



Rocket Car: Better Learning through PBL

Eric Flewelling, Raytheon Missile Systems, 6th-8th Science & Sustainability

College of Education, University of Arizona



TEACHERS IN INDUSTRY

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Introduction

I want more of my students to be self-directed and to remain engaged when the problems get complex. I want them learning science deeply by DOING science. I want to help them by focusing on timely feedback and supporting them individually and in small groups. Research indicates that well-designed PBL brings about these changes.

Investigation

I examined how the implementation of a PBL unit impacted my students' acquisition of content knowledge as well as their engagement.

I created and implemented a 10-week PBL physics unit. Students were presented with an engineering design challenge: build the fastest "rocket-powered" vehicle out of recycle bin materials and one balloon for propulsion. It was an iterative process whereby they largely taught themselves the physics concepts necessary for improving their vehicle. Their science notebook became a lab book, where they documented ideas as they learned them, formulas for reference, data tables and graphs to analyze their designs, etc. I led them in small activities and lessons only at first to model the design process and then a couple more times as particular conceptual bumps revealed themselves. The unit concluded with a race!

Project Based Learning (PBL) is a teaching method in which students gain both skills and knowledge by working for an extended period of time to investigate and respond to an open-ended and complex question, problem, or challenge.

Why PBL?

PBL is student-centered at a time when students are increasingly less likely to respond to teacher-centric lecture-based education. There is so much positive research that Norman and Schmidt (1992) felt comfortable claiming that PBL's positive effect on engagement is "conclusive." They also show that PBL units lead to long-term memory gains. Sternberg (2007) found that when creative and practical measures are included in assessment (as they are in my PBL), ethnic group differences in achievement are decreased.

Connection to Industry

While working at Raytheon, I noticed that almost everything was done in groups with regular checkpoints. They had to help each other solve problems and presented their progress to others. We focused on optimization within constraints (a Raytheon initiative from last summer: "Good, Fast AND Cheap"), and our primary activity was designing rockets. I wanted to integrate this type of work into my classroom.

Data Collection and Analysis

Data collected for evidence of content knowledge:

- District's eighth grade physics multiple-choice benchmark, administered before and after the PBL unit.
- I compared my students with students of the other eighth grade physics teacher, who uses a more traditional notes and quiz approach.**

Data collected for evidence of engagement:

- My observations of student engagement and reflections on these observations.

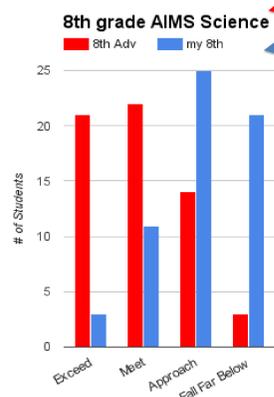
My Students

My four science classes, 114 students, were involved in this study, two classes of 8th grade science and two of 7th grade advanced science. Eighty percent of students were Hispanic and similar numbers qualified for free or reduced lunch. There were roughly equal numbers of males and females.

Advanced -v- Non-Advanced:

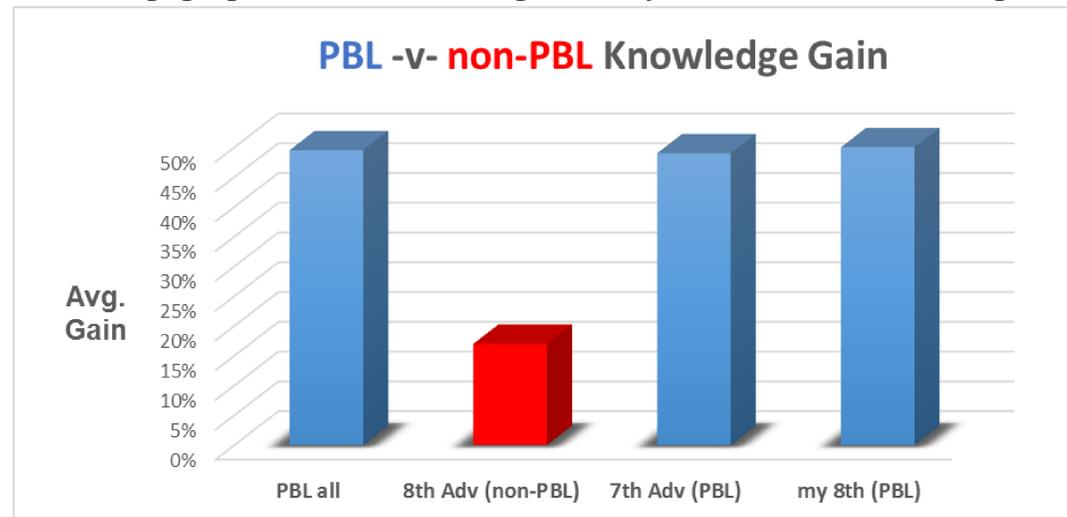
AIMS scores taken after my study. These scores mostly reflect previous acquisition of science literacy & testing skills.

