Key features of a Problem-Based Math Lab

1. Highly constructivist, inquiry based
2. Open ended problems worked over time
3. Highly tiered problems for maximum differentiation for diverse ability levels
4. Student autonomy
5. Emphasis on collaboration and communication (written and verbal) of math processes and analysis.
6. Classroom seating arranged for cooperative groups.
7. Emphasis on multiple approaches to problem solutions
8. Focus on mathematical habits of mind and developing student temperaments that build more effective math students in all math learning
9. Opportunity for students of diverse academic skill capacities (testing vs. writing vs. speaking etc.) to communicate what they know and show what they can do.

What capacities does it build in our students? How does it help our bottom line for learning?

1. **Creativity** in mathematical problem solving
2. **Metacognition** – Students learn about their own problem solving styles, habits, reactivity to challenge, self imposed limitations, and how to use that knowledge to become more effective math learners.
3. **Tolerance of ambiguity** – students gain a willingness and comfort level with not knowing or being challenged, and can proceed productively in spite of it.
4. **Authentic "real" mathematical activity,** "grit", tenacity, perseverance, tenacity – students realize that real problems require effort over time and that challenge and struggle is the norm and not the sign of some dysfunction or inadequacy.
5. **Self direction and autonomy** – students gain the habit of independently choosing multiple resources and tools on their own.
6. **Collaborative inquiry** – connecting with partners, parents, family members on the problems is encouraged, and problems are chosen that foster such interaction. Students gain an orientation toward collaboration and greater skills in doing so.
7. **Math communication** – students significantly raise their capacity in how to effectively communicate math concepts, solutions, ideas, etc. in written and verbal forms. This is emerging as a critical skill for success in math and STEM careers, and is increasingly reflected in standardized tests.

How is a“Problem-Based Math Lab implemented in a traditional math classroom?

1. Define the concept and goal to students (and parents)- this is super important as the emphasis on “grappling” and building tolerance of ambiguity can be misconstrued by all
2. Introduce a problem (possibly a full class)
3. Every several days or so, devote part of a class to “math lab”
4. Utilize problems floated in math lab as “do now” moments in class, or for sub days or other moments of down time.
5. Assessment: Students hand in write-ups and/or do presentations
6. Grading: Have math lab problems comprise a percentage of grade for class, as its own category. Typically 15% of the term grade.
7. Think of Math Lab as an alternate class within your regular class, a designated time when learning is done a bit differently.

Typical Math Lab cycle in a classroom

1. **Introduce concept** and purpose of math lab to students.
2. **Explain problem,** answer questions in full only in regard to understanding the problem
3. **Initial work session:** let students struggle/grapple with the problem, do not offer ANY help whatsoever other than clarifying the problem, goal and parameters.
4. **Convene as full class:** all groups share ideas, insights, debate them, use judgement to offer a concrete clue, or let them go back to work session
5. **Second work session:** roam and monitor
6. **Convene as full class:** All groups share. Offer first clues as needed.
7. **Third work session:** roam, monitor, debate/discuss with individual groups
8. **Convene as full class:** if one or more group has solved the problem, refrain from sharing the solution until more have had time with it. On a later class session have students submit solution write-ups and/or do class presentations.

Over-arching process advice for students (and parents!) in math lab:

1. **Math Lab** (special problems of the week) focuses on developing a different and expanded set of skills and capacities from traditional assignments (see list).
2. **Not being able to find an approach to a problem initially does not mean something is wrong** (e.g. its too hard, teacher didn't teach...), it is the way real mathematicians operate.
3. **If one approach does not seem to work, be free to switch to another,** be fluid and consider many possibilities.
4. **Take breaks, don't just stay stuck.** Taking even a 5 minute break and do something else then return to the problem. This can shift your thinking to find approaches that work.
5. **Share and discuss the problem** with classmates, friends and family members.
6. **Draw, doodle, make diagrams and pictures**--this can help you "see" the problem more clearly and make connections. Don't just sit there stewing over it....