



Introducing: Problem Based Learning Honors Courses

In an effort to challenge our strongest math students and to provide them with opportunities to construct mathematical understanding and skill through inquiry and exploration, the Cate Math Department has decided to replace our traditional honors sequence of Honors Geometry, Honors Algebra 2, and Honors Pre-Calculus with a three-year problem-based learning (PBL) curriculum. These courses integrate geometry and algebra, algebra and precalculus, and precalculus and calculus, respectively, spiraling concepts throughout and emphasizing problem solving skills. The courses will use materials developed by Philips Exeter Academy Math Department.

How is PBL different from the traditional honors courses?

Traditionally, a teacher delivers a lesson to explain concepts or demonstrate skills and then assigns problems so students can practice or apply the objectives of that lesson. In Cate's PBL math courses, students explore on their own before discussing an explanation in class the next day. The teacher facilitates group discussion by highlighting important misconceptions, important realizations, and by prompting students to generalize from their solutions. In this way students "discover" mathematical systems through problems rather than being told via lecture.

Why did Cate decide to make this change?

- 1. Inquiry is demanding and we wanted to challenge our strongest students:** A PBL curriculum is an inquiry based curriculum that creates problem-solving scenarios that trigger natural curiosity. A PBL math book has carefully written, carefully placed problems that trigger students' prior knowledge and push students to make conjectures and generalizations, to analyze different perspectives, and to synthesize information. It is always easier for students to just write down what the teacher says a rule or pattern is, but the effortful work the students do to construct their understanding leads to long-term learning.
- 2. Students learn the math, but more importantly, they become adept problem solvers.** Content threads are spiraled throughout the PBL text so students are continually engaging with several content areas simultaneously, rather than studying one topic then moving onto the next. Learning is not compartmentalized and therefore students need to decide on their own what tools and knowledge to try as they begin to make sense of each problem. Students develop resilience and creativity as problem solvers, and they learn to communicate their ideas clearly to each other. This focus on problem solving helps students develop the skills they'll need to be successful on standardized tests as well as in the real-world context of the 21st century.

What will my child's classroom and homework experience be like?

Students are asked to start 8-10 problems every night, and to bring their attempts to solve the problem (complete or not, correct or not) to discuss in class the next day. In class, students sit in a circle, showcasing work on the board using iPads with Apple TV, and talk through specific problem solving strategies, highlight content connections, and seek feedback on alternate methods. Class time is also spent on journaling and group problem solving.

What if my child struggles? Will there be support?

Students will struggle with these problems. The questions are designed to push them to the edge of what they know and can do, and these questions were also designed to be solved in a boarding school environment so there is a lot of support available. First of all, students are encouraged to do their homework with a peer. These problems are often best solved by talking through strategies with a partner. Encourage your child to meet with a classmate in group study areas before study hours. There are also math labs staffed by trained peer tutors three nights of the week, and students may also reach out to meet with their teacher at any time by setting up a meeting that suits both of their schedules.

It may also be reassuring to know that the problem sets are written so that the similar problems appear several times throughout the curriculum. These multiple exposures give students the chance to re-engage with problems over time, as their content knowledge and skills develop, so that even if they don't master something the first time around, they'll have the opportunity to try again.

Will the teachers actually teach?

Teaching a PBL course looks a lot different than a traditional course. The teacher sits with the students in discussion and must be prepared to address the multiple ways students have approached each problem. To prepare for class, teachers solve each problem themselves, read the commentary written by the curriculum's authors, and identify points they want to emphasize as most important. In class, teachers facilitate discussion by highlighting important misconceptions, pushing students to make valuable generalizations, and create opportunities for students to extend the ideas they came up with while doing homework. Teachers also set up a daily journal process and respond in writing to get insight on each student's problem solving process and progression.

Is there another option besides PBL?

Our grade level courses will continue to offer a more traditional approach to math instruction that still emphasizes student-centered discussion and questioning, mathematical reasoning, communication skills, and achievement toward rigorous learning goals.

Why are you offering PBL only as an honors track? Are you planning to adopt PBL for all your math courses?

Problem-based learning places a heavier cognitive load on students than a more traditional curriculum. The problems are difficult. Students are called on daily to demonstrate perseverance in problem solving, critical thinking, productive discussion, and responsibility for their own learning. For this reason, we are offering it only in our honors level courses. We do not currently have plans to adopt PBL for grade-level courses. To do so would involve significant re-writing of the problem sets, which may or may not be a project the Math Department takes on in the future.

Can a student who enters their Cate math program at grade-level gain access to the honors level PBL courses?

Yes, students entering the curriculum at 31H or above will complete transition problems that help bridge the gap between their more traditional prior math course and the PBL course they're entering.

What are the Honors PBL math courses at Cate?

Math 21H - integrating geometry and algebra 2, usually offered to 9th graders who have had an exceptionally strong Algebra 1 background and have not yet had Geometry. Uses PEA Math 2 Book. Offered starting 2017-2018.

Math 31H - integrating algebra and precalculus, usually offered to 10th graders or 11th graders. Uses PEA Math 3 Book. Offered starting in 2018-2019.

Math 41H - an honors course in a lab-based modeling approach to precalculus and calculus usually offered to 11th or 12th graders. Uses PEA Math 41C Book. Offered starting in 2019-2020.

**If you have additional questions, please contact your child's teacher or Annalee Salcedo,
Chair of the Math Department, at 805 684 4127 x 271 or annalee_salcedo@cate.org.**