meaningful way. Finally, I chose to utilize writing as a major component of this project as Common Core math emphasizes the importance of understanding how to solve complex problems while also explaining the thought process in writing.

Review of literature:

In an attempt to learn more about how to successfully implement PBL into my own classroom, I utilized educational journals to assist with my research and to help in assessing its effectiveness. One helpful resource included an article from a journal published by the American Educational Research Association entitled *Effects of Problem-Based Learning: A Meta-Analysis from the Angle of Assessment* (Gijbels et al., 2005), in which authors define what PBL looks like in the classroom and how to incorporate authentic assessments in order to monitor growth. Though the primary focus of this research examines PBL's effectiveness in higher education, I learned how to maintain my role as facilitator throughout the intervention and to avoid my inclination to return to the conventional instruction to which I'm accustomed. This literature also assisted me in designing high-quality assessments that would require students "transfer the knowledge and skills acquired previously and to demonstrate understanding of the influence of contextual factors on problem analysis as well as on problem solving" (Birenbaum & Dochy, 1996). Finally, the article included research conducted by Albanese and Mitchell (1993) with two groups of medical students; one group received

traditional instruction while the other group engaged with problem-based learning. They discovered that although students found PBL to be more “enjoyable and nurturing” than conventional lecture, the examination results proved that there was little difference in performance, with some students even citing a lack of preparedness in basic skills. If given the opportunity to implement PBL long-term, this discrepancy, or lack thereof, in test performance would be something I would like to explore at the elementary level.

Another article titled *Problem based learning: As authentic as it gets* (Stepien & Gallagher, 1993) also examines the role of teachers in a problem-based learning classroom and the importance of selecting high quality questions that demand a certain level of critical thinking and mathematical skill. The authors argue that utilizing this approach helps students develop critical thinking skills which allow them to identify what information is known, what is still needed to solve the problem, how to gather the necessary information and how to collaborate and evaluate the collected data. While I was hoping to observe my students’ ability to decipher information with ease, it was incredibly perplexing for many of them and would require far more time and repetition to ensure success among the majority of my students. Because I recognized this new approach for solving problems would present challenges, I guided my students’ thinking by including space to write the math problems in addition to asking them to explain why they took the steps they did. As the authors of this article suggest, ample time for staff development is crucial to the success of problem-based learning which may explain my lack of confidence and uncertainty on its effectiveness in my classroom, as I have not been provided the resources to help me understand how to properly implement this practice.

Finally, I came upon a book titled *How to Use Problem-based Learning in the Classroom* by Robert Delisle. This book clearly explains what PBL is, why it's useful in the classroom, and includes guidelines for teachers to ensure they accomplish their goals for the lessons. Additionally, suggestions are provided for how to get students actively participating in the process and ways in which the teacher can keep the conversation and critical thinking moving along. Most helpful for my lessons were the recommendations and checklists included, which assisted me in creating ill-structured problems and determining student success as they worked independently. I learned how to become an evaluator and take a backstage role, allowing my students to work on the problem without the constant direction they are accustomed to receiving. Also, as a result of this literature, I realized the direct correlation between real-world problems, and offering choice in how to solve them, to student motivation and active engagement. The inclusion of a cooperative, small-group learning component for my intervention also stemmed from this research as it stressed the importance of children learning to work together and building teamwork skills while balancing multiple perspectives.

Modes of inquiry:

In order to assess the success of problem-based learning in my own classroom, I chose a mini-project that culminated our most recent unit on multiplication and division. Students were thrust into the role of teachers and asked to prepare a budget for two field trips before deciding which one they would choose. They were provided complex real-world problems written by me that involved a great deal of critical thinking and an application of newly acquired multiplication and division skills. To end each class, I invited students to show the steps they took to solve on the board and we discussed the

math as a class. This presented a welcomed opportunity for students to agree or disagree with what was being delivered, and offered the students who were asked to share and seemed confused, time to reflect and revise their thinking.

On the first day of the lesson, students received a worksheet with all the information about the first history museum for which they were asked to configure the cost of taking three fourth grade classes. I explained to my students that I would circulate the room as they worked, only to ask questions that could help them further their thinking. They were given ten minutes to work independently followed by twenty minutes to work within small groups. The budget could be computed using any preferred method and solved in any order; the only requirement was to explain why they took the steps they did to solve. Adding this component to my lessons was the most enlightening aspect for me, as it revealed a lack of understanding among many of my students regarding which particular mathematical operation made sense for individual parts of the problem as well as what the information gathered at each step of the process meant for the overall scope of the problem. Considering this was the first time students had been left to complete their work without direct assistance, it was a challenge and some of my students really struggled with the change in structure while others thrived.

The second day of the project delivered new information about a different history museum that students were asked to consider. Again, they had to figure out the cost and how it compared to the first museum, but were also asked to weigh the benefit of a more expensive museum that offered additional exhibits. I wanted to allow students some choice during this process and reduce the emphasis on only making accurate

computations. This was included as part of my approach after reading the book *How to Use Problem-based Learning in the Classroom* (Delisle, 1997) which, in part, focused on the increased motivation and engagement that results when students have some flexibility in how they reach the outcome.