Basically: "Good" -v- "Bad" at school

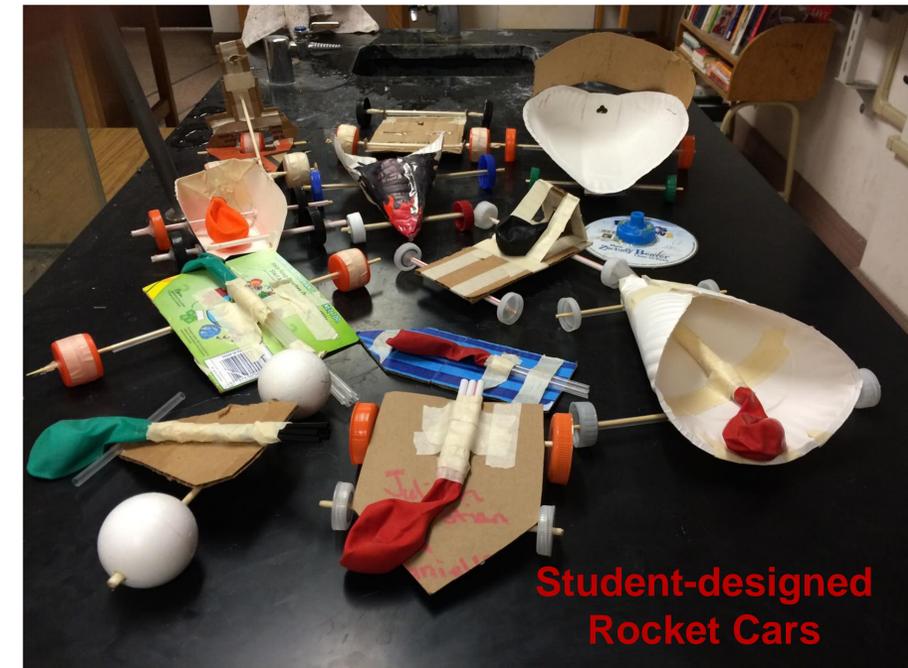


Finding 1

Engaging students in PBL significantly increased their learning of science content



- My students showed over 3x more growth on district benchmark
- My Non-Advanced students (see chart in bottom left corner) gained as much or more than Advanced students
- I want to emphasize: **This happened despite the fact I "taught" less than ever.** They taught themselves!



Student-designed Rocket Cars

Finding 2

The use of PBL drastically increased student engagement

After decades of teaching, I finally observed nearly too-good-to-be-true levels of mental & physical engagement. Students were not just on task but debating, thinking and building together.

Some examples: One group celebrating an understanding of how air resistance affects their design, another collaborating on two different designs, groups regularly getting to work before the bell even rings, incidence of heads down and delayed starts fell to almost nothing, cheers when I would tell them we would build tomorrow, groups designing their own experiments, lots of great questions from "low" kids, last minute creative desperation ideas like popping the balloon to throw their vehicle across the finish line first, hearing students say things like "Yaaaay... hammers" or "I learned to hammer!"

And a story: One day, finishing off an hour of Rocket Car redesign, everyone hard at work- drawing & debating new ideas and their physics-based reasoning, the bell rings. And I hear something I've never heard before... the whole class, in unison, yells out in excited frustration "AWWWWWW!"

References

- Norman, G. R., & Schmidt, H. G. (1992). The psychological basis of problem-based learning: a review of the evidence. *Academic medicine*, 67(9), 557-65.
- Sternberg, R. J. (2007). Who are the bright children? The cultural context of being and acting intelligent. *Educational Researcher*, 36(3), 148-155.

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Future Work

I will continue to use the Rocket Car PBL to teach Physics as well as give my students experience with practices commonly used in industry. I will also design PBL units for my other topics. Due to my particularly positive experience, I intend to spread the good word as far and wide as possible about the benefits of PBL.