The third day of the lesson asked students to break down the costs for museum admission and buses and include a written proposal to the "school board" explaining their selection. If students opted for the more expensive trip, they were required to provide a rationale for how the additional cost would support an educational experience that the other museum could not offer. I chose to include this as part of the lesson as a way to wrap up the activity, allow some imagination and creativity, and to have their math knowledge revealed through writing.

Originally, before planning this specific intervention, I had hoped to pursue a lesson in which groups worked together to create an itinerary for a "family" vacation given a certain amount of money and with the help of the internet to research real costs. Flights, meals and miscellaneous expenses were all to be included in the budget. After giving this more thought, however, I decided it was an overly ambitious goal and one that went too far outside the narrow parameters my students are accustomed to. Additionally, a much greater amount of time would have been necessary to ensure the same skills were mastered as were with this lesson.

Results:

As I stated prior, the problem-based learning approach is entirely outside of what my students usually encounter in math class, which created varying degrees of anxiety and difficulty felt by some of my students. To gather data for this intervention, I relied on

student work, which was collected daily to assess accuracy, and anecdotal notes taken during independent and small-group work time and following whole-class discussion. Many issues arose during this process that made acquiring results indicative of overall effectiveness difficult for me. First, some students simply shut down as a result of not understanding how to begin solving the problem. Even with some prodding from me, which helped get them started, the next step became another obstacle that prevented a few individuals from moving forward. Secondly, I was unable to observe the way all students worked within their groups, which inevitably led to sharing of answers rather than discussing how and why it made sense to solve the steps using a particular method. Lastly, it became apparent that some students did not understand how to multiply a whole number and a decimal or when it was appropriate to use multiplication as opposed to division, subtraction, and addition. As a result, I made time for mini lessons along the way in order to review skills necessary to solve the larger problem. I also attempted to steer my students in the right direction by asking them to think about what the result to each problem would reveal. Questions included, *Are you seeking an amount of money by multiplying those numbers or a certain number of people? If you know the total number of people, how will you figure out the number of buses needed given the fact that you're told how many can fit on each bus?* My hope in doing this project was that students would further their own thinking with this type of self-guided questioning, but for many, this was not the case.

Despite all of the unexpected issues, I am confident that conducting the class in this manner was beneficial for some of my students, and if given more time and practice, almost all would thrive in this type of learning environment. I was pleased with

the way it challenged and excited some of my stronger math students who tend to get bored with the slow and monotonous pace of occasional math classes. Also gratifying was the rich conversation and respectful debate that occurred within some of the groups and led to a greater understanding of the task. Finally, some of my students really impressed with their ability to articulate their thinking in words and offer a detailed rationale as to why they selected their chosen museum.

Conclusions and Limitations:

Through this inquiry, I learned that utilizing problem-based learning is an effective tool that helps students understand real-world situations through math, teaches children how to work cooperatively in a group to reach a common goal, and sparks a motivation in students that I don't often observe with traditional instruction. Due to the short duration of this particular project, it is difficult to determine whether or not this approach had a positive impact on all students or if it could improve their overall understanding of math. In order to gain more insight on this, I would like to further explore how teaching math in this manner directly impacts test results, since that is currently the primary emphasis of our education system. To make this possible, I would be required to split my class into two groups with one group receiving traditional instruction and the other engaging in problem-based learning. Both pre and post-assessments would be utilized to provide numerical data and it would occur over the course of an entire unit. I would be curious to discover whether or not the results would be similar to those revealed in *Effects of Problem-Based Learning: A Meta-Analysis from the Angle of Assessment* (Gijbels et al., 2005), in which students who learned through problem-based learning tended to struggle more with the basic concepts tested on exams despite their ability to

conquer more abstract material. I would also be interested in researching how problem-based learning influences students of varying academic levels. This issue presents a unique challenge in that it would be difficult to determine the effect of the approach without teaching the same material to the same group of students using two different methods.

Next steps:

If I had the opportunity to plan a follow-up inquiry, I would like to utilize problem-based learning within the Response to Intervention (RTI) structure and work with the children requiring the most intervention at the tier three level. Considering the whole purpose of the RTI model is to maintain a goal of instructing all students in the least restrictive environment, I believe examining the effects of this approach on the most at-risk children in a small-group setting would be highly beneficial. My question would be to study whether or not PBL would improve those students' ability to understand mathematical concepts, thus decreasing the amount of time spent outside of the general education classroom. It was through the inquiry recently conducted in my own class that this question became relevant to my teaching. I observed some of my students who customarily perform poorly in math, most noticeably on tests, exceled at and enjoyed this different approach. If given the opportunity to engage with math in a more positive and meaningful way for a period of time, perhaps student performance and overall understanding of math would improve. I look forward to utilizing the knowledge gained through this inquiry to put my topic of interest into practice in the future.

References

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